Transforming Wastewater Management for Small Communities in the Far North District of NZ

Evaluating Electrocoagulation Technology as a Future-Fit Solution

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Disclaimer:
The author and Carbon Neutral NZ Trust declare no financial interest in any electrocoagulation provider, equipment manufacturer, or wastewater service company. This report evaluates electrocoagulation as a class of technologies and does not promote or endorse any specific supplier, proprietary system, or product. All analysis and findings are offered in good faith, based on independent research, technical literature, field data, and community consultation.

He Tuku - An Offering

Maranga mai e te iwi e	Rise up, people,
Whaia te tika i roto i te ngākau	Seek what is right within the heart.
Kei hea ngā hua o te whenua?	Where are the fruits of the land?
Aue, aue te mamae o taku wairua	Alas, alas, the pain of my spirit.
E kore au e mātakitaki	I will not stand by,
I te takanga ki te hē	Watching the fall into wrong.
Kia tūpato	Be cautious,
Whakarongo mai	Listen well,
Maharatia ngā tikanga	Remember the tikanga
A ō tātou tupuna	Of our ancestors.
Ruia atu e, Aue.	Cast it forth, Alas.

Ngāpuhi waiata. Composer unknown.

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Full Disclaimer:

This report was commissioned by Carbon Neutral NZ Trust as an independent assessment of electrocoagulation (EC) for wastewater treatment in the Far North District. It is intended to support informed decision-making by councils, communities, and other stakeholders.

The author and Carbon Neutral NZ Trust do not hold any financial interest in EC technology providers, and the report does not constitute regulatory, legal, or engineering advice. Implementation decisions remain the responsibility of the reader. No liability is accepted for actions taken based on the contents of this report.

A Note on Use of Te Reo Māori:

This report uses reo Māori language terms where appropriate to reflect concepts that do not always have direct English equivalents. Key terms are defined at first use and listed in the glossary.

Section 1: Executive Summary and Key Findings

📌 *Why read this section?*

Elected officials: For a high-level view of the opportunity and challenge. This section summarises the report’s purpose, findings, and recommendations in plain terms.

Council staff: It outlines the scope of analysis and key takeaways that may impact planning, asset management, and infrastructure finance.

Hapū and community: Why this matters for land, water, and people, and how wastewater can become a resource through nutrient and water recovery.

Journalists: This section captures the newsworthy argument: a proven technology overlooked in planning, resurfacing through community-led demonstration, set against the Far North context.

Estimated Reading Time: 5 minutes

Executive Summary

1.1 Purpose

This report, commissioned by Carbon Neutral NZ Trust, evaluates electrocoagulation (EC) as a wastewater treatment option for small and rural communities in the Far North. It compares EC with conventional systems to inform Far North District Council (FNDC) investment and consent decisions.

1.2 Context

FNDC operates 15 wastewater treatment plants, most built around oxidation ponds. These systems are ageing, inconsistently maintained, and poorly suited to today's contaminants such as pharmaceuticals, hormones, and microplastics. Compliance is patchy, public confidence is low, and hapū continue to oppose discharge of human waste to water. At the same time, regulation under the National Policy Statement for Freshwater Management is tightening, costs are rising, and the small rating base makes large conventional upgrades unaffordable.

1.3 Key Findings

- **Technology performance:** EC achieves high removal rates for suspended solids, nutrients, and pathogens, with smaller sludge volumes and stable operation under variable loads.
- **Financial viability:** Modular EC systems typically cost $50,000–$500,000 to build and $0.30–$0.50/m³ to operate. At a community scale, this equates to $33–$50 per person annually, significantly less than recent multimillion-dollar conventional upgrades.
- **Resource recovery:** EC produces fertiliser-grade nutrients and safe irrigation water, reframing wastewater as a resource.
- **Cultural alignment:** EC supports land-based discharge, consistent with tikanga Māori (customary practices and protocols) and long-standing, increasing community opposition to discharges-to-water.
- **Governance and Trust:** Narrow decision frameworks and the stalled commissioning of FNDC's own pilots have eroded confidence. Rebuilding confidence will require broader evaluation criteria and independent oversight.

1.4 Conclusions

Electrocoagulation offers a technically viable, economically realistic, and culturally aligned alternative to conventional wastewater treatment in the Far North. Demonstration at community scale is essential to confirm performance under continuous-flow conditions.

Ultimately, the Far North District Council has the opportunity to lead by getting real about what works, and set a precedent for how small communities across Aotearoa can reimagine wastewater management.

1.5 Recommendations

Immediate (next 12 months)

1. **Enable EC pilots at Rāwene and Taipā.** Commissioning and operating these systems should be treated as a priority to generate real-world data at community scale.

2. **Broaden evaluation criteria.** Move beyond capital cost alone to include lifecycle value, resilience, nutrient recovery, and cultural alignment.

3. **Establish independent technical oversight.** Partner with a kaupapa-aligned advisory group that can strengthen decision-making and rebuild trust.

4. **Expand EC deployment to high-risk FNDC plants.** Target small, resource-constrained communities to reduce non-compliance, operational burden, and reliance on costly centralised infrastructure.

Medium Term (2–3 years)

5. **Engage with Te Taumata Arowai on regulatory settings.** Work to ensure decentralised and low-toxicity systems are enabled within performance-based consent frameworks.

6. **Trial modular EC systems in papakāinga and marae settings.** Support hapū-led initiatives where local infrastructure can reduce pressure on centralised schemes.

7. **Undertake lifecycle financial modelling.** Include avoided infrastructure costs, health benefits, nutrient recovery value, and financing options to inform investment pathways.

Longer Term (3–5 years)

8. **Develop nutrient recovery opportunities.** Explore market or community reuse pathways for EC-derived fertiliser and soil conditioners, supporting both environmental and economic outcomes.

Section 2: Introduction

📌 *Why read this section?*

Elected officials: The local context in plain view, why the Far North is at a turning point, and the different path this report sets out.

Council staff: What the study covers, how the methodology works, and why it maps to FNDC's real world infrastructure challenges.

Hapū and community: It traces the local history of wastewater issues and how hapū and communities are already leading solutions, including what's been ignored.

Journalists: How centralised assumptions came to dominate the sector and the challenge this report puts on the table.

Estimated Reading Time: 6 minutes

2. Introduction

2.1 Background and Drivers (Regulatory, Environmental, Cultural, Financial)

Wastewater management in the Far North is under pressure from multiple fronts. The National Policy Statement for Freshwater Management (NPS-FM) embeds '*Te Mana o te Wai'*, requiring councils to prioritise the health of freshwater ahead of other uses[1]. The establishment of Water Services Authority | Te Taumata Arowai as the new water services regulator has further reinforced that discharges must meet higher environmental and cultural expectations[2].

At the same time, the composition of wastewater has shifted. Systems built in the 1970s and 1980s were designed primarily for faecal matter and food residues. Today's wastewater contains pharmaceuticals, hormones, microplastics, and chemical residues that were not part of earlier design assumptions and are not effectively removed by pond systems[3].

Cultural drivers are equally significant. Hapū (kin groups with ancestral authority) and iwi (Māori tribal collectives) across the Far North have consistently opposed discharges of human waste to water, asserting that wai (water) is a taonga (treasure) with its own mauri (life essence) and mana (authority)[4]. This position has been recognised in recent consent processes. In 2020, Hokianga groups petitioned the Northland Regional Council to have the Ōpononi–Ōmāpere wastewater consents publicly notified[5]. In 2023, commissioners to the Ōmāpere hearings criticised FNDC for not adequately evaluating land-based options before proposing continued discharge to water[6].

Financial constraints compound these issues. The district has a small and dispersed rating base, making it difficult to fund conventional upgrades. The most recent Kerikeri upgrade cost $27.1 million and required external subsidies[7]. Replicating this model across the district is unrealistic and would impose unsustainable burdens on ratepayers.

2.2 Objectives of the Evaluation

This evaluation has been commissioned by Carbon Neutral NZ Trust to provide an independent, evidence-based assessment of electrocoagulation (EC) as a wastewater

[1] Ministry for the Environment, *National Policy Statement for Freshwater Management 2020*.
[2] Te Taumata Arowai, *Regulatory Approach Statement*, 2021
[3] Coxon, S., & Eaton, C. (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater.* Institute of Environmental Science and Research (ESR)
[4] See Appendix A3 for extended background explanation
[5] Northland Regional Council (2020). *Council Meeting: Public Forum – Petition from Hokianga Environmental Forum*, Item 3.0, 21 July. Document ID: A1332672.
[6] Northland Regional Council (2023). *Combined Report and Decision of Independent Hearing Commissioners – Ōmāpere WWTP Consent Hearing*
[7] FNDC, *Kerikeri Wastewater Treatment Plant Upgrade Business Case*, 2018

treatment option for the Far North District[8]. The Trust has long advocated removing treated wastewater from waterways. It commissioned this work after conventional upgrades repeatedly failed to deliver outcomes that are affordable, culturally appropriate, or environmentally sustainable (see Appendix C for further detail).

The purpose of the evaluation is to test whether EC can offer FNDC a credible alternative. Specifically, the objectives are to:

- Assess EC's technical performance in removing key contaminants under New Zealand conditions.
- Examine the financial implications of EC, including indicative capital and operating costs, lifecycle value, and potential for nutrient recovery.
- Consider EC's alignment with hapū (kin groups with ancestral authority) and iwi (Māori tribal collectives) aspirations for land-based discharge and protection of the mauri (life essence) of wai (water).
- Compare EC with conventional treatment systems currently used in the Far North district.
- Provide recommendations to inform FNDC's future wastewater investment and consent decisions.

2.3 Methodology and Evidence Sources

This report brings together multiple forms of evidence to assess the viability of electrocoagulation (EC) for wastewater treatment in the Far North. It considers both technical performance and cultural acceptability, with a focus on small and rural communities.

The scope includes:

- Literature and data: scientific studies on wastewater treatment and EC, including contaminant removal, nutrient recovery, sludge management, and system scalability.
- Pilots and field evidence: site-level data from EC systems in Aotearoa, including batch and continuous-flow trials at Taipā and Kerikeri.
- Community perspectives: oral accounts, hui (gatherings), and submissions from hapū and whānau (family), alongside reflections grounded in mātauranga Māori (indigenous Māori knowledge systems).

Analysis draws on technical literature, council reports, consent processes, and community experience. It is intended to inform council decision-making while also supporting hapū and

[8] An introduction to Carbon Neutral NZ Trust is provided in Appendices to this report.

community advocacy. The assessment is technology-neutral, with no commercial suppliers involved in drafting or reviewing.

All research, analysis, and drafting were undertaken by the author. Standard digital tools (e.g. reference management, statistical software, and language support programs) were used to aid clarity and accuracy, but authorship and conclusions remain the work of the author.

Section 3: Current Wastewater Management in the Far North

📌 *Why read this section?*

Elected officials: This is where the stakes are made plain: health, environment, cost, and culture. It shows the systemic choices that kept the district stuck and why the status quo is no longer tenable.

Council staff: Evidence-based detail on what's in our wastewater, where risks are rising, and why standards will demand new responses.

Hapū and community: This section brings tikanga and lived experience alongside technical evidence, recognising mātauranga as essential knowledge for safer, more just wastewater choices.

Journalists: The human story of wastewater, why the current systems fail: policy and funding settings that favoured conventional designs, and missing national standards for contaminants of emerging concern.

Estimated Reading Time: 10 minutes

3. Current Wastewater Management in the Far North

3.1 Overview of FNDC Wastewater Treatment Plants

FNDC operates 15 wastewater treatment plants across its district, which covers 6,690 km^2. These systems vary widely in size and process. Larger facilities, such as Kaitāia and Kerikeri, serve several thousand residents, while others, such as Kohukohu and Rangiputa, serve populations of fewer than 500 (Appendix B, Table B.1).

The predominant treatment process remains oxidation ponds, often coupled with constructed wetlands. Some sites have received partial upgrades. Russell uses a sequencing batch reactor, Paihia hosts a proprietary Bio-Shell® bioreactor system, and Kerikeri underwent a significant upgrade in 2020[2]. Despite these interventions, the majority of FNDC plants remain pond-based and constrained by their original design.

Wastewater: a Complex and Evolving Stream

Wastewater is both a chemical and cultural signature of how communities live, what they consume, and how they are served by infrastructure. At its core, wastewater still contains the expected biological materials: faecal matter, food scraps, and organic residues. But in practice, it carries far more. Pharmaceuticals, cleaning agents, microplastics, illicit drugs and their metabolites, hormones, and synthetic compounds now flow daily through household and community networks.

The long-term impacts of such contaminants, including their accumulation in ecosystems and transformation into toxic by-products, are still being understood. What is already clear is that the risks are intergenerational, and that existing systems were never designed with these compounds in mind. Oxidation ponds and other conventional technologies cannot reliably address them.

Appendix A: Wastewater and Its Constituents provides further detail on ecological and public health risks associated with these contaminants, and demonstrates how research and regulatory capability is still catching up with exposure patterns.

3.2 Performance and Compliance Record

Compliance monitoring between 2020 and 2024 shows variable and often poor performance. Only one or two of FNDC's plants consistently achieved full compliance across this period (Appendix B, Table B2). Most sites, including Ahipara, Ōpononi, and Whatuwhiwhi, recorded repeated exceedances of nutrient and pathogen limits. Even upgraded facilities such as Kerikeri and Kaitāia occasionally failed to meet consent conditions.

This record highlights both systemic weaknesses (discussed further in section 3.4) and institutional shortcomings within the Council, including a lack of in-house technical expertise and inadequate maintenance. Reliance on external advisers left FNDC reactive rather than proactive, preventing improvements in plant performance even within the limited resources available.

3.3 Regulatory and Policy Settings - Critical Gaps in NZ Approach

FNDC's wastewater systems operate within the broader regulatory frameworks of the Resource Management Act, the National Policy Statement for Freshwater Management (NPS-FM), and the oversight of the Water Services Authority | Te Taumata Arowai. While these frameworks have been reformed repeatedly over the past 30 to 40 years, critical gaps remain.

There are still no consistent national standards for pollutants such as microplastics, pharmaceuticals, or nutrient levels beyond those specified for drinking water and contact recreation. This means a system may be judged "compliant" while discharging substances that affect ecosystems and human health.

Regulation also continues to be treated as the sole marker of credibility, sidelining mātauranga Māori despite it being able to provide credible scientific and technical insight into water safety and treatment. Permit applications are assessed primarily on cost and engineering feasibility, while demonstrated performance from innovative approaches receives little recognition.

This compliance paradigm discourages innovation. Councils and consultants are incentivised to remain within the safety of conventional design codes, because new technologies lack clear regulatory pathways. As a result, promising approaches such as electrocoagulation have been excluded from feasibility studies or discounted in option assessments, regardless of their performance record.

Internationally, the regulatory discourse has shifted toward systems that recover water, nutrients, and energy as part of a circular economy model. By contrast, New Zealand remains bound to a framework that permits ongoing discharges to waterways, leaving communities and future generations to carry the burden of a system that effectively licences harm and exposes ecosystems and people to risks that compliance alone cannot resolve.
See Appendix A1-A2 for extended background explanation on wastewater and regulatory settings.

3.4 Limitations of Historical Funding and Policy Settings

A review of historical funding and policy settings (Appendix A4) shows that funding patterns created clear incentives for conventional design choices. Systems that conformed to existing codes and engineering practice were more likely to be subsidised and approved, while decentralised or innovative options such as EC lacked policy recognition and were often excluded from feasibility studies[9].

[9] Harrison Grierson (2020) "Kaitaia and Kaikohe WWTP Options Assessment". Report for FNDC

As a result, wastewater planning in the Far North defaulted to centralised, multi-community infrastructure built around gravity-fed systems and oxidation ponds, even in landscapes where geographic, cultural, or hydrological conditions called for different approaches.

In this context, it is unsurprising that EC was not considered. Its modularity, low footprint, and nutrient recovery potential did not align with funding priorities or evaluation frameworks of the time. Only now, as councils face pressures ranging from climate adaptation to cultural redress, and from affordability to decentralisation, is the potential of such technologies being re-evaluated.

3.5 Electrocoagulation Pilots: Rāwene and Taipā

The electrocoagulation (EC) pilot projects at Rāwene and Taipā represent pioneering efforts to validate EC technology for community-scale wastewater treatment within the Far North District. These pilots are instrumental in transitioning from small-scale and batch trials toward continuous, operational systems that can support full township wastewater needs.

Significance
Rāwene and Taipā provide real-world environments to assess EC’s technical performance, operational resilience, and compliance with evolving regulatory frameworks. Success at these sites will demonstrate EC's capacity to meet cultural expectations, including supporting land-based discharge and enabling resource recovery, while addressing the specific environmental and infrastructural challenges of rural settlements.

Challenges
Despite promising results, both pilots have faced barriers that have delayed commissioning and scale-up:

- Site-specific constraints: At Rāwene, delays in connecting power cables to the solar array (funding-related) have stalled start-up. At Taipā, insufficient desludging of settlement ponds (again due to funding limitations) and delays in implementing required independent, real-time monitoring has held back progress.

- Resource limitations: Limited local technical expertise and maintenance capacity have constrained consistent operation.

Unlocking the value of EC in the Far North depends on overcoming these issues. Once resolved, the pilots can provide the definitive proof points needed to inform wider adoption and investment.

At the time of writing, neither pilot had commenced full operation, despite all equipment being in place.

Section 4: Electrocoagulation Technology Overview

📌 *Why read this section?*

Elected officials: How EC restores compliance quickly, turns waste into irrigation water and nutrients (revenue), reduces operational burden, and enables staged rollout that is climate resilient.

Council staff: How EC achieves fast compliance, integrates with existing assets, supports land application, lowers sludge and truck movements, and uses remote monitoring for reliable operation.

Hapū and community: What changes on the ground: cleaner outputs for whenua irrigation, fewer trucks, small footprint that suits papakāinga and marae, and real-time, remote monitoring. Why its small footprint and modular units suit papakāinga and marae, including off-grid setups, and how nutrients and water can be returned to Hine-ahu-one to whakanoa te wai.

Journalists: If you're writing on innovation, local infrastructure, or climate-smart upgrades, this is where the 'what's-not-to-like', transformational story lives.

Estimated Reading Time: 20 minutes

4. Electrocoagulation Technology Overview

4.1 Process Description and Operating Characteristics

Core Process

Electrocoagulation (EC) is a wastewater treatment process that uses a low-voltage electric current to remove contaminants (Figure 1). When current is applied across submerged metal plates, typically made of iron or aluminium, metal ions are released into the water. These ions bind with suspended solids, nutrients, and pathogens, forming larger particles known as flocs. These flocs can then be removed through settling, filtration, or flotation. The process does not require chemical additives and can be scaled to suit small or dispersed communities.

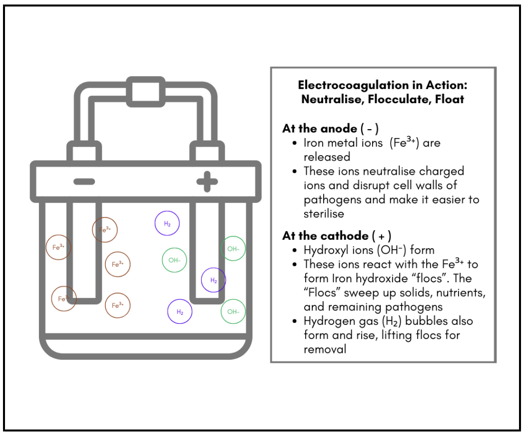

Figure 1: Illustration of electrocoagulation process

Process Flow

Before entering the EC chamber, wastewater may pass through a settlement tank or screen to remove coarse solids and grit (Figure 2). This step reduces wear on electrodes and supports stable performance.

After treatment, the process generates flocculated solids that require handling. These solids (nutrient-rich resource) can be settled in a clarifier, collected in a holding tank, or dewatered using a screw press, geobag, or drying bed depending on the site and intended reuse. The clarified stream (irrigation water), depending on its quality and receiving environment, may then be irrigated or further polished through filtration or disinfection.

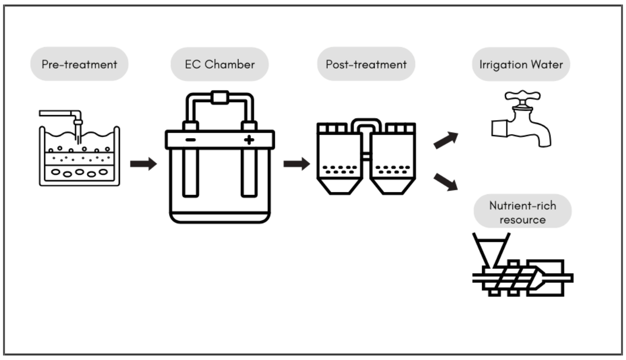

Figure 2: Illustration of EC within a typical process flow

System design depends on factors such as land availability, consent conditions, community size, and cultural preferences. In general, EC significantly reduces the scale and complexity of downstream treatment stages. Where well integrated, EC provides a relatively compact option that communities may adapt for land-based discharge or soil conditioning.

Sludge Management and Pre-/Post-Treatment

Electrocoagulation generates flocculated solids (sludge) by binding contaminants into larger particles. This sludge volume is significantly lower than that produced by conventional biological systems because EC does not rely on biomass growth. However, proper handling of this sludge is essential. Pre-treatment steps typically include a settlement tank or coarse screening and are used to remove large solids and grit before EC treatment. Post-treatment commonly involves sedimentation, or clarification to separate flocculated solids from the treated water, followed by optional dewatering processes such as pressing, drying beds, or use of geobags. These steps prepare the sludge for safe disposal, composting, or land application, depending on site-specific permits and reuse goals. Managing sludge efficiently reduces environmental risks and ongoing operational costs while supporting resource recovery objectives.

Remote Monitoring and Operational Efficiency

Modern EC systems often include advanced remote monitoring and automated control capabilities. These enable continuous tracking of critical parameters such as water quality, flow rates, and electrode condition. Remote access allows operators to detect faults early, optimize treatment performance in real time, and schedule maintenance based on actual system needs rather than fixed intervals. This reduces unnecessary site visits and associated costs, which is particularly valuable for decentralized or rural wastewater systems with limited on-site technical support. Additionally, remote data logging facilitates regulatory compliance and supports efficient troubleshooting through off-site diagnostics and technical assistance.

Operating Advantages

EC systems offer a number of operating advantages that make them well suited to rural or decentralised environments. Treatment occurs quickly, often in minutes rather than hours or days, allowing for smaller system footprints and more predictable output. Because EC does not rely on biological processes, it is less affected by temperature changes, intermittent use, or shock loading. This makes it suitable for papakāinga (communal housing), marae, or remote sites where flow rates may vary.

Energy and Power Requirements

Power requirements are low and can be met through standard supply or small-scale solar systems. Operation involves applying a low electrical current across the electrodes, with most systems drawing between 0.3 and 0.6 kilowatt-hours per cubic metre depending on water quality and treatment goals.

Modularity and Deployment

EC systems are modular and can be deployed at scales ranging from individual households to community-wide networks. They can operate in either batch or continuous flow mode, and they integrate easily with both existing infrastructure and new builds. Their compact-ness and simple operation allow for staged deployment that in turn enables councils and communities to invest gradually rather than committing to large, upfront infrastructure upgrades.

Maintenance and Electrode Lifespan

Maintenance typically includes periodic inspection, basic cleaning, and replacement of electrode plates as they gradually degrade through use. Electrode plates are consumable components that degrade over time due to oxidation. Typical lifespan ranges from 3 to 12 months depending on influent quality, flow rate, electrode material, and maintenance schedule. Replacement costs are included in the operating cost estimates provided in Section 5.4.2. Site-specific design and monitoring will determine optimal replacement intervals.

4.2 Performance in Removing Key Contaminants

Appendix D, Table D.1 summarises the performance of electrocoagulation across a range of key pollutants, including suspended solids, nitrogen, phosphorus, pathogens, and selected emerging contaminants. In most categories, EC matches or exceeds the removal rates achieved by conventional biological systems.

Suspended solids and phosphorus
EC achieves very high removal efficiencies for both suspended solids and phosphorus, typically above 90 percent. These are the two parameters most closely linked to visible water quality impacts, and they are also the areas where conventional pond systems perform poorly. Consistently high phosphorus removal makes EC particularly suitable in catchments where nutrient enrichment is driving algal blooms or degrading estuarine environments.

Nitrogen species
Ammoniacal nitrogen and nitrate are both effectively reduced when systems are operated at appropriate pH levels and with sufficient retention time. Removal rates are high enough to support compliance with land-based discharge standards. This is a critical advantage, as nitrogen is one of the most frequent causes of non-compliance across FNDC plants.

Pathogens
EC systems reliably achieve major reductions in faecal indicator bacteria such as *E. coli*. Levels in treated effluent consistently meet or exceed thresholds required for safe land application. This pathogen removal capacity not only reduces environmental risk but also lowers the likelihood of human health impacts associated with exposure to wastewater in small communities.

Emerging contaminants
EC has also shown promising results for a range of contaminants that conventional systems cannot address. Pilot data and international case studies report significant reductions in pharmaceutical compounds, microplastics, and endocrine-disrupting chemicals. While treatment of highly persistent contaminants such as PFAS generally requires complementary processes, EC remains a strong candidate for most standard and emerging wastewater profiles.

Comparative system characteristics
Appendix D summarises comparative system characteristics; detailed assessment is provided in Section 5 of this report.

4.3 Resource Recovery and Circular Value

A distinctive feature of electrocoagulation is its ability to recover resources from wastewater. In addition to contaminant removal, EC separates influent into two distinct outputs:

- a clarified effluent suitable for irrigation or land application; and
- a concentrated nutrient stream rich in nitrogen, phosphorus, and potassium.

This dual outcome transforms wastewater from a disposal burden into a productive input, creating local value and aligning with circular economy principles.

For councils, this reframing is significant. Nutrients recovered through EC reduce reliance on imported synthetic fertilisers, which carry both economic and environmental costs. Local reuse options, such as agricultural application or community gardens, allow nutrients to be cycled back into land and improve productivity. At the same time, the irrigation water supports safe land-based discharge, directly addressing cultural expectations that wastewater not be returned to rivers or harbours.

Evidence from OraOra Retreat in Kerikeri demonstrates the viability of this approach. The site has operated a continuous-flow EC system since 2021. Sampling over three years shows consistent partitioning of nutrients into a fertiliser-grade outlet line (Appendix C, Table C.1). Certificates of Compliance have been received for the irrigation stream following electrocoagulation, confirming that pH, ammonium, nitrate, phosphate, and E. coli levels meet food safety standards for garden produce.

At a community scale of 500 people, the nutrient concentrate produced through EC equates to fertiliser value estimated between $6,500 and $10,000 annually[10]. While markets for EC-derived fertiliser products are not yet established in New Zealand, international precedents suggest this could become a material benefit. Even without formal commercialisation, direct reuse of recovered nutrients can reduce costs for local growers, marae, or community gardens.

4.4 Energy and Emissions Profile

The energy demand of electrocoagulation varies with influent quality, treatment objectives, and system configuration. International studies[11] report average use between 0.3 and 0.6 kilowatt-hours per cubic metre, while NIWA's 2018 trial of pond effluent at Taipā estimated around 1 kilowatt-hour per cubic metre under conservative assumptions[12]. Energy use is predictable and scales with volume, allowing councils to estimate operating costs with confidence.

These figures compare favourably with mechanical-biological reactors, which are typically more energy intensive, and are broadly similar to low-energy surface aeration systems. Unlike ultraviolet disinfection or chemical dosing, EC achieves pathogen removal and nutrient capture through physical processes. This reduces reliance on chemical inputs and the carbon footprint associated with their manufacture and transport.

Because EC systems are modular and operate on low-voltage power, they can be integrated with solar generation or operate off-grid in remote areas. The ability to pair treatment with local reuse of water and nutrients further reduces transport-related emissions, including those associated with sludge removal, fertiliser imports, and centralised disposal.

While electricity demand remains an important factor in lifecycle performance, the emissions profile of EC compares well with conventional infrastructure. The advantages are most significant where the alternative involves energy-intensive mechanical upgrades or ongoing discharges to sensitive water bodies.

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[10] Ballance Agri-Nutrients. (2024). *Product Catalogue and Regional Pricing*.
[11] Butler et al. (2011) "Electrocoagulation in Wastewater Treatment" *Water*
[12] NIWA (2018) *Electrocoagulation of Wastewater Treatment Pond Effluent*, prepared for FNDC

4.5 Local, National, and International Case Studies

Local Trials

The Far North District has already taken steps to explore the potential of electrocoagulation. In 2018, NIWA and Beca conducted a pilot trial at Taipā using pond effluent[13]. The system was tested in batch mode across three pond stages and achieved significant reductions in ammonium, nitrate, phosphate, and pathogens. Although the trial did not involve continuous flow, it demonstrated a clear capacity for performance in local wastewater profiles and confirmed EC's ability to address the key contaminants driving non-compliance across FNDC plants.

Community-Scale Operation

OraOra Retreat in Kerikeri provides New Zealand's first continuous-flow, integrated EC system. Commissioned in 2021, it has operated for several years across seasonal variations. The system reliably produces a stabilised irrigation stream that meets discharge guidelines and a concentrated nutrient outlet suitable for land application (Appendix C). Certificates of compliance confirm that outputs meet food safety standards for garden produce. This example demonstrates EC's readiness for real-world operation and its ability to provide dual outcomes of safe discharge and resource recovery.

International Examples

Internationally, EC has moved well beyond pilot scale. In Turkey, a municipal EC plant serving 17,500 people reported operating costs between $0.44 and $0.52 per cubic metre, with strong reductions in chemical oxygen demand (COD), biochemical oxygen demand (BOD), and suspended solids[14]. In Northern Greece, a smaller EC system demonstrated reliable COD reduction and energy autonomy through solar integration[15]. Both systems confirm that EC can operate effectively under continuous flow, adapt to varying climates, and make use of locally available resources.

Implications for FNDC

Together, these examples confirm that EC is not experimental but a proven technology adaptable to both small community clusters and larger settlements. The Taipā and OraOra evidence provides a strong local foundation, while international systems demonstrate scalability and cost competitiveness. For FNDC, the challenge is no longer whether EC works, but how to translate proven performance into district-wide application.

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[13] BECA Ltd (2020) *Electrocoagulation Wastewater Treament Plan: Evaluation for Taipā Wastewater Treament Plan*. Prepared for FNDC

[14] Koyuncu et al (2020). Domestic wastewater treatment by real-scale electrocoagulation process. *Water Science & Technology*, 81(4), 656–667

[15] Marmanis, D., et al. (2022). *Electrocoagulation for Municipal Wastewater Using Photovoltaics: Northern Greece Case Study*. Sustainability, 14(7), 4323

Section 5: Comparative Assessment

📌 *Why read this section?*

Elected officials: Side by side outcomes to inform a clear choice on safety, reliability, and fit for small towns and a clear-eyed reflection on risks, limitations, and knowledge gaps (that are within your power to resolve).

Council staff: Performance and O&M reality check: EC holds under variable loads and seasons, produces less sludge, shows predictable \$0.30–\$0.50 per m^3 operating costs, and flags practical limits.

Hapū and community: Which option supports land based use, local control, and dependable service.

Journalists: The pivot story: city-scale upgrades that price out small towns versus modular EC built for rural budgets and consents; who wins on compliance, who pays, and what the pilots still need to prove.

Estimated Reading Time: 5 minutes

5. Comparative Assessment

5.1 EC vs Conventional Systems

Pond-based systems, which make up most of FNDC's plants, can reduce suspended solids and biochemical oxygen demand under stable conditions. They are, however, poorly suited to deal with contaminants characteristic of today's sewage waste profile. Even with well-maintained constructed wetlands in treatment series, evidence shows that they remain limited in the types of contamination that they can treat.

As shown in Appendix D, Table D.1, Electrocoagulation achieves consistently higher removal rates for suspended solids, phosphorus, and pathogens, and does so within a compact footprint. Its performance holds steady under variable loads and seasonal temperature shifts, in contrast to pond and biological systems, and it generates smaller, more manageable sludge volumes. Strong results are reported for EC's ability to treat contaminants of emerging concern such as pharmaceuticals, endocrine-disrupting chemicals, and microplastics, where conventional systems remain limited. For pathogens and viruses, EC achieves removal rates in the 90–99% range, exceeding the moderate and variable reductions typical of pond or biomechanical systems.

Cost performance comparisons in Appendix D, Table D.2, likewise show clear advantages for EC over conventional treatment systems. Large centralised upgrades such as sequencing batch reactors carry significant capital and operating costs. By contrast, EC's modular design allows infrastructure to be scaled to need without over-investment, with operating costs consistently reported in the $0.30–$0.50 per cubic metre range. Other operational factors also favour EC: its low climate sensitivity avoids expensive over-design, treatment occurs in hours rather than days, and modern units enable remote monitoring that reduces staffing and site visit costs.

5.2 Suitability for Small and Rural Communities

The Far North is not uniform in its needs. Some townships are growing rapidly, while others are maintaining steady or declining populations, or have to support populations that fluctuate significantly over holiday season. Some have access to skilled technical labour and grid connections, while others live effectively off-grid. EC is shown to accommodate these differences. It can be right-sized to meet changing load demands, its process operating parameters can be adapted quickly to deal with changes in the waste profile, and it is capable of being scaled up or adapted as community needs change.

Its modularity, small footprint (the pilot plant at Rawene is housed in a 20, and 10-ft container), and stable energy profile lend the EC technology further to being suitable for remote, dispersed, or environmentally constrained locations such as those observed in the Far North district.

Equally and from a long-term financial risk perspective, modularity, scalability, and remote operability become increasingly important considerations as we look forward to more severe weather systems and flooding impacting our ability to access parts of the district.

In this context, EC's ability to be staged, relocated, or replaced in parts provides resilience that larger centralised conventional systems cannot.

5.3 Risks, Limitations, and Knowledge Gaps

Like any technology, EC has limitations. The electrodes are consumable components and require periodic replacement, typically every three to twelve months depending on influent quality and flow conditions. The cost is predictable but minor in consideration and is included in the estimates for ongoing operational expenses.

Electrocoagulation will require supplementary processes to deal with more complex contaminants such as PFAS. While this limitation is not unique to EC, it highlights the importance of pairing the technology with complementary treatment where these compounds are found to be of concern.

The most significant knowledge gap in the New Zealand context is the lack of long-term continuous-flow data at township scale. The OraOra Retreat system demonstrates viability at household-cluster scale, and the 2018 Taipā trial confirmed performance under batch conditions. However, FNDC's pilots at Rāwene and Taipā remain critical to validating EC under local conditions. Commissioning and monitoring the pilot is urgent to confirm performance, improve understanding of operating parameters for EC deployment at community scale, and developing training.

Section 6: Financial and Ratepayer Implications

📌 *Why read this section?*

Elected officials: What this option costs, what it saves, and how to stage investment so rates stay manageable. Funding levers you can use now.

Council staff: Budget inputs you can plug in today. Capex and opex bands, per person impacts, electrode and sludge assumptions, and how modular staging reduces risk.

Hapū and community: What it means for household bills. Where savings show up from less sludge and local reuse of nutrients, and how staged rollout avoids overbuilding.

Journalists: The money story. Real costs, hidden costs councils often miss, and the funding tools that make small town solutions viable.

Estimated Reading Time: 20 minutes

6. Financial and Ratepayer Implications

6.1 Indicative Capital and Operating Costs

Capital Costs

Based on current New Zealand market data, modular EC systems with treatment capacities between 20 and 150 cubic metres per day typically require capital investment between $50,000 and $500,000, excluding GST, transport, or installation[16]. These estimates cover the treatment unit and optional solids separation components.

When expressed per capita, communities of 100 to 500 people are likely to face capital costs between $650 and $1,200 per person. These figures assume a design flow of 200 litres per person per day and include a safety factor of 1.5. They are significantly lower than the cost of proposed centralised upgrades in the district, which have been estimated in the range of several million dollars for comparable populations[17].

If amortised over a 20-year asset life, this equates to an annualised burden of approximately $50 per person per year. A 30-year horizon reduces this to around $33 per person per year. These variations reflect standard local government asset planning assumptions and illustrate how financial modelling choices influence ratepayer impact.

Electrocoagulation systems also provide a stable and modular capital profile. Unit sizes and costs increase predictably with flow requirements, which supports staged investment aligned to community growth and funding availability. EC avoids the step-in costs and long design lead times typical of centralised upgrades, making it a practical option where scale, resilience, and timing matter.

Operating Costs

Operating costs for EC are modest and stable. International trials and local application at OraOra Retreat suggest typical costs between $0.30 and $0.50 per cubic metre treated[18]. This includes electricity, routine maintenance, sludge management[19], and periodic replacement of electrode plates[20].

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[16] Confidential supplier pricing provided to Carbon Neutral NZ Trust
[17] BECA Ltd. (2020). *Review of Small Community Wastewater Treatment Options in the Far North District*
[18] This range ($0.30–$0.50/m³) is derived from observed performance at OraOra Retreat and NIWA's small-scale modelling (low end), and the Turkey case (mid-scale). The upper limit of $0.52/m³ from the Turkey case is excluded to account for uncertainty in cross-jurisdictional cost structures (e.g. labour and energy pricing). The NIWA large-scale cost of $0.21/m³ is not included in the "typical" range, as it reflects larger systems than are likely to be adopted in the Far North initially.
[19] Sludge management costs are included in the estimated operating range. EC sludge volumes are typically lower than those from biological systems and can be managed with low-tech, decentralised solutions, particularly at small scale
[20] Electrode lifespan typically ranges from 3 to 12 months depending on influent quality, electrode material, and system operation. These assumptions are reflected in the per-cubic metre cost estimates.

Electrodes are consumable components that wear through oxidation during treatment. Lifespan typically ranges from three to twelve months, depending on wastewater quality, flow, and maintenance schedules. Replacement costs are factored into operating estimates, ensuring predictable and manageable expenses.

Sludge management adds some cost but remains lower than for biological systems. EC generates smaller volumes of inert, easily dewaterable solids. Handling options include sedimentation, pressing, composting, or controlled land application, depending on site permits. Pre- and post-treatment such as screening and settlement are standard inclusions in cost estimates and contribute to stable performance.

Based on average household water use of 200 litres per day, this results in an estimated annual operating cost of $22 to $34 per person. This compares favourably with many conventional systems, which often involve higher energy demand, chemical inputs, or external sludge disposal costs.

Evidence from both Aotearoa and international case studies reinforces these findings:

- OraOra Retreat (~1.2 m^3/day): $0.30–$0.33/m^3
- NIWA small-scale modelling (548 m^3/day): $0.33/$m^3$
- Turkey municipal plant (~3,500 m^3/day): $0.44–$0.52/m^3
- NIWA large-scale modelling (20,000 m^3/day): $0.21/$m^3$

Collectively, these data points show that operating cost per cubic metre decreases as flow increases, reflecting typical economies of scale. While this relationship is clear, site-specific design and cost modelling will be required at the implementation stage, as local factors such as energy pricing, staffing, system integration, and consent conditions will influence outcomes.

6.2 Cost-Benefit Considerations

Electrocoagulation (EC) systems present a financially realistic alternative to conventional wastewater treatment infrastructure. This is especially relevant for small communities where existing systems face compliance issues or where larger upgrades have been costed beyond reach. EC systems offer modular design, low operational costs, and the potential for discharge to land, which can reduce long-term environmental and financial burdens.

The capital and operating cost ranges outlined above are based on live system performance, published modelling, and international case studies. While these figures are suitable for indicative planning, councils are encouraged to undertake site-specific financial modelling and sensitivity analysis prior to procurement. This is necessary to validate assumptions about asset life, electrode replacement cycles, sludge management requirements, and cost-per-capita outcomes.

Note: The examples provided here use assumptions common in New Zealand infrastructure planning. Far North District Council has not publicly disclosed the asset life or financial modelling parameters it applies to wastewater treatment plant assets. Further engagement will be required to confirm alignment with Council's specific planning and funding frameworks.

Avoided Costs
Beyond direct expenditure, EC provides wider economic benefits by reducing hidden or downstream costs. Conventional upgrades impose ongoing costs for sludge disposal, chemical inputs, and energy demand. They also carry health risks where pathogens are not consistently removed, with costs borne by households and the public health system. Large centralised upgrades further lock small communities into debt that is disproportionate to their rating base.

Nutrient Recovery and Circular Value
Evidence from OraOra Retreat highlights the scale of opportunity for nutrient recovery. The system consistently partitions nitrogen, phosphorus, and potassium into a dedicated outlet stream suitable for land-based reuse. Scaled to a 500-person community, this equates to approximately 180 kilograms of nitrogen, 80 kilograms of phosphorus, and 120 kilograms of potassium per year. These are the same macronutrients found in commercial synthetic fertilisers. At current Ballance Agri-Nutrients pricing (2024), the recovered nutrient profile would cost between $6,500 and $10,000 to purchase commercially, depending on crop type and application method.

Additional savings may also be realised through reduced sludge handling, lower discharge costs, and avoided transport or storage of biosolids. EC systems therefore shift wastewater from a liability into a productive input, enabling local nutrient cycles that support both economic and ecological goals.

Beyond financial metrics, nutrient recovery contributes to soil health, local food production, and community self-reliance. The alignment with agroecological values and tikanga Māori (customary practices and protocols) is significant. Returning nutrients to whenua in a safe and controlled form reflects both practical benefit and cultural responsibility. As one OraOra participant put it: *"What was once considered waste can now be returned to the whenua with value. Resource recovery is not just technical; it is a shift in mindset."*

For councils and communities seeking to embed circular economy principles in infrastructure planning, fertiliser recovery is a significant feature. It represents a structural opportunity to link environmental compliance with local economic value and cultural wellbeing.

Reducing Future Costs
Electrocoagulation creates further economic value by preventing costs that are often hidden, fragmented, or externalised in conventional planning. These include overbuilt capital works, public health impacts, emergency upgrades, and inter-community waste transfers that carry significant social and cultural consequences.

In council budgets, key expenses such as sludge transport, consent applications, and public consultation are often spread across separate budget lines, giving a distorted picture of what a wastewater system truly costs. Yet for affected communities, these costs are real and cumulative. In Rāwene, for example, working group members described sludge from other towns being trucked in and dumped locally because it was cheaper for contractors to offload there. This practice was not consented to by the community, yet it left local whānau (family) to carry the environmental and cultural burden.

EC systems reduce the likelihood of such cost-shifting. Because they produce less sludge, can be managed locally, and support land-based reuse, they lower the need for long-distance transport and disposal. They also help councils avoid overcommitting to large, debt-heavy upgrades. Past cost assessments of EC created mistrust about whether alternatives were being evaluated on a fair basis. Once community-led evaluation and independent costing were applied, the system was delivered for ca. $1 million being a fraction of the original estimate of $22million to upgrade the plant using conventional bio-mechanical means[21]. This demonstrates how grounded planning approaches can prevent unnecessary debt and mismatched infrastructure.

There are also clear public health savings. Outbreaks of gastroenteritis, norovirus, and other waterborne illnesses can cost hundreds of dollars per case in direct health expenses, not including the wider impacts on household income, school attendance, and wellbeing. By removing pathogens at source, EC systems help prevent these costs, particularly in smaller or rural settlements where medical access may be limited and vulnerability is higher.

In high-growth areas such as Kerikeri, decentralised EC systems could be deployed upstream to relieve pressure on existing plants. By intercepting wastewater flows from marae, papakāinga, or new housing clusters, councils could reduce discharge volumes, extend consent viability, and delay expensive system-wide upgrades. This provides time and flexibility for planning without compromising service quality.

Preventing these types of financial, cultural, and environmental costs requires councils to look beyond immediate capital outlays. EC supports infrastructure strategies that are staged, adaptable, and closely aligned with community values. By making smarter investment choices now, councils can reduce future risks, increase long-term affordability, and deliver more equitable outcomes across the district.

Synthesis
By incorporating avoided costs, nutrient recovery, and reduced future risks into the financial assessment, EC presents a stronger cost-benefit case than conventional systems. The technology offers not only lower upfront and ongoing costs but also pathways for resilience, cultural alignment, and tangible local value.

6.3 Funding and Incentive Options

FNDC already has mechanisms in place to finance wastewater infrastructure. Targeted wastewater rates are used to fund scheme-specific upgrades, and the current capital funding mix includes borrowing, subsidies, and asset renewal reserves. Approximately 54 percent of FNDC's capital projects are funded through loans, in line with national borrowing provisions available through the Local Government Funding Agency (LGFA). While the Council's financial strategy applies prudential debt limits, the existing structure is well suited to modular deployment, where costs are distributed across time and across specific communities.

[21]Carbon Neutral NZ Trust. (2025, March 1). *Transcript: Community Field Visit to Rāwene Wastewater Treatment Site*. Unpublished internal document.

Historically, funding schemes shaped the development of conventional, centralised systems. Subsidies were more readily available for large-scale projects that conformed to standard engineering practice, while decentralised or innovative options were often excluded from feasibility studies. The result was a bias toward centralised wastewater plants even in small or culturally sensitive communities. That context is important, but the current landscape offers a different set of opportunities.

Central government now provides a broader range of tools to support locally tailored infrastructure. These include direct subsidies, transitional grants, and access to low-interest borrowing through the LGFA. For example, the Kerikeri Wastewater Treatment Plant upgrade, completed in 2020, received $7.31 million in Ministry of Health subsidies toward its $27.1 million total cost[1]. More recently, the Three Waters reform programme[22] made $2.5 billion available to assist councils with water services, and although that package has since been replaced, its successor Local Water Done Well preserves access to long-term infrastructure finance. Under current policy, council-controlled entities are able to borrow up to five times their annual revenue for water infrastructure[23,24].

There is also potential to capture value from resource recovery. Fertiliser-grade by-products can offset the need for imported synthetic fertilisers, creating direct savings for local growers and marae. While a formal market for EC-derived products has not yet been established in New Zealand, international examples show that nutrient recovery can become a material part of the financial case. Even without commercialisation, direct reuse of nutrient concentrate within local food systems reduces household costs and provides a tangible community benefit.

Electrocoagulation is well positioned within this funding environment. Its modular design allows for staged investment, reducing upfront capital pressure and aligning infrastructure with actual growth and community readiness. EC also aligns with several central government priorities, including reducing emissions, increasing climate resilience[25], supporting '*Te Mana o te Wai*'[26], encouraging community-led infrastructure[27], and embedding circular economy outcomes[28].

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22 *Russell McVeagh* (2021) "Three Waters: Government announces $2.5 billion package to support local government transition," news release, 16 July.
23 Local Government Funding Agency (2024) "Update: Local Water Done Well and Additional Financing for High Growth Councils."
24 New Zealand Infrastructure Commission.(2024)**.** *Financing Water Infrastructure: Trends and Options*. Wellington: Te Waihanga
25 Ministry for the Environment (2023) *Climate Adaptation and Infrastructure Strategy: Enabling Low-Carbon Wastewater*. Wellington: MfE
26 Ministry for the Environment (2020) *National Policy Statement for Freshwater Management*. Wellington: MfE
27 Department of Internal Affairs (2021) *Three Waters Reform Programme: Overview and Investment Pathways*. Wellington: Te Tari Taiwhenua
28 Ministry for Primary Industries (2022) *Supporting the Circular Bioeconomy: Nutrient Recovery Opportunities in Primary Sectors*. Wellington: MPI.

International reports, including those from UNEP[29,30], highlight the growing importance of climate resilience in wastewater planning. With storms becoming more frequent and intense, infrastructure that can maintain performance and recover quickly after extreme weather is increasingly valued. Modular and low-complexity systems such as EC can be protected more readily, restarted rapidly after outages, or even relocated if necessary. These features reduce both the risk of service disruption and the long-term costs of repair.

Strategic finance is not only about affordability. It is about selecting infrastructure that delivers social, cultural, and environmental value within available funding parameters. EC offers councils the flexibility to design wastewater systems that are resilient, community-aligned, and cost-effective. The tools to support such approaches now exist. Whether EC is adopted will depend on how well FNDC's decision-making frameworks can integrate emerging technologies and match solutions to local conditions.

[29] United Nations Environment Programme (UNEP) & GRID-Arendal. (2023). *Wastewater: Turning Problem to Solution*. Nairobi
[30] United Nations Environment Programme (UNEP) & GRID-Arendal. (2023). *Wastewater: Turning Problem to Solution*. Nairobi

Section 7: Strategic Considerations for the Far North

📌 *Why read this section?*

Elected officials: Reset the decision frame. Focus on lifecycle cost, resilience, and cultural alignment. Correct past cost distortions with clear, fair criteria.

Council staff: Turn pilots into action. Identify and clear the blockers to commissioning at Rāwene and Taipā. Generate operating data to ramp up solutions for wastewater.

Hapū and community: See how decisions reflect tikanga and *'Te Mana o te Wai'*. How land based solutions can be considered and prioritised. How commissioning the pilots can rebuild relationships.

Journalists: Delayed pilots, 20x times cost claims, and a new decision framework that may change who benefits from rural wastewater investment. This is the accountability story to track.

Estimated Reading Time: 10 minutes

7. Strategic Considerations for FNDC

7.1 Decision Criteria and Evaluation Framework

Historically, FNDC's wastewater decisions have been guided by upfront capital cost and conventional engineering codes. This narrow framing entrenched pond-based systems even where their performance was poor and cultural acceptability low. In some cases, consultant reports projected EC costs at many times market reality, reinforcing the perception that only conventional upgrades were feasible.

Several assumptions that have shaped planning now need to be tested:

- Conventional biological and mechanical plants are the most scalable and cost-effective.
- Decentralised alternatives are unproven or unaffordable.
- External consultants provide independent, locally tailored advice.

Local evidence tells a different story. At Rāwene, consultants suggested a $22 million conventional upgrade[31]. By contrast, the community working group has installed an EC unit with solar integration for around $1 million[32]. Continuous operation at OraOra Retreat and earlier trials at Taipā confirm that modular EC systems can achieve higher nutrient recovery and pathogen removal than ponds, within a fraction of the footprint and cost.

A more balanced evaluation framework is required. Future decisions should include criteria that extend beyond capital cost to include life-cycle operating cost, nutrient recovery potential, energy efficiency, and resilience under variable loads. The evaluation should also account for avoided costs such as sludge disposal, health impacts, and emergency upgrades. These considerations are often excluded from conventional business cases.

Broader and more grounded frameworks should also ask different questions:

- Does the system reflect local tikanga (customary practices and protocols) and cultural values?
- Will it contribute to the restoration of mauri?
- Can it be governed locally and support community control?
- Is it flexible and robust enough to adapt to growth, constrained funding, or climate stress?

Electrocoagulation is included in this report because it meets many of these deeper tests. For smaller and rural communities, EC presents a credible, adaptable, and culturally aligned alternative to conventional systems. It should therefore be evaluated on its full merits, not as a compromise option, but as a potentially more appropriate and complete response.

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[31]BECA (2022) "*Whakawhanaungatanga. Rawene Workshop #1*". Presentation to stakeholders. 24 November 2022.

[32]Carbon Neutral NZ Trust. (2025, March 1). *Transcript: Community Field Visit to Rāwene Wastewater Treatment Site*. Unpublished internal document.

7.2 Pilot Projects – Lessons and Next Steps

The council's own pilots at Rāwene and Taipā are critical to validating electrocoagulation at community scale. Equipment has been procured and installed at both sites, yet commissioning has been delayed. Reasons for the delays are not entirely clear. However it is clear that once operational, these pilots can generate the data needed to test performance under local conditions, build trust with hapū and communities, and provide FNDC with a stronger evidence base for future decisions.

Local experience at OraOra Retreat demonstrates that continuous-flow EC can operate reliably at the scale of household clusters. The 2018 NIWA–Beca trial at Taipā confirmed EC's performance in batch mode using pond effluent. Scaling up to township level requires confirmation through FNDC's pilots. Commissioning and operating these systems should therefore be handled as a strategic priority.

Addressing barriers to commissioning will require focused effort. Site-specific integration challenges and limited local technical expertise have all contributed to delays. These barriers can be resolved, but they require proactive governance support, transparent communication with hapū and communities, and resourcing of technical oversight. Once operational, the pilots will provide the definitive proof points FNDC needs to assess the scalability of EC across the district.

Looking ahead, several other communities in the Far North are also well positioned for exploration of EC. Comparative data in Appendix D suggest that locations such as Kohukohu, Rangiputa, and Ahipara face high per-unit infrastructure costs, experience seasonal or variable wastewater loads, and are constrained by environmental or cultural sensitivities that make large-scale upgrades impractical. In such contexts, decentralised or staged EC deployment could reduce financial risk, improve environmental outcomes, and align more closely with community preferences. While detailed feasibility studies would be required, these locations offer a starting point for smarter and more targeted investment.

7.3 Governance, Community Acceptance, and Cultural Alignment

Community trust is central to wastewater decision-making in the Far North. Across the district, Māori communities have consistently opposed the discharge of human waste to water. Their stance is grounded in tikanga Māori (customary practices and protocols), was affirmed by '*Te Mana o te Wai*', and has been reinforced through multiple consent hearings. Increasingly, the wider public shares these concerns, calling for land-based solutions that are culturally aligned as well as environmentally safer.

Past experience has made trust difficult to sustain. As mentioned elsewhere, the overstatement of EC costs by consultants has eroded confidence that alternatives will be assessed fairly. Unless addressed, this mistrust will continue to undermine the council's ability to secure social licence for infrastructure investment.

Inasmuch as electrocoagulation is but a technology, it importantly provides an opportunity to realign governance and community expectations. The Far North District Council has already established a range of Working Groups that engage with hapū and local communities, and these have created valuable spaces for dialogue at the local, scheme level. To build on this foundation and strengthen credibility, FNDC would benefit from establishing or partnering with an independent technical advisory group to oversee wastewater planning. Such a body could draw on kaupapa Māori expertise, hapū representatives, and independent engineers, complementing the existing Working Groups. This structure would improve decision transparency, embed cultural alignment, and reduce the risk of prolonged consent challenges.

Electrocoagulation has also highlighted regulatory tensions. Current building codes and wastewater design standards continue to favour conventional septic tanks and aerobic systems. These frameworks can exclude newer technologies even when evidence demonstrates better performance. Addressing these gaps will require advocacy at regional and national levels so that FNDC and its communities are not constrained to outdated or less effective systems.

Recognising and responding to these cultural and regulatory dimensions is fundamental to FNDC's ability to deliver wastewater infrastructure that is technically sound, financially sustainable, and socially acceptable.

Section 8: Conclusions and Recommendations

📌 *Why read this section?*

Elected officials: A ready-to-run roadmap you can adopt now: commission Rāwene and Taipā pilots, widen decision criteria beyond capex, and stand up independent oversight.

Council staff: The implementation playbook: how to support pilots within procurement settings, engage Te Taumata Arowai, and run lifecycle financial modelling to pick the best-value path.

Hapū and community: What happens next, in writing: hapū-led trials at papakāinga and marae, independent technical oversight, and a shift toward land-based, lower-sludge systems that create local benefit.

Journalists: The decision point story: a staged, fundable alternative on the table, with pilots that could turn wastewater from liability to resource if council moves.

Estimated Reading Time: 5 minutes

8. Conclusions and Recommendations

8.1 Conclusions

Reframing wastewater management from a disposal task to an opportunity for resource recovery opens significant potential for transformation in the Far North. Rather than discharging treated effluents into rivers and coastal waters, electrocoagulation (EC) offers the means to recover valuable nutrients, reduce harm, and support community resilience.

This evaluation has shown that EC is a technically viable treatment approach with proven performance at small scale. It has demonstrated potential to address the core challenges facing FNDC: ageing infrastructure, compliance obligations, budget constraints, and increasing community opposition to discharging waste, albeit treated, to water..

EC aligns with hapū (kin groups with ancestral authority) and community aspirations for land-based treatment systems.

At OraOra Retreat in Kerikeri, EC has operated continuously since 2021, producing stable outputs that meet discharge standards and generating fertiliser-grade by-products. Earlier trials at Taipā confirmed strong pollutant removal under local wastewater profiles. Together, these examples demonstrate readiness for community-scale deployment. To that end, it is important to resolve the blockages to commissioning the EC Pilots at Rawene and Taipā.

In summary, EC is not a compromise solution. For many communities in the Far North, it offers a complete and socially acceptable response to the intertwined technical, financial, and cultural challenges of wastewater management.

8.2 Recommended Actions

Immediate (next 12 months)

1. **Enable EC pilots at Rāwene and Taipā.** Commissioning and operating these systems should be treated as a priority to generate real-world data at community scale.
2. **Broaden evaluation criteria.** Move beyond capital cost alone to include lifecycle value, resilience, nutrient recovery, and cultural alignment.
3. **Establish independent technical oversight.** Partner with a kaupapa-aligned advisory group that can strengthen decision-making and rebuild trust.
4. **Deploy additional EC units at other high-risk or resource-constrained FNDC plants.** Sites such as Kohukohu, Rangiputa, and Ahipara could benefit from modular EC to reduce compliance risk, operational costs, and reliance on centralised upgrades.

Medium Term (2–3 years)

5. **Engage with Te Taumata Arowai on regulatory settings.** Work to ensure decentralised and low-toxicity systems are enabled within performance-based consent frameworks.
6. **Trial modular EC systems in papakāinga and marae settings.** Support hapū-led initiatives where local infrastructure can reduce pressure on centralised schemes.
7. **Undertake lifecycle financial modelling.** Include avoided infrastructure costs, health benefits, nutrient recovery value, and financing options to inform investment pathways.

Longer Term (3–5 years)

8. **Develop nutrient recovery opportunities.** Explore market or community reuse pathways for EC-derived fertiliser and soil conditioners, supporting both environmental and economic outcomes.

Conditions for Success

For FNDC to adopt new technologies such as electrocoagulation with confidence, two conditions will be essential: appropriate funding pathways and access to independent technical guidance. Recent experience has shown that reliance on conventional advice alone does not always deliver outcomes that are culturally acceptable, financially sustainable, or fit for local conditions. Establishing or partnering with a regional technical advisory group grounded in public interest values would help ensure decisions are robust.

Electrocoagulation is not a silver bullet, but it is a well-evidenced, internationally tested, and locally demonstrated technology. Its compatibility with renewable energy systems, modular scalability, and low-toxicity operation make it especially well suited to rural and off-grid contexts in the Far North.

FNDC does not need to replace its entire system overnight. Targeted interventions such as deploying EC alongside or upstream of existing plants can reduce load, improve discharge quality, and enable new service areas without overextending core assets. These incremental steps, supported by existing funding mechanisms, provide a practical pathway to transition toward more resilient, culturally aligned, and future-fit wastewater infrastructure.

To maintain integrity in procurement and public investment, any future EC implementation should be guided by independent technical review, open-market supplier selection, and kaupapa-aligned, or more fulsome, evaluation frameworks. This will ensure that both council and community interests remain at the centre of decision-making.

Ultimately, FNDC has the opportunity to lead by adopting infrastructure that is future-fit, financially sustainable, and set a precedent for how small communities across Aotearoa can reimagine wastewater management.

APPENDIX A: Extended Background

A1. Wastewater and its Constituents

Wastewater is a chemical and cultural signature of how communities live, what they consume, and how they are cared for by infrastructure. In the Far North, municipal wastewater systems collect a mix of household sewage, greywater, and occasional commercial or light industrial runoff. These systems were never designed to capture the complexity of today's waste stream, nor to treat it adequately.

At its core, wastewater still contains the expected biological materials: faecal matter, food scraps, and organic residues. But in practice, it carries much more. Pharmaceuticals, cleaning agents, microplastics, illicit drugs and their metabolites, hormones, and synthetic compounds now flow daily through our pipes. These pollutants are increasingly referred to as contaminants of emerging concern (CEC). They are found even in small settlements and isolated catchments.

Far from being "diluted away," these contaminants persist. Some bind to solids and accumulate in organic matter. Others pass through conventional treatment altogether and re-enter rivers, wetlands, or the ocean. Their long-term impacts are still being understood. What is already clear is that existing systems were not designed with these compounds in mind, and are often incapable of addressing them.

The implications for both environmental health and human wellbeing are significant.

Ecological and Public Health Risks

In ecosystems, excess nitrogen and phosphorus fuel algal blooms, choke wetlands, and degrade shellfish beds. Ammonia is acutely toxic to aquatic life. Microplastics and drug residues accumulate up the food chain, affecting species behaviour, reproduction, and survival. These impacts are already observable across Aotearoa, and they are particularly acute in the Far North, where discharges to water remain common and land-based alternatives underdeveloped.

But the risks are also personal. For people, exposure to wastewater contaminants can result in acute illness such as gastroenteritis, skin infections, respiratory complications, as well as chronic health burdens. **E. coli**, a human marker of faecal contamination, can cause severe infections, particularly in children and immunocompromised adults. **Nitrates** in drinking water are linked to 'blue baby syndrome' and have been associated with colorectal cancer. **Norovirus**, often spread via wastewater overflows or storm events, is highly contagious and dangerous to kaumātua (elders) and pēpi (babies, and young children) alike.

The presence of methamphetamine in wastewater, now widely measured through community testing, also introduces ecotoxicological risks for aquatic species, with early studies showing behaviour changes in exposed fish. Meanwhile, **endocrine-disrupting chemicals** from pharmaceuticals and personal care products are beginning to appear in sediment and aquatic life. These substances affect hormonal systems in both wildlife and, potentially, in humans. Research is still catching up to exposure patterns.

Perhaps most concerning is the overall regulatory lag. While conventional pollutants like nitrogen and E. coli are monitored, **many emerging contaminants remain unregulated**.

There are no enforceable limits for microplastics, drug residues, or endocrine disruptors under current New Zealand law. Even pathogen thresholds vary depending on whether water is classified for contact recreation or not.

This gap between what is present and what is regulated represents a structural failure in how people and the environment are protected.

Wastewater and Human Experience

In the Far North, the technical challenges of wastewater management are layered with deeper social, cultural, and historical patterns. Communities have long lived with system failures: overloaded ponds, infrequent inspections, and unnotified discharges. FNDC's wastewater plants are monitored inconsistently and often only after complaints or observed breaches. Where illnesses occur, there is no formal effort to correlate outbreaks with infrastructure performance.

Mātauranga Māori (Māori knowledge systems) provides a holistic lens for assessing water health that predates and often outpaces the regulatory system. Changes in water clarity, colour, smell, or flow are noticed immediately. So too are the tohu (signs) such as recurring sickness after swimming, disappearing species, especially species like kanae (mullet) which feed from the sediment, fish with growths around their mouth and gills, foam or scum on the surface, or sudden declines in kaimoana (seafood)[33]. These indicators are tracked not through spreadsheets but through observation, story, and whakapapa (relational lineage). They are often shared at hui (gatherings) or wānanga (spaces for learning), and they carry deep legitimacy.

In Waitangi, for example, whānau (families) have reported patterned and predictable illness following heavy rainfall. In Taipā, elders speak of shellfish beds once abundant, now closed or avoided. In other places, children are told not to play in streams once considered safe. These changes are not accepted as normal. They are warnings, signs that the water is no longer well.

Community science has attempted to document some of these effects. Local groups have sampled stream health, tested for contaminants, and pushed councils to act. But these efforts are often under-resourced and undervalued. Formal monitoring remains disconnected from lived reality.

> **"When our water is sick, our people get sick. Especially our mokopuna and our kaumātua."[34]**
> *Hapū leader, Ngāti Kawa, Ngāti Rāhiri (community transcript, 2025)*

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[33] Kōrero captured during Open Day at Rawene EC Trial (March, 2025)
[34] Statement shared during local working group hui, May 2025. Used with permission.

The case for improved wastewater treatment is not simply one of environmental management. It is about restoring relationships between people and place, between knowledge systems, and between policy and practice. It is also about ensuring that infrastructure reflects the values of the communities it serves, and that it upholds the mana (inherent authority) of the water on which all life depends.

Poorly treated wastewater represents more than a compliance issue. It poses measurable risks to public health, undermines local food systems, and compromises cultural values tied to water, land, and customary practice. These impacts fall disproportionately on communities with limited infrastructure investment, on those who rely directly on environmental resources, and on tangata whenua (indigenous peoples) whose tikanga (customary practices and protocols) upholds wai (water) as a taonga (treasure). Without appropriate treatment and discharge practices, the consequences extend beyond environmental degradation to include social, economic, and cultural harm.

The result is that the waste stream itself has outpaced the systems meant to manage it. Unless infrastructure and monitoring evolve to reflect what wastewater actually contains, councils will continue managing yesterday's problem while today's contaminants accumulate in people, ecosystems, and food chains.

Key Takeaways from this Section

Regulation has not kept pace with science.

Most emerging contaminants remain without enforceable limits, and decision-making is still weighted toward cost and engineering feasibility rather than cultural or ecological safety.

Unless regulation evolves, the current system will continue to license harm, exposing communities and ecosystems to risks that compliance alone cannot resolve.

In practice, this makes an anticipatory approach essential: discharges to land can be monitored and managed, while discharges to water bodies expose environments and people to risks that cannot be contained once released.

A2. Regulation and Standards in New Zealand

Wastewater discharges in Aotearoa are regulated under the Resource Management Act 1991, which is based on an effects-based model. This approach was intended to support flexible and locally responsive decision-making. In practice, it has resulted in varied processes and requirements. Resource consents for discharges to land or water are assessed individually by regional councils. There are no consistent national standards for pollutants such as microplastics, pharmaceuticals, or nutrient levels beyond those set for drinking water and contact recreation.

In 2020, the government introduced the National Policy Statement for Freshwater Management (NPS-FM) to improve how freshwater is managed. At the centre of this policy is the principle of '*Te Mana o te Wai'*, which recognises that water has its own authority, vitality, and wellbeing. Councils are now required to prioritise the health of water bodies before considering human use or economic benefit. This includes recognising the intrinsic value of wai (water) and reflecting that value in how decisions are made.

The reforms introduced new responsibilities. Councils are adjusting to different expectations and communities are seeking clarity on how these changes apply. This includes efforts by tangata whenua to uphold their rights under Te Tiriti o Waitangi and '*Te Mana o te Wai'*. Similar treatment systems can still face different conditions for monitoring, reporting, or improvements depending on the region or the history of the consent process.

However, while the intention of reform is clear, implementation has been uneven. Many councils, including Far North District Council, continue to operate within outdated frameworks. Consent applications are still assessed primarily on cost and engineering feasibility, with cultural impacts relegated to consultation comments or appended reports. Regulatory consistency remains elusive, especially for small or decentralised systems.

For non-municipal dischargers such as marae, papakāinga (communal housing), farms, and rural subdivisions, the challenges are greater still. Without clear standards or affordable compliance pathways, many small-scale operators are excluded from viable infrastructure options. Innovation is often discouraged simply because it is 'new' or unknown. This has slowed adoption of alternative technologies, even where community support is strong and environmental benefits are demonstrable.

Tikanga Māori (customary Māori practice), despite growing legal recognition, continues to sit at the margins of decision-making. Under '*Te Mana o te Wai'*, councils are required to give effect to the principles of Te Tiriti o Waitangi and to uphold the primacy of water. Yet in practice, technical standards remain dominant. The cultural unacceptability of discharging treated or untreated human waste into waterways is well documented in hearings and submissions, but has rarely altered the outcome of a consent process.

The result is a regulatory system that does not yet reflect the values it now claims to uphold. While statutory frameworks have begun to shift, the burden of change has fallen largely on communities - particularly Māori, to advocate, resist, and propose alternatives. Until these frameworks are fully implemented and resourced, the gap between policy and practice will remain.

Internationally, the United Nations Environment Programme has advanced the global narrative that wastewater is a resource and not merely a 'waste'. Its report *Sanitation, Wastewater Management and Sustainability: From Waste Disposal to Resource Recovery*[35] encourages shifting perspectives toward systems that recover water, nutrients, and energy. The subsequent UNEP–GRID-Arendal report *Wastewater: Turning Problem to Solution*[36] further articulates the role of wastewater management in contributing to climate mitigation and circular economy goals. These insights offer a credible international benchmark for aligning FNDC's wastewater strategy with sustainability principles that reach beyond technical compliance.

Limits for Discharges to Water

Discharges of treated or untreated wastewater into freshwater or coastal environments require resource consent from regional councils. While these consents are intended to manage environmental risk, there are no consistent national standards that set enforceable limits for key contaminants. The most commonly regulated pollutant is ammonia, which is highly toxic to aquatic life at low concentrations and is therefore often treated as the critical indicator of risk.

Nitrates and phosphorus also contribute significantly to environmental degradation, particularly through eutrophication and algal blooms. However, their impacts are often considered secondary in consent assessments. In practice, this means that consents for surface water discharges prioritise ammonia reduction while other nutrient and microbial risks may receive less scrutiny.

In the Far North, the majority of wastewater treatment plants still discharge to water. This reflects both the historical absence of alternative infrastructure and the limited capacity of local authorities to implement land-based systems. Recent consent hearings, such as those in Ōmāpere, have acknowledged the cultural and ecological challenges of this approach. Despite this, consents have continued to be granted on the basis of practicality, rather than cultural or environmental preference.

Limits for Discharges to Land

Discharging treated wastewater to land is generally considered a more protective option, particularly in cultural and ecological terms. Land application allows soil and plant systems to absorb nutrients and reduce contaminants before they can reach groundwater or surface water. However, this approach introduces a different set of risks and constraints that must be carefully managed through consent conditions.

The most significant of these is nutrient loading. Nitrogen, particularly in the form of nitrate, is highly soluble and can move quickly through the soil profile. This poses a risk to groundwater quality, especially in areas with shallow aquifers or high rainfall. Phosphorus can also accumulate in soil over time and contribute to long-term contamination. For this

[35] United Nations Environment Programme (UNEP). (2021). *Sanitation, Wastewater Management and Sustainability: From Waste Disposal to Resource Recovery* (2nd ed.). Nairobi: UNEP.
[36] United Nations Environment Programme (UNEP) & GRID-Arendal. (2023). *Wastewater: Turning Problem to Solution*. Nairobi

reason, many land discharge consents include conditions related to total nitrogen, total phosphorus, hydraulic loading rates, and soil permeability.

In some cases, it is preferable for nitrogen to remain in its ammoniacal form. Ammoniacal nitrogen tends to bind to soil particles and is more readily taken up by plants, making it less likely to leach into water bodies. This distinction has important implications for system design and nutrient management planning. While land-based discharge is often more acceptable to communities, it requires careful monitoring and site-specific controls that are not always in place or enforced.

Discharge Limits for Pathogens, CECs

Municipal wastewater standards and discharge limits for pollutants such as pathogens, drugs, microplastics, and emerging contaminants of concern (CECs) vary globally. Coxon et al (2023)[37] provides a comprehensive review of regulations per contaminant class for New Zealand as well as internationally (Table A.1).

Most jurisdictions still lack enforceable limits for contaminants of emerging concern, especially for drugs, microplastics and pharmaceutical residues.

For New Zealand specifically, key findings are[38,39]:

- Pathogen standards mostly follow drinking water and recreational water guidelines
- No enforceable limits exist for microplastics, CECs, or methamphetamine.
- PFAS (Per- and Polyfluoroalkyl Substances) are increasingly monitored, but regulation is still developing.
- A national standard or monitoring framework for emerging contaminants is currently absent.

[37] Coxon et al (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater*. ESR.
[38] Coxon et al (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater*. ESR.
[39] Coxon, S. (2024). *Health Impacts of Climate Change on Wastewater Networks in Aotearoa New Zealand*. ESR

Table 1. Wastewater Regulations – Comparative Summary

This table summarises key regulatory approaches to wastewater contaminants across New Zealand, the United Kingdom, the European Union, and Australia. It highlights the **absence of enforceable limits in Aotearoa** for many contaminants of emerging concern (CECs), and reinforces the case that **technical compliance may fall short of tikanga-based expectations** for protecting wai (water) and its mauri (life essence).

Region	Pathogens (e.g. norovirus)	Microplastics	Methamphetamine Drugs	Pharmaceuticals (PPCPs)	Regulatory Style
New Zealand	Yes (recreational water only)	❌ No regulation	❌ No regulation	❌ No regulation	*Effects based*
United Kingdom	✅ Yes (indirect via water quality targets)	⚠️ Monitored only	❌ Not regulated	⚠️ Monitored (via Clean-in-Place programmes)	*Statutory / Directive*
European Union	✅ Yes	⚠️ Regulation in progress	⚠️ Monitored	⚠️ Likely to be regulated	*Directive driven*
Australia	✅ Yes (guidelines, not enforceable)	❌ No regulation	❌ No regulation	⚠️ Risk-based guidance only	*State-led under AGWR*

Notes:

- New Zealand has **no enforceable standards** for microplastics, drugs, or pharmaceutical residues in wastewater.
- Pathogens are regulated only **where water is designated for contact recreation**.
- This regulatory gap contrasts sharply with the **cultural unacceptability of discharge** acknowledged in mātauranga Māori frameworks.

Source:

Adapted from: Coxon, S., & Eaton, C. (2023). *Review of contaminants of potential human health concern in wastewater and stormwater.* ESR.

A3. He Tirohanga Ao Māori | An Indigenous Perspective

Alongside statutory and technical frameworks, tikanga Māori (customary practices and protocols) continues to provide a parallel and enduring basis for wastewater governance. Where regulation sets minimum compliance, tikanga Māori carries obligations that are constitutional, cultural, and spiritual in nature. Recognising this perspective is essential to understanding both the legitimacy of community concerns and the potential alignment of technologies such as electrocoagulation.

Tikanga Māori forms the original and enduring constitutional foundation of Aotearoa, established long before the arrival of Europeans. Rooted in whakapapa (relational lineage), whanaungatanga being the interdependent relationships between people, land, and the natural world, tikanga guided all aspects of governance, authority, and social order. He Whakaputanga (1835)[40] and Te Tiriti o Waitangi (1840) emerged later as diplomatic instruments designed to express, assert, and safeguard Māori Tino Rangatiratanga (full authority)[41] in the face of increasing foreign presence. These documents must be understood as responses within an existing constitutional context, shaped by tikanga Māori, which continues to provide the legitimate framework for Māori governance and self-determination today.

> **"Wai is not a resource to manage. It is a living presence, with its own mana, mauri, and tapu."**

In traditional Māori society, all aspects of daily life - including the management of waste, were governed by tikanga.

Tikanga were shaped by the principles of tapu (sacred, restricted) and noa (neutral, free from restriction), and guided by the need to protect the mauri (life force) and mana (inherent authority) of both whenua (land) and wai (water).

The scale and nature of contemporary wastewater and stormwater systems do not permit the practice of relevant tikanga, and compliance with regulatory water quality standards is never enough to ensure cultural safety, as intrinsic tapu may remain. Coxon and Eaton (2023)[42], writing from within the Crown science system, acknowledged that for many Māori, no level of treatment can remove the tapu associated with wastewater. Discharge to water, they noted, remains culturally unacceptable regardless of technical compliance.

The presence of new and poorly understood contaminants presents additional concerns for which tikanga may need to evolve, and where appropriate tikanga may not yet be fully understood.

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[40] He Whakaputanga o te Rangatiratanga o Nu Tireni (1835), (Declaration of Independence of New Zealand); acknowledged King William IV formally in 1836.

[41] Tino Rangatiratanga more fully expressed as the right of Māori to exercise leadership, authority, and decision-making in accordance with their tikanga and whakapapa

[42] Coxon et al (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater*. ESR.

Concerns regarding the discharge of wastewater to the environment extend beyond potential physical health concerns, and include adverse impacts on cultural, spiritual and social wellbeing that may result from the loss of access to wāhi tapu (sacred places), wai māori (fresh water) and mahinga kai (food, crop gardens) or the transgression of tapu or mana as waste moves through and impacts differing realms where tangata (humans) have no jurisdiction or authority.

Some technologies resonate not only because they perform well in technical trials, but because they reflect longstanding understandings of how the natural world responds to imbalance. In the case of electrocoagulation, hapū (kin groups with ancestral authority) in the Far North have identified alignments between its function and ancestral knowledge that describes the cleansing of wai (water) through naturally occurring energetic forces[43]. These understandings are held within protected bodies of mātauranga (knowledge) and are not detailed here. What matters is the recognition that this technology connects with knowledge systems that predate engineering, science and remain active today.

For those steeped in intergenerational learning, such resonance is not esoteric. It reflects a lived understanding of taiao (natural world) and the embedded science carried within pūrākau (story telling), karakia (ritual incantation), and observation. When a technology can be understood through both mātauranga Māori and engineering logic, it carries greater legitimacy, and may be more readily trusted, adapted, and governed at the local level.

In this way, EC has been viewed by some not merely as a treatment unit, but as a contemporary manifestation of older principles that once guided the management of wai. That recognition cannot be engineered into a system after the fact. It must be earned through relationship, time, and whakapapa (relational lineage).

Key Takeaways from this Section

Wastewater governance treats regulation as the sole marker of credibility.

This narrow lens excludes knowledge systems that have safeguarded water for centuries and that continue to provide valid technical and scientific insight today. Tikanga has always carried empirical rigour, observing and responding to environmental change over generations.

The effect is a governance system that licenses harm while sidelining solutions capable of bringing science and tikanga together to meet the realities of an evolving waste stream.

[43] Kōrero captured during Open Day at Rawene EC Trial (March, 2025)

A4. Historical Funding and Policy Drivers

The wastewater infrastructure landscape in the Far North has not evolved in a vacuum. Central government policies and funding schemes have played a significant role in shaping the decisions made by local councils over the past three decades. Understanding these influences helps explain why certain technologies were adopted while others, such as electrocoagulation (EC), remained unexplored or under-utilised.

In the early 1980s and early 2000s, central government introduced the Sanitary Works Subsidy Scheme, administered by the Ministry of Health[44]. This provided capital subsidies for small towns facing public health risks from failing septic systems or inadequate treatment. Communities were supported to convert septic tanks to reticulated sewerage or to upgrade basic oxidation pond systems. These subsidies were motivated primarily by the need to reduce direct human exposure to pathogens, rather than long-term environmental or cultural considerations

In the early 2000s, the central government introduced the Tourism Demand Subsidy Scheme, which provided financial support to rural or coastal settlements under pressure from seasonal visitor numbers[45]. Communities with small resident populations but high peak loads were encouraged to invest in wastewater upgrades that could meet fluctuating demand. While useful, this scheme tended to reinforce investment in conventional technologies that could demonstrate compliance under established engineering models.

The release of the 2002 New Zealand Waste Strategy added environmental compliance as a third driver[46]. It encouraged councils to meet national standards by 2020 and pushed for improved wastewater management, particularly in relation to receiving environments. However, while the strategy set national goals, it did not come with flexible funding pathways for alternative technologies. Councils continued to prioritise upgrades that were eligible for existing subsidy streams, reinforcing a default reliance on conventional designs.

These funding patterns created clear incentives. Systems that conformed to existing design codes and engineering practice were more likely to be subsidised. Centralised systems and pond-based treatments were easier to justify within the accepted planning and procurement frameworks. Decentralised or innovative options, such as EC, lacked policy recognition and were often excluded from early-stage feasibility studies.

As a result, wastewater planning in the Far North favoured conventional, centralised infrastructure. Most plants were designed to serve multiple communities through gravity-fed systems and oxidation ponds, despite the geographic, cultural, and hydrological diversity across the district. The legacy of these decisions is still visible today in the structure, location, and limitations of FNDC's wastewater assets.

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[44] Ministry of Health (2002). *Sanitary Works Subsidy Scheme: Information for Local Authorities*. Wellington.
[45] Department of Internal Affairs (2005). *Tourism Demand Subsidy Scheme – Criteria Announced*, March.
[46]Ministry for the Environment (2002). *The New Zealand Waste Strategy: Towards Zero Waste and a Sustainable New Zealand*.

In this context, it is unsurprising that EC was not considered. Its modularity, low footprint, and nutrient recovery potential did not match the funding priorities or evaluation frameworks in place at the time. Only now, as councils face renewed pressures from climate adaptation to cultural redress, from affordability to decentralisation, is the potential of such technologies being re-evaluated.

Key Takeaways from this Section

Central government funding streams entrenched conventional, centralised wastewater systems while excluding innovative or decentralised options like EC.

The result is an infrastructure legacy that is costly, inflexible, and slow to adapt.

Until incentives reward ecological performance, cultural alignment, and innovation, councils will continue to pour resources into yesterday's solutions.

APPENDICES B-D: Technical Support

B. FNDC WWTP and Regulatory Context

Table B.1: Overview of FNDC Wastewater Treatment Plants[47]

Facility	Capacity (m³/day or PE[48])	Treatment Process	Key Features / Notes
Kerikeri	1,000 m³/day (~6,000 PE)	Extended aeration, UV disinfection, wetland	Major $27.1M upgrade to support urban growth
Kaitāia	2,400 m³/day (~5,000 PE)	Oxidation and maturation ponds; wetland discharge	UV disinfection added; exploring land discharge
Taipā	500 m³/day	Lagoons, constructed wetlands, EC trial (2018)	Early trial site for EC; culturally engaged
Rāwene	250 m³/day (~1,000 PE)	Oxidation ponds and wetlands	EC pilot underway
Paihia	Not specified	Oxidation pond with Bio-Shell® bioreactors	Largest global Bio-Shell® installation; high NH4 removal
Kaikohe	~4,000 PE	Oxidation ponds	Serves Kaikohe and Ngawha; land discharge under assess't
Kawakawa	~3,000 PE	Facultative pond; land discharge consented	Serves Kawakawa township
Kāeo	Not specified	Oxidation ponds	Serves Kāeo and Whangaroa
Russell	~1,200 PE	Sequential Batch Reactor (SBR)	High-tech system; MBR upgrade possible
Ahipara	Not specified	Oxidation ponds	Operating under abatement
Hihi	Not specified	Constructed wetlands, UV disinfection	Small-scale; discharges to sensitive coastal catchment
Kohukohu	Not specified	Septic tank solids retention	Solids retained in tanks on individual properties
Rangiputa	Not specified	Oxidation ponds	Remote system; limited operational data
Whatuwhiwhi	Not specified	Oxidation ponds	Similar to Rangiputa; coastal pressures apply
Ōpononi / Ōmāpere	~800–1,000 PE	Oxidation ponds	Longstanding community opposition to discharge-to-water

[47] **Sources:** FNDC Wastewater OIA Responses (2024–2025); Harrison Grierson (2020); BECA (2020); NRC Hearing Report (2023)
[48] **PE = Population Equivalent.** A design metric used in wastewater to approximate the number of people served based on organic loading (typically 60g BOD_5/person/day).

Table B.2 Performance FNDC Waste Water Treatment Plants

This table presents the quarterly compliance status of Far North District Council (FNDC) wastewater treatment plants over a five-year period, 2020 -2024. Each cell uses a coloured symbol to indicate the level of regulatory compliance recorded in that quarter:

Legend:

🟢 Full Compliance (G): All monitored parameters met the consent conditions.

🟡 Partial Compliance (Y): One or more parameters exceeded thresholds, but not to the extent of formal non-compliance.
🔴 Non-Compliance (R): Significant exceedances or failures to meet consented limits.

– No Data: Compliance data was unavailable or not recorded for that quarter.

The table allows for quick visual comparison of performance across time and between sites. It supports FNDC, communities, and technical advisors in identifying persistent non-compliance, seasonal trends, or improvements at each treatment plant.

	2020				2021				2022				2023				2024			
WWTP Site	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Ahipara	🔴	🔴	🟢	–	–	🟡	🟡	🟡	🟡	🟡	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Hihi	🟢	🟡	🟡	–	–	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡
Kaeo	🔴	🟡	🟢	–	–	🟢	🟢	🟢	🟢	🟡	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟢	🟢
Kaikohe	🔴	🔴	🔴	–	–	🟡	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Kaitaia	🟢	🟢	🟡	–	–	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Kawakawa	🟢	🔴	🟢	–	–	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡	🟡
Kerikeri	🔴	🔴	🔴	–	–	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Kohukohu	🟢	🟢	🟡	–	–	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Opononi	🔴	🔴	🔴	–	–	🟡	🟡	🟡	🟡	🟡	🟢	🟡	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴
Paihia	🔴	🔴	🔴	–	–	🟢	🟡	🟡	🟡	🟡	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟢	🟡	🟡
Rangiputa	🟡	🟢	🟡	–	–	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🟡	🟢	🟢	🟢	🟢
Rawene	🟢	🟢	🟢	–	–	🟢	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Russell	🔴	🔴	🔴	–	–	🟡	🟡	🟡	🟡	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🟡	🟡	🟡	🟡
Taipa	🔴	🟢	🔴	–	–	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Whatuwhiwhi	🔴	🔴	🔴	–	–	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡

This compliance data was sourced from Far North District Council (FNDC) wastewater treatment plant monitoring records, provided in response to an Official Information Act (OIA) request in 2025

C. Carbon Neutral NZ Trust

Introducing the Trust and OraOra Retreat

Carbon Neutral NZ Trust (CNZ) is a citizen-led organisation with the motto “emit less - sequester more", to help New Zealanders measure and reduce emissions through practical, locally designed tools. It supports Green House Gas (GHG) offsetting projects that keep benefits close to home and has an active presence in Kerikeri and Waiheke. CNZ’s priorities include recognition of GHG sequestration through native trees and forests linked to the Emissions Trading Scheme, pushing for cleaned wastewater to be diverted from waterways, advancing the shift towards multimodal transport as well as progress New Zealand’s electrification, de-carbonisation and ocean sequestration.

CNZ has followed wastewater management practices in the Far North for the last 10 years. In 2020, founding Trustees in Kerikeri improved their septic tank system with an Electrocoagulation (EC) unit not only to treat the wastewater, but also to recover resources (nutrients and irrigation water) from the wastewater of five households at their property in KeriKeri, as well as to protect the water of the KeriKeri River. This experience demonstrated firsthand that EC is not simply a treatment technology, but a potential enabler of circular infrastructure. The system consistently produced nutrient-rich water for land application and supported seasonal food cultivation on-site. These outcomes prompted further interest in EC’s viability for other rural and small-scale communities in the Far North, particularly where discharges to water are culturally unacceptable and land-based reuse offers both ecological and economic value.

In the intervening years, CNZ has followed the improved evolution of EC capability throughout the Far North District and subsequently commissioned this study to enable a wider understanding of wastewater treatment possibilities for communities living rurally, in papakainga (communal housing), or those living in general isolation of municipal reticulated water and waste water systems.

CNZ also considers that the best decisions are those where meaningful consultation within the community has taken place and that particular regard must be given to tirohanga ao Māori (a Māori world view) or what might be expressed as a more holistic, regenerative manner which is closer to what mother nature might intend.

We have a myriad of ways to express our perspectives of water, waste and the environment. Iwi Māori (Māori tribal collectives) will talk in terms of mauri (life force) and kaitiakitanga (responsibility to care). Wastewater specialists will talk in terms of water chemistry, and marginal cost of treatment. Community members might talk more straightforwardly in terms of how it looks or smells.

Carbon Neutral NZ Trust therefore hopes that this work will help to empower communities and Iwi Māori to advocate more effectively for water treatment in their own rohe, or area.

Table C.1: Nutrient Removal Performance: OraOra Retreat (Kerikeri)

OraOra Retreat operates a live, continuously flowing EC system. Sampling in 2021, 2024 and 2025 shows consistent separation of nutrient-rich and low-nutrient streams. This supports resource recovery and discharge to land.

Parameter	16/11/2021		14/03/2024		05/05/2025	
	Fertiliser	Irrigation	Fertiliser	Irrigation	Fertiliser	Irrigation
pH	7.2	7.3	7.2	7.4	6.90	6.85
NH_4^+ (mg/L)	310.0	8.1	370.0	6.7	89.0	6.7
NO_3^- (mg/L)	6,700.0	1.5	7,100.0	0.6	140.0	<0.5
PO_4^{3-} (mg/L)	900.0	0.5	98.0	0.2	210.0	<0.2
K^+ (mg/L)	315.0	0.3	470.0	0.0	245.0	—
Fe (mg/L)	—	—	—	—	143.0	0.15
E. coli (CFU/100mL)	—	—	—	<1	<100	<1
Faecal coliforms	—	—	—	<1	<100	<1

Data Source: The Far North Lab (reports provided by Carbon Neutral NZ Trust)

D. Operational and Cost Performance: EC vs Conventional Systems

This appendix presents comparative pollutant removal performance; cost, energy, and operational metrics for electrocoagulation (EC) versus conventional biological wastewater treatment systems. Data is drawn from international pilot studies, council infrastructure assessments, and field deployments such as OraOra Retreat.

Table D.1. Pollutant Removal Performance: Electrocoagulation vs Conventional Wastewater Treatment

Pollutant Type	Electrocoagulation (EC)	Conventional Biomechanical Methods
Suspended Solids & Turbidity	Very high removal (up to 99% TSS)[49]	Moderate to high via sedimentation and filtration[50]
Organics (BOD/COD)	High; up to 90% removal via flocculation and oxidation[51]	Moderate to high, depending on system health and oxygenation[52]
Ammoniacal Nitrogen (NH_4^+)	Average 60 % NH_4^+-N removal in Taipa 2018 batch EC and OraOra continuous flow pilots under local wastewater conditions	Moderate via nitrification/denitrification
Nitrates (NO_3^-)	>80% NO_3^--N removal in Taipa 2018 batch EC and OraOra continuous flow pilots under local wastewater conditions	Moderate; effective denitrification in well-maintained systems
Phosphorus (P)	>90% removal. High efficiency with Al or Fe electrodes through chemical precipitation[51]	Moderate; relies on sedimentation and plant uptake[52]
Contaminants of Emerging Concern (CECs)	Effective for some CECs (e.g. up to 99% for pharmaceuticals, illicit drugs, EDCs)[52]	Low to moderate; removal varies by compound and conditions[53]

[49] Barrera-Díaz et al. (2012). *Electrochemical Treatment Applied to Food-Processing Wastewater*. Industrial & Engineering Chemistry Research, 45(1), 34–38.
[50] Tchobanoglous et al (2014). *Wastewater Engineering: Treatment and Resource Recovery*. 5th ed. McGraw-Hill.
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[53] Coxon et al (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater*. ESR.

Pollutant Type	Electrocoagulation (EC)	Conventional Biomechanical Methods
PFAS	Low removal; requires post-treatment (e.g. activated carbon or AOPs)[54]	Very low; conventional systems largely ineffective[55]
Endocrine Disrupting Chemicals (EDCs)	High (80 % to 99 % current density 10–30 mA/cm², and 10–30 min contact time[54]	Low to moderate; incomplete breakdown in standard treatment
Microplastics	Removal efficiencies > 95 % for PP and PS microplastics using Fe electrodes, pH 7, 15–20 mA/cm², 15–20 min contact time[56]	Low to moderate; partial entrapment in sludge, but fine particles pass through[57]
Pathogens (bacteria, protozoa)	Removal efficiencies typically 90–100 % using Al or Fe electrodes, pH 6–8, 10–20 mA/cm², and 5–20 min contact time[58]	Moderate; some removal via sedimentation and biological filtration[59]
Viruses (e.g. Norovirus)	Surrogate virus removal 90–99+ % under optimal EC conditions with Al or Fe electrodes, pH 6.5–7.5, 15–30 mA/cm², and 10–30 min contact time[60]	Moderate; sedimentation-based with wide variability[61]

[54] Liu et al. (2023). *Periodically reversing electrocoagulation technique for removal of long and short-chain PFAS contaminants simultaneously from natural water matrices*. (Accepted manuscript on ScienceDirect.)
[55] UNEP Environmental Effects Assessment Panel. (2016). *Sources, fates, toxicity, and risks of trifluoroacetic acid and its salts and other short-chain per- and polyfluoroalkyl substances*. Journal of Toxicology and Environmental Health, Part B, 19:S45–S68
[56] Shen,et al (2022). Efficient removal of microplastics from wastewater by an electrocoagulation process. *Chemical Engineering Journal*, 428, 131161.
[57]Lares et al (2018). *Occurrence, identification and removal of microplastic particles and fibers in conventional activated sludge process and advanced MBR technology*. Water Research, 133, 236–246
[58] Ghernaout, D. (2019). *Disinfecting Water: Electrocoagulation as an Efficient Process*. Applied Engineering, 3(4), 60–68.
[59] Judd, S. (2006). *The MBR Book: Principles and Applications of Membrane Bioreactors for Water and Wastewater Treatment*. Elsevier
[60] Ghernaout, D. (2019). *Virus Removal by Electrocoagulation and Electrooxidation: New Findings and Future Trends*. Open Access Library Journal, 6, 1–17
[61] Coxon et al. (2023). *Review of Contaminants of Potential Human Health Concern in Wastewater and Stormwater*. ESR

Table D.2: Detailed Performance Comparison: EC vs Conventional Systems

Criteria	Electrocoagulation (EC)	Conventional Biological Systems
Capital Cost	Medium – modular; scalable	Low – simple ponds, high cost at scale
Operating Cost	Turkey (3,500 m³/day): \$0.44–\$0.52/m³ OraOra Retreat (~1.2 m³/day): \$0.30–\$0.33/m³ NIWA (2019) – Small: 548 m³/day @ \$0.33/m³ NIWA (2019) – Large: 20,000 m³/day @ \$0.21/m³	\$0.60–\$1.20/m³
Energy Use	Butler (2011): 0.3 and 0.6 kWh/m³ NIWA (2019): ~1 kWh/m³	0.6–1.5 kWh/m³ (if aerated)[62]
Sludge Generation	Low – inert, dewaterable[63]	High – pathogen-rich biosludge
Maintenance Requirements	Moderate – basic cleaning, electrode replacement	High – often requires specialist input[64]
Skill / Training Required	Moderate – basic technical training needed	Low – often managed by council contractors[65]
Climate Sensitivity	Low – works in wide temperature ranges	High – biological processes degrade in cold climates[66]
Adaptability to Load Change	High – easily tuned via voltage/current settings[67]	Moderate – sensitive to overloading
Footprint Required[68]	Small – containerised options (<10 m² for 6 households)	Large – ponds/wetlands may need >2,000 m²
Treatment Time	Fast – minutes to hours	Slow – days to weeks
Remote Monitoring	Easily integrated SCADA-compatible	Often not supported

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62 Judd, S. (2006). *The MBR Book: Principles and Applications of Membrane Bioreactors for Water and Wastewater Treatment*. Elsevier.
63 Barrera-Díaz, C. et al. (2012). *Electrochemical Treatment Applied to Food-Processing Wastewater*. Industrial & Engineering Chemistry Research, 45(1), 34–38.
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66 Metcalf & Eddy, Inc. (2014). *Wastewater Engineering: Treatment and Resource Recovery* (5th ed.). McGraw-Hill Education.
67 Ghernaout et al (2011). *Ferric Chloride and Alum as Coagulants in Wastewater Treatment: A Review*. Desalination, 252(1–3), 1–12.
68 Refers to legacy pond-based treatment systems where biological processing occurs within the pond. Not to be confused with pre-treatment settlement ponds used alongside electrocoagulation

Criteria	Electrocoagulation (EC)	Conventional Biological Systems
Scalability	High – modular for 3 to 10,000+ people	Low to moderate – large systems hard to downscale
Suitability for Decentralised Use	Strong – designed for local or off-grid deployment	Weak – designed for centralised networks
Land Footprint	Low - settlement/storage capacity needed for pre- and post-treatment	Large

APPENDICES E-G: References

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F. Glossary of Māori Terms

This glossary provides brief contextual meanings of Māori terms as used throughout the report. The definitions prioritise clarity for general readers while respecting the depth and nuance of each concept.

Hakihaki
Lesion or skin condition; used in this report as a tohu (sign) of contamination or ecological stress in fish.

Hapū
Kin group or sub-tribe; the primary political and social unit in many iwi structures.

Iwi
Tribal group or extended kin collective; often used in legal and policy contexts.

Karakia
Incantation, prayer, or ritual chant; used to set intention, offer protection, or transition between states.

Kaupapa Māori
An approach or practice grounded in Māori values, philosophies, and ways of knowing.

Kaitiakitanga
Guardianship or stewardship, often applied to environmental and intergenerational responsibility.

Mahinga kai
Customary food gathering practices and places; also reflects systems of care and responsibility for food sources.

Mana
Authority, prestige, spiritual power, or integrity. Can apply to people, land, actions, or relationships.

Mana i te whenua
Customary authority exercised by hapū or iwi over a particular area of land.

Mauri
Life force or vital essence; the binding force between the physical and spiritual.

Motuhaketanga

The state of being self-determining and independent, according to tikanga and whakapapa. Motuhaketanga reflects the authority of hapū and iwi to govern in ways consistent with Māori law and relationships, distinct from Western notions of sovereignty. It is a foundational concept in Māori constitutional thinking.

Noa
A state of neutrality or balance, often contrasted with tapu (sacredness); enables safe everyday interaction.

Papakāinga
Communal housing or settlement on ancestral land.

Tangata whenua
People of the land; used to describe Māori with ancestral connection to a particular place.

Taiao
The natural world; often used to describe an interconnected environmental system.

Taonga
Treasured item, resource, or relationship; may be tangible or intangible.

Tapu
Sacredness, restriction, or spiritual protection; requires observance of proper conduct.

Te Mana o te Wai
A foundational principle in freshwater law affirming the vital importance of water and prioritising its health.

Tikanga
Correct procedure or customary practice; context-specific and grounded in whakapapa and collective ethics.

Tino Rangatiratanga
Absolute authority or self-determination; often referenced in legal and political contexts.

Tohu
Sign, signal, or environmental indicator; may be physical, spiritual, or relational.

Wai
Water; understood as a living entity and taonga.

Wairua
Spiritual essence or soul; present in people, environments, and relationships.

Whakapapa
Genealogy or layered interconnection; a core organising principle in Māori worldviews.

Whānau
Extended family or kin network; foundational to social organisation and support.

Whenua
Land; also means placenta, reflecting the deep relational significance between people and land.

G. List of Acronyms

BOD – Biochemical Oxygen Demand

CEC – Contaminants of Emerging Concern

COD – Chemical Oxygen Demand

EC – Electrocoagulation

EDC – Endocrine Disrupting Chemical

FNDC – Far North District Council

I&I – Inflow and Infiltration

MBR – Membrane Bioreactor

NPS-FM – National Policy Statement for Freshwater Management

NRC – Northland Regional Council

PFAS – Per- and Polyfluoroalkyl Substances

RMA – Resource Management Act

SBR – Sequencing Batch Reactor

TSS – Total Suspended Solids

TToW – Te Tiriti o Waitangi

UV – Ultraviolet

WWTP – Wastewater Treatment Plant