Carbon Inventory Report for *Far North District Council*

Period: Financial Year 2018/2019

Far North District Council

Te Kaunihera o Tai Tokerau ki te Raki

Contact Details

Ryan Houba

WSP

Mansfield Terrace Service Lane
125A Bank Street
Whangarei 0110
+64 94376321
+64 21 0220 4649
ryan.houba@wsp.com

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Prepared by
Brigitte Hicks

Reviewed by
Dr. Rowan Dixon

Approved for release by
Eros Foschieri – 3 Waters, Work Group Manager (Whangarei)

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Executive Summary

Far North District Council (FNDC) commissioned WSP New Zealand to calculate it's organisational or 'corporate' greenhouse gas (GHG) inventory for the financial year 2018/2019.

FNDC has adopted a climate change roadmap to mitigate and adapt to a changing climate. This corporate GHG inventory is part of this work, helping FNDC to 'walk the talk' and formulate a carbon reduction programme of work for the Long-Term Plan (LTP).

Methodology

The preparation of the GHG inventory follows the guidelines in the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, 2004 (GHG Protocol) and the Corporate Value Chain (Scope 3) Accounting and Reporting Standard, 2011.

The GHG inventory followed the operation control approach. FNDC therefore accounted for 100% of emissions from operations over which it owns or controls, within the limits of data availability. This includes emissions from all wastewater treatment plants (WWTP) and drinking water treatment plants (DWTP) in scope 1, which are considered direct emissions for FNDC.

The GHG Inventory reports on all direct emissions, indirect emissions from electricity and several other indirect emissions. Exclusions and data limitations are explained in the report.

Table 1 Emissions included and excluded in FNDC operational boundary

Scope 1	Scope 2	Scope 3	Exclusions/Gaps in data
Diesel	Purchased Electricity for Facilities, WWTP and DWTP	Air Travel	Office waste
Regular Petrol		Employee commute	Taxis & Rental Cars
Premium Petrol		Freight of waste (from transfer stations)	Accommodation
Landfill (owned)			Embodied carbon in capital projects e.g. roading
Stationary combustion			Chemicals
Refrigerants			LPG Stationary
WWTP			Natural Gas

A data quality management plan was developed that enabled the quality of each data source to be understood. This included WWTP data which was scored satisfactory but not robust. Recommendations for data quality improvement are made in section seven of this report.

Results

In 2018/19, FNDC's carbon footprint is estimated as 6,241 tCO_2e (tonnes of Carbon Dioxide Equivalent). This is made up of 4,707 tCO_2e of direct emissions (Scope 1), 391 tCO_2e of electricity indirect emissions (Scope 2) and 1,143 tCO_2e of indirect (Scope 3) emissions.

WWTP emissions are by far the biggest (51%) including 2,856 tCO_2e methane and 300 tCO_2e nitrous oxide. The second largest emissions source is the Russell Landfill (16%). WWTP and

DWTP are the largest electricity consumers, followed by FNDC's facilities including offices, service centres, information centres and street lighting.

Opportunities and Recommendations

FNDC will benefit from using this baseline inventory to inform carbon reduction activities within its Climate Change Roadmap. It may also wish to integrate these within its long term plan, capital works programme and asset management plans.

The next step is to explore reduction solutions and engaging key stakeholders to establish carbon reduction targets and a long-list of interventions. It is recommended that interventions be refined and ranked based on: carbon reduction targets (where biogenic methane has less stringent targets than other greenhouse gases), carbon reduction potential, cost to implement, payback period and managerial, technical, commercial and procurement implementation processes. This will support more informed decision making for FNDC's Councillors and Leadership Team.

More detailed recommendations are made in section four of this report, however key emissions reduction opportunities to investigate in line with the Climate Change Response (Zero Carbon) Amendment Act and Climate Change Commission include:

- Exploring options to better quantify and ultimately reduce emissions from WWTPs
- Exploring options for the Russell landfill
- Improving energy and electricity efficiency to reduce consumption
- Reducing the role of fossil fuels in vehicle use and electrifying the vehicle fleet

1 Introduction

Far North District Council (FNDC) commissioned WSP New Zealand to calculate its organisational or 'corporate' greenhouse gas (GHG) inventory for the financial year 2018/2019. This report includes the results from the inventory, context for FNDC's emissions sources and reduction opportunities and recommendations.

1.1 Organisation and District Structure

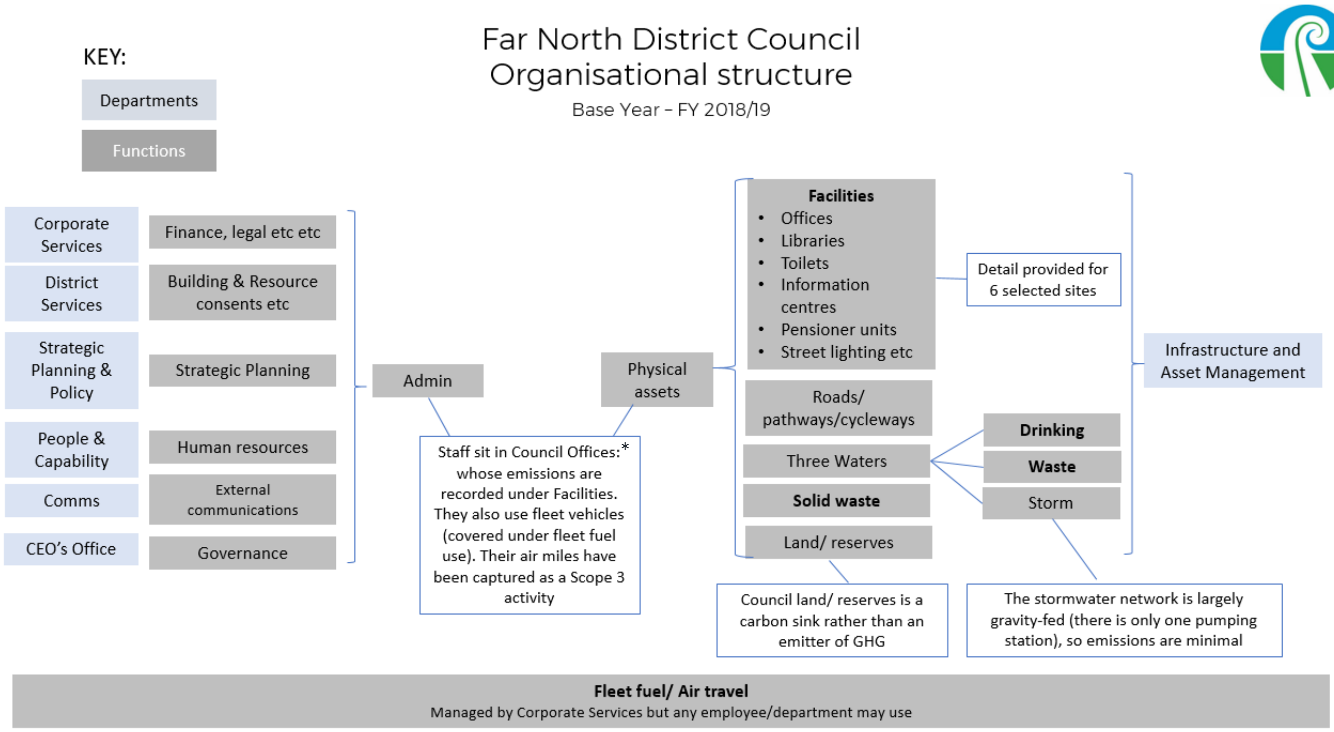
The Far North District covers an area of 6677 km^2 and has a population of 68,500 (June 2019). It has a low population density of 10.3 people per km^2. The district is made up of small and medium sized towns with no large centres of population.

FNDC is 9th out of 67 territorial authorities by area. It is 13^{th} in population size and 32^{nd} in terms of population density.

FNDC is responsible for a wide range of activities across the district, including management of local infrastructure and services. Activities include;

- Supply and management of local infrastructure and services, including drinking water treatment and supply, wastewater treatment, waste collection and transfer, libraries, parks, recreation services and town planning.
- Strategic planning for the district – delivered through statutory instruments, such as the district plan, long term plan and other non-statutory documents.

Figure 1 FNDC Area Map



* The above diagram is based on the situation applying in the 2018/19 financial year, the base year for the inventory. With the COVID-19 lockdown and subsequent changes to staff working patterns, some major changes have occurred e.g. staff in general no longer sit in Council Offices but work from home.

1.2 The Far North and a changing climate

A changing climate will have specific impacts on the Far North. Key concerns include:

- Compared to 1995, temperatures may be 0.7˚C to 1.1˚C warmer by 2040
- Droughts may increase in both intensity and duration leading to water shortages, increased demand for irrigation and increased risk of wild fires.
- Future frosts may become extremely rare.
- Coastal roads and infrastructure may face increased risk from coastal erosion and inundation, increased storminess and sea-level rise.
- Production of some crops (such as kiwifruit) may become uneconomic in Northland by 2050 because of a lack of winter chilling.
- Impacts due to climate change will be disproportionately borne by vulnerable groups.

FNDC has adopted a climate change roadmap to mitigate and adapt to the changes outlined above. The corporate GHG inventory will complement this work, helping FNDC to 'walk the talk' and formulate a carbon reduction programme of work for the LongTerm Plan (LTP).

1.3 Purpose of Greenhouse Gas inventory

This organisational GHG inventory is *a breakdown and total sum of the emissions occurring as a result of activities under the control of* FNDC between 1st July 2018 and 30th June 2019 (FNDC's financial year). The objectives of the inventory are to:

- Quantify FNDC's overall organisational GHG emissions for Scope 1, 2 and 3 emission sources,
- Establish a baseline year for the inventory and provide a standard methodology for use in future inventories,
- Provide FNDC with information for engaging with key stakeholders, including employees, contractors and the Far North community,
- Recommend high level actions that would enable the Council to reduce its emissions.

2 Methodology

This inventory follows the guidelines in the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, 2004 (GHG Protocol). The following section outlines the methodology and approach used to develop the inventory including: boundary definition and exclusions, emission factors, activity data, assumptions and limitations.

2.1 Organisational and Operational Boundary

FNDC's inventory boundary consists of an organisational and an operational boundary. The organisational boundary relates to the ownership aspect of FNDC and its subsidiaries, and which organisations FNDC chose to account for. FNDC used the control approach to do this by including the GHG emissions from the operations over which it has control. FNDC has not accounted for GHG emissions from operations in which it owns an interest but does not have control of its operating policies. An example of this is Far North Holdings Limited, which FNDC owns but does not have direct control of the operating policies of its assets or the ability to directly influence their GHG emissions. As such, Far North Holdings Limited was excluded from the organisational boundary.

2.1.1 Operational Boundary

The operational boundaries were set within the organisational control approach so that the emissions of all operations where FNDC controls operating policy are included in the GHG inventory. The inventory boundary therefore includes all wastewater treatment plants and drinking water treatment plants and one owned landfill in Russell that is managed by Broad Spectrum. Other emission sources included in the boundary are all facilities including offices, service centres, libraries, community centres, housing for elderly, public toilets and street lights.

The GHG Inventory reports on all direct emissions (scope 1), indirect emissions from electricity (scope 2) and several other indirect emissions (scope 3).

Scope definitions:

- Scope 1: Direct GHG emissions occurring from sources that are owned or controlled by FNDC, for example, emissions from combustion in owned or controlled boilers, natural gas for heat production, petrol and diesel for fleet vehicles, stationary diesel for boilers, refrigerants for central air conditioning, sewage from owned treatment plants, etc.
- Scope 2: GHG emissions from the generation of purchased electricity consumed.
- Scope 3: Indirect GHG emissions that occur in the value chain. Scope 3 emissions are a consequence of the activities of FNDC that occur from sources not owned or controlled by FNDC. These would include staff air travel, taxis, waste generated from operations (office waste, recycling, general waste), freight and employee commuting. Scope 3 is an optional reporting category.

2.1.2 Operational Boundary Exclusions

Potential emission sources and their inclusion in the project boundary were discussed throughout the 'boundary and definition' task with FNDC.

Size of emissions and ability to measure emissions were used to determine the materiality of the various emission sources and their inclusion in the boundary. A data management plan was used throughout the data collection process.

Data sources were given quality ratings such as robust, satisfactory or poor. These ratings can be found in the accompanying data collection spreadsheet. Further explanation on the data quality rating system can be found in Appendix A; *Data Quality*

The tables below list inventory exclusions and explanations for the exclusions.

Scope 1

Potential Emissions Source	Reason for Exclusion
DWTP	Insufficient data available
LPG	Insufficient data available
Natural Gas	Insufficient data available

Scope 3

Potential Emissions Source	Reason for Exclusion
Office waste	No detailed data was available
Taxis & Rental Cars	De minimus - likely to be a very small source of emissions
Accommodation	De minimus - likely to be a very small source of emissions
Capital projects embodied carbon	Insufficient data available
WWTP & DWTP Chemicals	Insufficient data available
Upstream assets	None identified or not applicable
Processing of sold products	
End-of-life treatment of sold products	
Use of sold products	
Franchises	
Investments	
Upstream leased assets	

2.2 Inventory Emission Sources, Emission Factors and Activity Data

The following section contains all activities covered in the GHG inventory. A brief description of the data collection process, data source and quality of the data has been included.

All emissions factors are derived from Ministry for Environment (2019). Emission factors all include the six direct Kyoto gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) in accordance with requirements under the GHG Protocol.

2.2.1 Scope 1 Direct Emissions

Vehicle combustion

As of 30 June 2019, (the end of the inventory period), FNDC had 73 vehicles in its fleet. This included 23 petrol and 50 diesel vehicles. The vehicles run on either diesel, or regular and premium unleaded petrol.

All fuel data was derived from Card Smart Fuel Cards, a service run by Card Smart Ltd. The activity data is considered to be robust.

Stationary combustion (gas and diesel)

Emissions from stationary combustion have come from different data sources and locations. The Kaikohe office has a standby generator for electricity outages. Diesel use for this has been included in the Card Smart diesel purchases.

The Paihia WWTP is remote with no access to an electricity line and is therefore powered by a diesel generator. As the current operation is a new installation, historic data is not available. However, the current usage rate is assumed to be 400L of fuel a year.

The Kaitaia Service Centre, library and i-site has a backup diesel generator that runs for ½ an hour once a month to ensure it is in good working condition and starts when there is a power outage. It was difficult to estimate actual use as it is rarely topped up. An estimate of 100l per annum assumption was proposed. However, due to poor data quality this has been excluded from the inventory report and results.

Data for stationary combustion as a whole is considered to be satisfactory.

Wastewater Treatment Plants

The inventories approach to WWTPs has followed a treatment process calculation rather than the MfE population calculation. Based on the guidance from the Intergovernmental Panel on Climate Change (IPCC), methane (CH_4) and nitrous oxide (N_2O) emissions resulting from WWTP processes were calculated based on the facilities' treatment processes, base population and flow data from the FNDC Long Term Plan.

In following this approach FNDC will not benefit from benchmarking against other councils who have not followed this approach. FNDC will instead have a more accurate understanding of the emissions from each WWTP and once action is taken to reduce emissions at each facility, the measured reductions will be captured during monitoring.

The data quality is considered to be satisfactory. For further detail refer Appendix B; *Basis of Carbon Footprint Calculations for WWTP*.

Drinking Water Treatment Plants

Scope 1 emissions resulting from drinking water treatment plants include diesel stationary combustion (electricity consumption). This was not screened for in the data collection process. It is therefore recommended that a screening of stationary combustion be completed in future inventories.

Chemicals used in treating drinking water are considered scope 3. This data was also not provided for the 2019 inventory. It is recommended that chemical data is gathered for future inventories.

Landfill

The Russell Landfill gas generation (and subsequent emission) capacity was derived using the LandGEM Landfill Gas Emission Model (Version 3.02). The model was developed by the United States Environmental Protection Agency Clean Air Technology Centre to quantify landfill gas emissions. LandGEM is a first-order decay model whose purpose is purely to estimate landfill gas emissions over time within the waste mass.

The data quality is considered to be robust. For further detail refer Appendix C; *Basis of Carbon Footprint Calculations for Russell Landfill*.

Refrigerants

Activity data was derived from records of Active Refrigeration Ltd for the Kerikeri office server room and Chill Technology Ltd for the whole building in Kerikeri. The data quality is considered to be satisfactory.

2.2.2 Scope 2 Indirect Emissions

Electricity

Electricity consumption data has been provided by Meridian and Genesis Energy. Activity data was gathered from numerous meters and amalgamated reports for the financial year

2018/19 from Meridian and Genesis Energy This data was gathered for all facilities, including offices, libraries, community halls, housing for elderly and street lights, etc.

Electricity consumption data for WWTP and DWTP was provided separately from Broad Spectrum Ltd, the operator of these plants.

The activity data is considered to be robust.

2.2.3 Scope 3 Other Indirect Emissions

Air Travel

Air travel data was sourced from FNDC financial records. In accordance with recommendations from MfE, an uplift factor of 8% was added to all airline travel. This is to compensate for indirect flight routes, circling and delays. While this figure is not likely to be accurate in every situation, it is a conservative approach in the absence of more specific information. Emissions associated with a given flight will be dependent on variations in aircraft type, fuels used, weather conditions, flight paths and loads.

The activity data is considered to be robust.

Employee commute

In the financial year 2018/19 an employee scheme via IRD paid back 191 staff members who commute 20 kilometres or more to work each day (round trip). Activity data was sourced from FNDC financial records and includes the information required for reporting to Inland Revenue. This data excluded 98 staff who did not qualify for the scheme.

Activity data is considered to be satisfactory.

Waste Transportation (Recycling Transfer Stations)

Fuel use from the Russell, Waipapa and Kaikohe recycling transfer stations was derived from weighbridge data from the three collection sites. These transfer stations consist of mainly household waste collected at these transfer stations.

The data excludes kerbside collection and industrial and commercial waste that is collected by private companies. All solid waste is trucked out of district to Whangarei by contractors (Northland Waste and Waste Management) while recycling waste is trucked to Auckland. The activity data is considered to be satisfactory.

3 Results

This section presents the results of the FNDC carbon foot printing study. It presents:

- A broad overview of all activities
- An overview of the emissions
- A focus on each of the key emission sources.

Emissions are presented in carbon dioxide equivalent (CO_2e), a standard unit for measuring and reporting greenhouse gas emissions.

3.1 All Activities and Scopes

In 2018/2019, FNDC's carbon footprint is estimated as 6,176 tonnes CO2e (tCO_2e). Table 1 provides a summary breakdown of all the emissions included in the carbon footprint. The largest source of emissions was the WWTP which contributed 3,212 tCO_2e.

Table 1 Far North District Council Emissions Inventory Summary

Source	kg CO2e	% of total
Scope 1		
Fuel	441,679	7%
Facilities	54,964	1%
WWTP	3,211,766	51%
Landfill	998,800	16%
Scope 2		
Electricity for facilities (offices, service centres, libraries and street lighting etc)	126,960	2%
Electricity for Waste Water Sites	147,349	2%
Electricity for Processing Drinking Water Sites	116,245	2%
Scope 3		
Air Travel	70,671	1%
Commuting	702,109	11%
Waste Transfer	370,584	6%
Total	**6,241,127**	**100%**

Figure 1 shows the breakdown of total emissions by scope of which 4,707 tCO2e are direct emissions (Scope 1), 391 tCO2e are from electricity indirect emissions (Scope 2), and 1,143 tCO2e are indirect emissions (Scope 3).

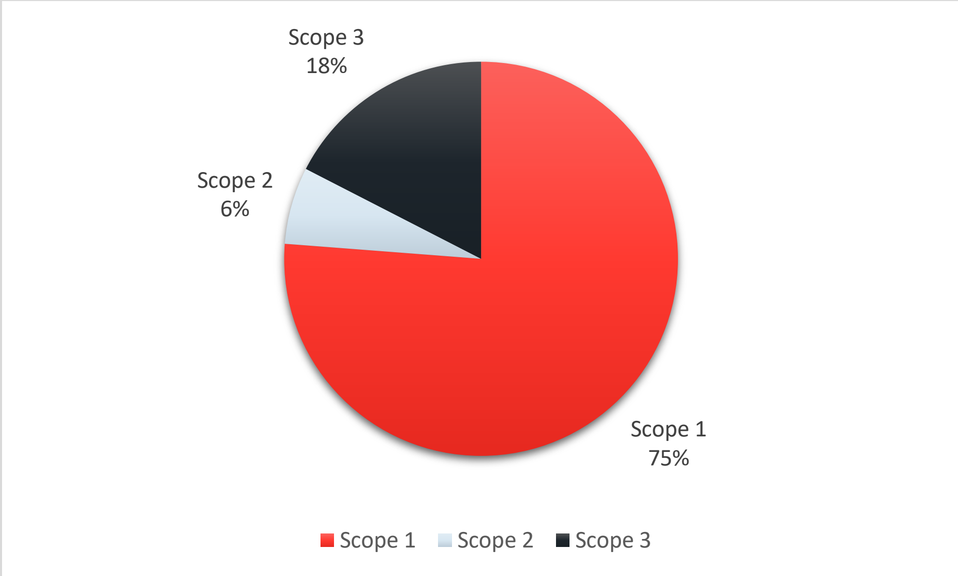


Figure 2 Total Emissions by Scope

3.1.1 Scope 1 Direct Emissions

Scope 1 emissions represent the dominant source of emissions, accounting for 75% of the overall footprint. The majority of the emissions come from the 16 WWTPs, which are responsible for 3,212 tCO_2e.

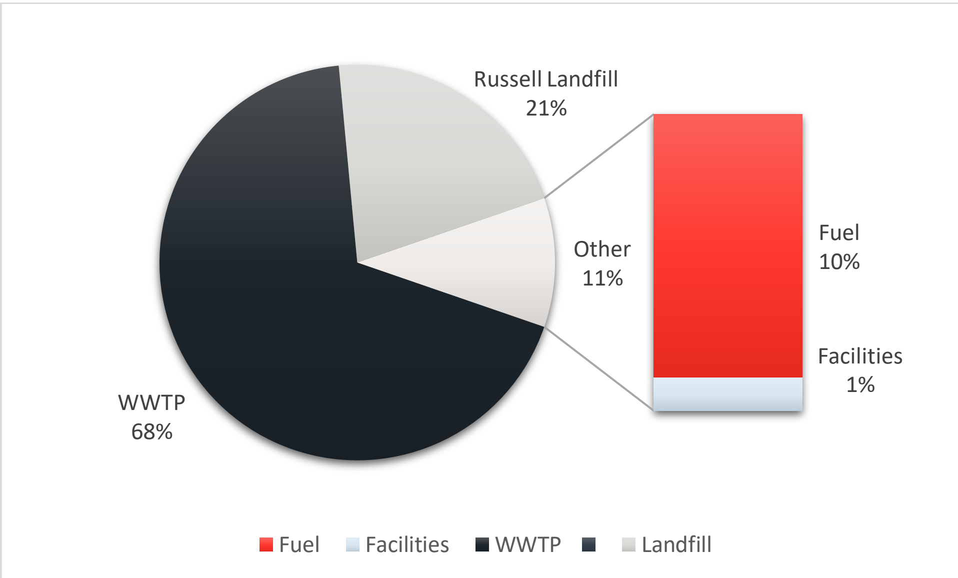


Figure 3. Scope 1 Emissions by Source

WWTPs account for 51% of FNDC's total emissions output, and 68% of the Scope 1 emissions. FNDC has a larger than average number of WWTPs for a local council due to the spread out nature of the district, small and medium sized towns with no main town centre within which a WWTP for the whole district could reasonably be located. Approximately half of the FNDC community are connected to the wastewater systems. Additional emissions from private systems and septic tanks may also be significant in the district but do not fall within the scope of this inventory.

Paihia is the largest contributor of emissions, followed by Kaikohe with both of these WWTPs featuring anaerobic ponds which contribute relatively high levels of methane when compared to other types of WWTP. Rawene also features an anaerobic pond. Overall these three WWTPs with anaerobic ponds service 31% of the connected population, however, contribute 60% of the WWTP methane emissions for the district. GHG emissions from Whangaroa wastewater were excluded as the treatment system is septic tanks with a very low population base

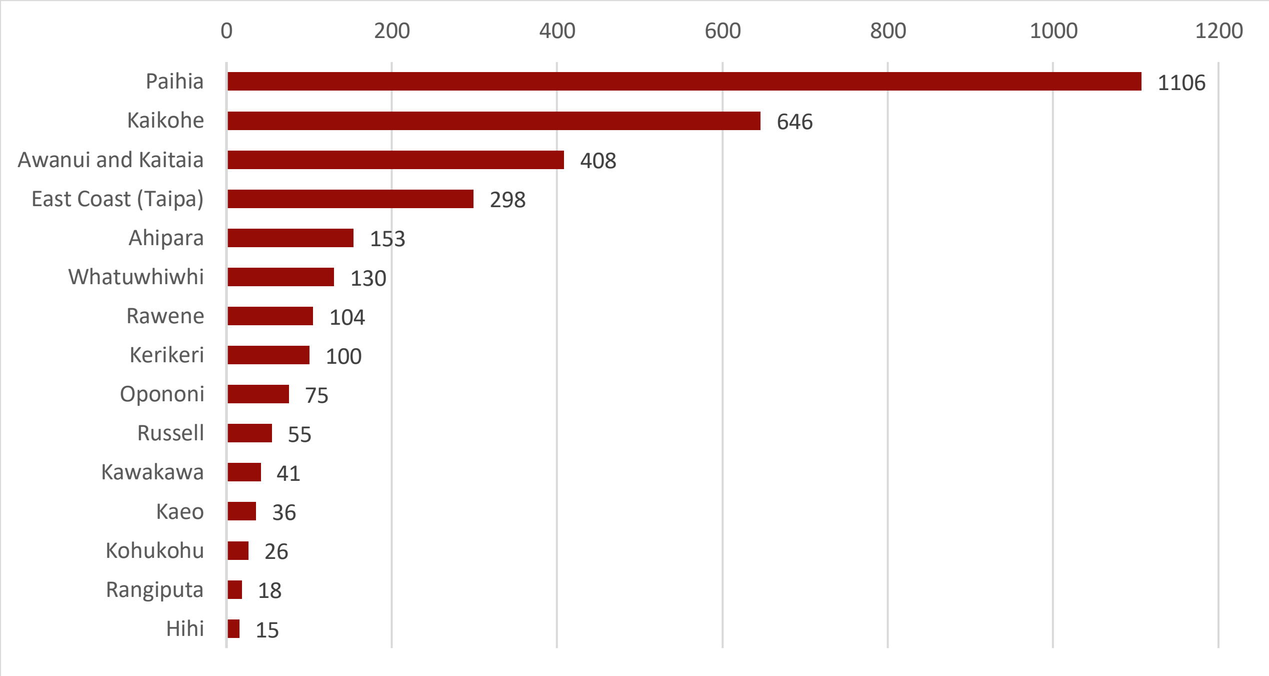


Figure 4 Scope 1 WWTP breakdown (tCO_2e)

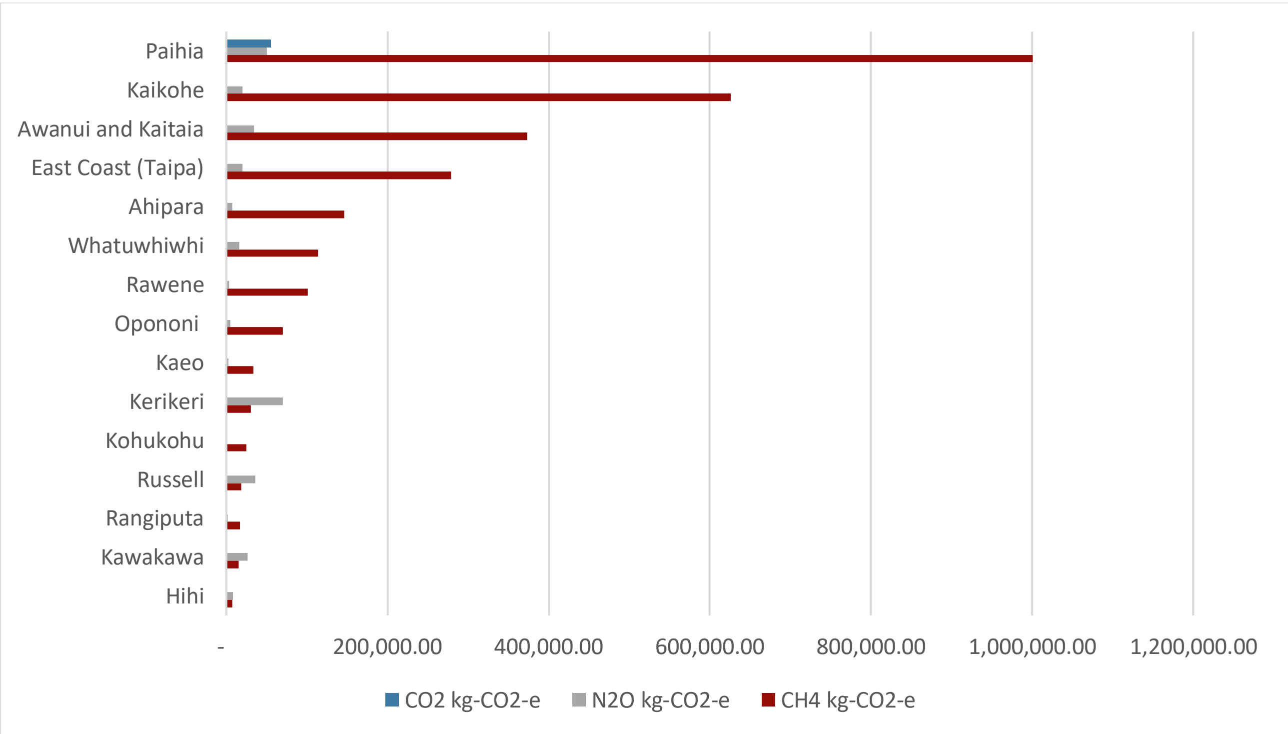


Figure 5 Scope 1 WWTP Breakdown of Carbon Equivalent Emission Types

CO2-e = Carbon Dioxide Equivalent (e.g. stationary combustion generator at Paihia)
N2O = Nitros Oxide
CH4 = Methane

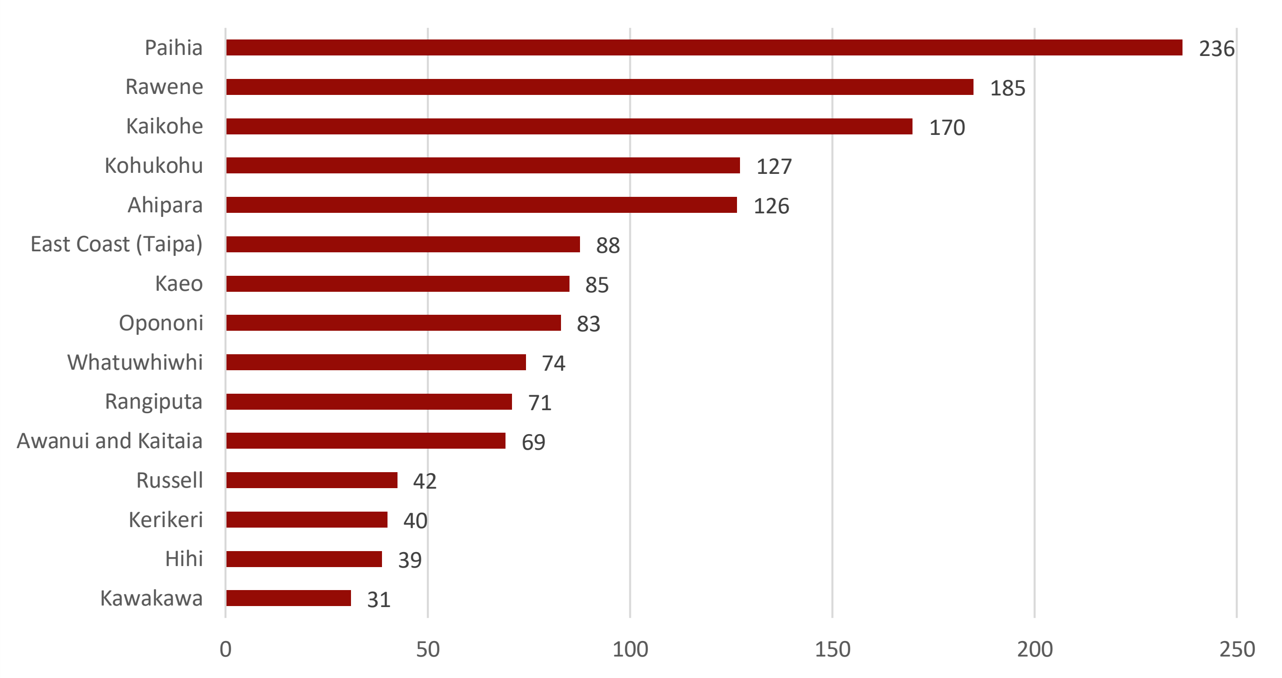


Figure 6 Scope 1 WWTP kgCO2-e per capita

The Russell Landfill is the second largest source of Scope 1 emissions contributing 999 tCO_2e. However, the Landfill received only 11% of the solid waste collected by FNDC, and approximately 4% of the waste estimated to be produced within the District. The remaining 96% of the waste generated in the district is either collected at the transfer stations and transported to the Puwera capped landfill in Whangarei (see scope 3 below) or is collected commercially. As such, the majority of the GHG emissions from waste generated in the FNDC jurisdiction is excluded from this GHG inventory. It is estimated that only 33% of the district's waste collection and transfer is handled by FNDC, with the other 67% commercially managed from kerbside and commercial or industrial collection. Additional waste is internally managed on farms throughout the district.

FNDC fleet fuel usage contributed 442 tCO_2e, of which there was an 80:20 split of diesel to petrol fleet usage, though there is a 68:32 split of diesel and petrol vehicles within the fleet, respectively. Due to the district's low population density and spread-out small to medium town sizes, fuel use emissions are relatively large compared to other councils such as Rotorua Lakes District Council (195 tCO_2e) Upper-Hutt City Council (102 tCO_2e) and Waitaki District Council (149 tCO_2e).

Of the council facilities included in the scope 1 operational boundary, only the Kerikeri Office reported sufficient data for scope 1 measurements, of which the only source was refrigerant use. This accounted for 55 tCO2e. While refrigerant usage is seemingly low (est. 29.5 kg), it has a very high global warming potential and thus forms a relatively high proportion of the GHG inventory. Refrigerants used by FNDC include R32 And R410. Emissions factor for these sources are 675 (R32) and 2,087.5 (R410A), meaning that they are 675 and 2,087.5 times more potent than CO_2 in warming the planet.

There were no direct emissions sources reported from other facilities in the operational boundary.

3.1.2 Scope 2 Indirect Emissions

Scope 2 emissions are generated from consumption of grid supply electricity for three main functions: facilities, wastewater sites, and processing drinking water sites. The electrical usage results in a total Scope 2 emission of 391 tCO_2e.

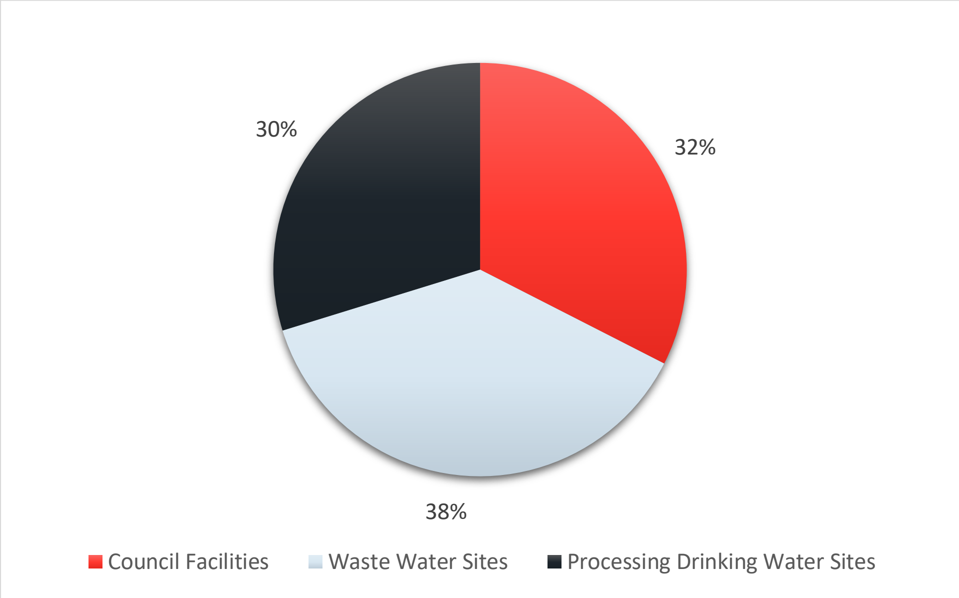


Figure 7 Scope 2 Emissions by Source

WWTP and DWTP were the largest contributors to electrical emissions overall (38% and 32% respectively – in total 70%).

Offices, service centres, and information centres were the largest contributor of electrical emissions for council facilities at 48%. Streetlights were another high contributor with 32% of council facilities electrical emissions.

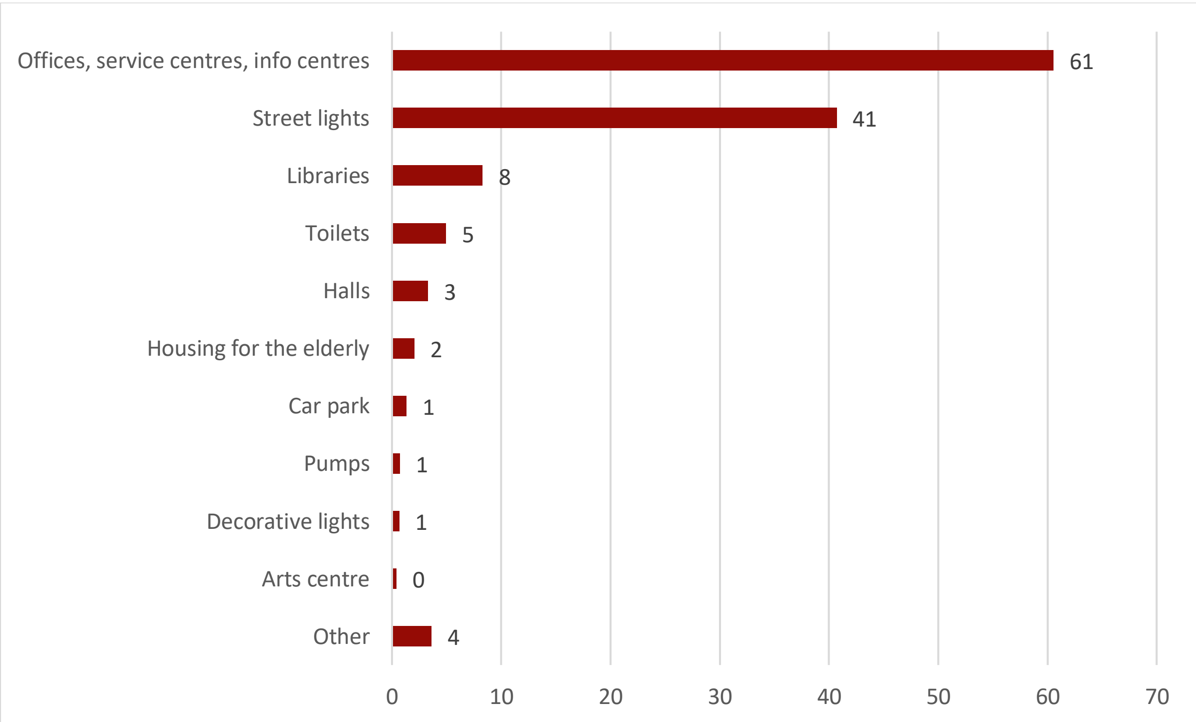


Figure 8 Scope 2 Electrical Breakdown by Council Facilities (tCO_2e)

3.1.3 Scope 3 Indirect Emissions

Scope 3 emissions totalling 1,143 tCO_2e are generated from three main sources: Waste Transfer, Commuting and Air Travel. The largest contributor of indirect emissions comes from the commuting scheme FNDC has in place to support FNDC staff living 20km or more from their place of work (round trip), this incentive supported 66% of the council staff members in the 2018/19 financial year, resulting in 2.6 million kilometres driven. Commuting emissions from the remainder of FNDC staff (32%) is unknown. The transportation of recycling to Auckland and solid waste to the Puwera capped landfill in Whangarei contributed 33% of FNDC's scope 3 emissions. Note this doesn't include the collection of waste from remote sites to the consolidation sites before it is transported south.

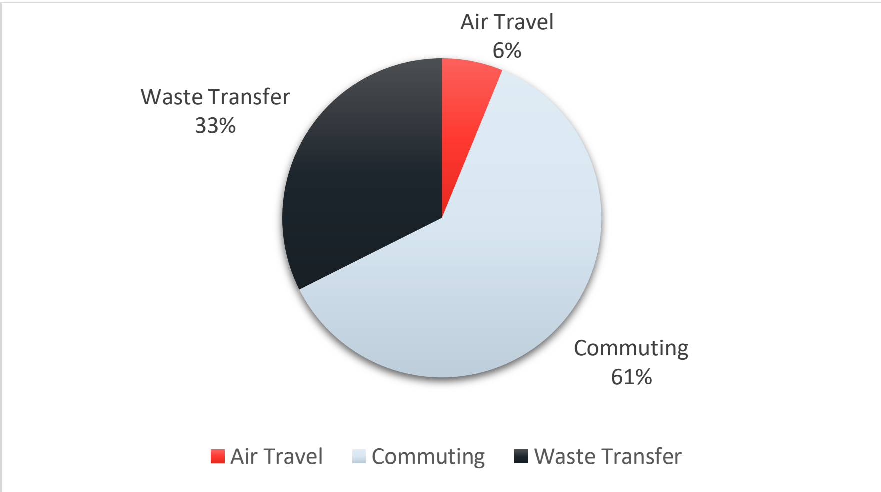


Figure 9 Scope 3 Emissions by Source

4 Carbon reduction opportunities and recommendations

This section describes the range of carbon reduction opportunities that FNDC might consider implementing. In many cases, there will be financial savings or other economic benefits associated with implementing these recommendations.

4.1 Wastewater Treatment Plants

Sixty percent of emissions from the WWTPs come from the anaerobic style plants, notably the Paihia and Kaikohe plants. It is recommended that FNDC plans to move away from the anaerobic pond technology when plants are upgraded.

Given the scale of WWTP scope 1 emissions and the inherent uncertainty in the data it is also recommended that monitoring programmes be established for WWTP methane and nitrous oxide emissions. In response to the monitoring results, it is recommended that FNDC workshop appropriate options for decreasing the WWTP emissions and include these in the Council's long term plan and capital works programme. This may include asset upgrades and optimisation of the operation of existing plants.

To improve the accuracy of future forecasts it is recommended that FNDC collects influent flow data and routinely monitors the incoming wastewater for BOD (organic matter) and for TKN (nitrogen) that provide key data in the assessment. It is recognised that this data need be of sufficient frequency to determine the changes of emissions as a result of visitors to the district that can substantially increase the population served.

4.2 Electricity Consumption

The three sources of electrical consumption, Wastewater Sites, Drinking Water and Facilities were all relatively equal in their emissions. We suggest efficiency measures are investigated separately for the operation of FNDC buildings, streetlighting, wastewater and drinking water treatment sites. The opportunities for improvement are likely to be different for different types of facilities, and also unique within those types (i.e. office buildings are not all the same and are likely to require separate energy efficiency effort).

4.3 Vehicle and Fuel Usage

The FNDC fleet makes up 7% of scope one emissions with a large percentage of emissions from diesel vehicles (88.3 tCO_2e from petrol and 353.4 tCO_2e from diesel). Staff commuter fuel use is the largest source of Scope 3 emissions. This area is heavily influenced by FNDC's Creating Great Workplaces Programme (see section 4.5) The following options could be explored to reduce fuel consumption:

- Transition fleet vehicles to electrical vehicles (EVs) or other fuel or transport alternatives to reduce fossil fuel use
- Whilst transitioning to an EV fleet, encourage the use of petrol fleet vehicles rather than diesel as petrol vehicles are generally less carbon intensive
- Investigate the feasibility of transitioning diesel vehicle to a biodiesel blend to reduce the carbon intensity of the diesel fleet
- Encourage and / or create an incentives scheme to support commuting staff to transition their private vehicles from carbon intensive options (diesel and petrol) to low carbon alternatives

- Encourage and / or create an incentives scheme to support commuting staff to carpool and reduce the quantity of individual trips made
- Consider opportunities for driver efficiency through training and behavioural programmes.

4.4 Landfill Emissions

- In order to reduce the emissions from the Russel Landfill the following options could be investigated: Divert methane generating waste (e.g. food waste) from the landfill, and set up a composting scheme to capture the diverted waste
- Gas capture to power a gas generator
- Install a flare to destroy the methane
- Upon closing the landfill at the end of its useful life, install a biocap which can increase oxidation rates of methane passing through it, converting it to CO_2.
- Alternatively, close the landfill before it reaches capacity and truck waste to the Puwera landfill – this would save an estimated 990 tonnes of carbon

4.5 Creating Great Workplaces

Creating Great Workplaces is FNDC's new programme to develop an operating rhythm that supports the future work environment of the Council. Teams are developing new ways of working together online, in new collaboration spaces, in remote locations and at home. Following the COVID-19 lockdown a high percentage of employees are continuing to work from home on a more frequent basis. As the Creating Great Workspaces programme develops and behaviour change is embedded, the following emission sources may be reduced or altered:

- Fuel usage for the commercial fleet may alter depending on the proximity of staff at the required work within the district. Digitisation of work records is already reducing the need for field staff to come into the offices.
- Reduction in Scope 3 employee commute emissions as more staff work from home, including a reduction in the employee scheme via IRD where 191 employees who commuted 20 kilometres or more to work each day (round trip) were paid back in the 2018/19 financial year. This scheme has been on hold since the pandemic lockdown.

The following recommendations will help align the Creating Great Workplaces Programme with FNDC's GHG emissions inventory and emission reduction action plans;

- Conduct annual employee surveys to record commuting details such as kilometers travelled and mode of transport as well as asking about their home heating arrangements in work hours (with employees largely working from home, the additional energy to heat their homes in work hours will increase their carbon footprint compared with working in air conditioned offices)
- Calculating employees' personal carbon emissions and embedding behaviour change e.g. through the FutureFit programme developed by Auckland Council.
- Launching an employee e-bike purchase support scheme by following the NZTA scheme guide. Other Councils have followed this approach such as Tauranga City Council where this scheme has enabled 50 staff to purchase e-bikes for their work commute.
- Monitor employee commuting patterns annually to enable carbon emissions to be calculated.

4.6 Strategic Planning

Where a culture of an organisation and its supply chain has been engaged to decarbonise a programme, the result can be astounding. To begin this work and following strategic development, the following actions are recommended:

- Any investment in new assets and capital equipment should mandate energy efficiency and low carbon options as key considerations in decision making and procurement processes
- Use this GHG inventory to set Science Based Carbon Reduction Targets (absolute and/or intensity) for the Council and its departments including KPIs to assess progress against these targets
- Engage key stakeholders to establish a long-list of interventions to reduce emissions and then refine and rank them based on: carbon reduction potential, cost to implement, payback period and managerial, technical, commercial and procurement implementation process (focus on WWTP's)
- Conduct a rapid review of the FNDC policies, development guidelines, procurement systems and standards to identify how these can be revised to facilitate and encourage Council's decarbonisation pathway. This work was also identified in the Climate Change Roadmap and we understand that this is already underway starting with a proposed Climate Assessment Policy that will need to be taken through the policy development process at Council.

5 Forest Carbon Sequestration Guidance

The GHG Protocol does not require that GHG sequestration from forests is included in the organisational GHG inventory. However, offsetting the GHG emissions in this inventory through forest carbon sequestration can be a helpful approach, with considerable biodiversity, water, social and cultural co-benefits. The most widespread standard and method to include GHG sequestration from forests is under the NZ Emissions Trading Scheme (ETS) via the generation of NZ Units (NZUs), or 'carbon offsets'.

NZUs can be purchased on the open market or earned through participation in the ETS itself (i.e. growing forests and earning NZUs). There are other carbon offset options available to purchase on the open market as well, it is recommended further advice is sought before any decisions are made regarding those.

The generation and self-supply of NZUs to offset emissions by FNDC would have a number of key benefits:

- Additional value stream (NZUs) from existing forest planting and conservation activities, and as such a reason to expand such activities,
- Readily available supply of NZUs to offset emissions
- The self-supply of NZUs reduces FNDC's exposure to the price fluctuations on the open NZU market, especially as prices are expected to steadily increase in coming years.

There are several steps involved for Council to generate its own NZUs under the ETS. But importantly, forest land must be at least a hectare in size and have (or will have) tree crown cover:

- of more than 30% in each hectare from forest species
- with an average width of at least 30m.

If FNDC has operational control of forest land that meets this definition, then these are some of the key questions that need answering before each forest area can be included in the GHG inventory:

- What age is each forest area?
- Was the forest area established before 1990? Or after 1989?
- What is the area (ha) of the forest area?
- For areas 100 hectares or more (post-1989 forest) you must use the Field Measurement Approach (FMA)
- For areas less than 100 hectares you can use the look-up tables
- What is the species mix in the forest area? (I.e. pinus radiata, douglas-fir, exotic softwoods, exotic hardwoods, indigenous forest)

Depending on the above, the economic feasibility of available options and additional planting opportunities, it may be that FNDC can offset its own emissions, and / or earn income (and maybe profit) from the sale of NZUs on the ETS.

6 Cost of Offsetting

In 2019 the New Zealand Government passed the Climate Change Response (Zero Carbon) Amendment Act. This increases the Government to climate change adaptation and mitigation response and establishes a new, independent Climate Change Commission to provide expert advice, set carbon budgets for sectors and monitor these to help keep successive governments on track.

NZ will need to cut its net emissions in half by 2030, and a system of declining five-year carbon budgets will be put in place to get us there. As the 5 year carbon budgets are set and changes to the Emissions Trading Scheme (ETS) implemented, the cost of carbon will increase.

As of July 2020 the cost of a carbon credit is about $26 (NZU). This is estimated to increase to about $50 - $100[1] by 2030. Figures 9 and 10 give an estimate of the cost for FNDC to becoming 'net zero' if its current emissions do not change and the carbon price increases.

Note: When an organisation is "net zero" it means, they are either not emitting any GHG emissions from their activities, or more often, are purchasing offsets for what they do emit. The boundary of any net zero commitment is also an important consideration – does it include Scope 1, Scope 1 and 2 or Scope 1, 2 and 3? This can vary from organisation to organisation. Cost estimations have been provided below for scope 1 and 2 (figure 9) and all scopes (figure 10) collected in this GHG inventory.

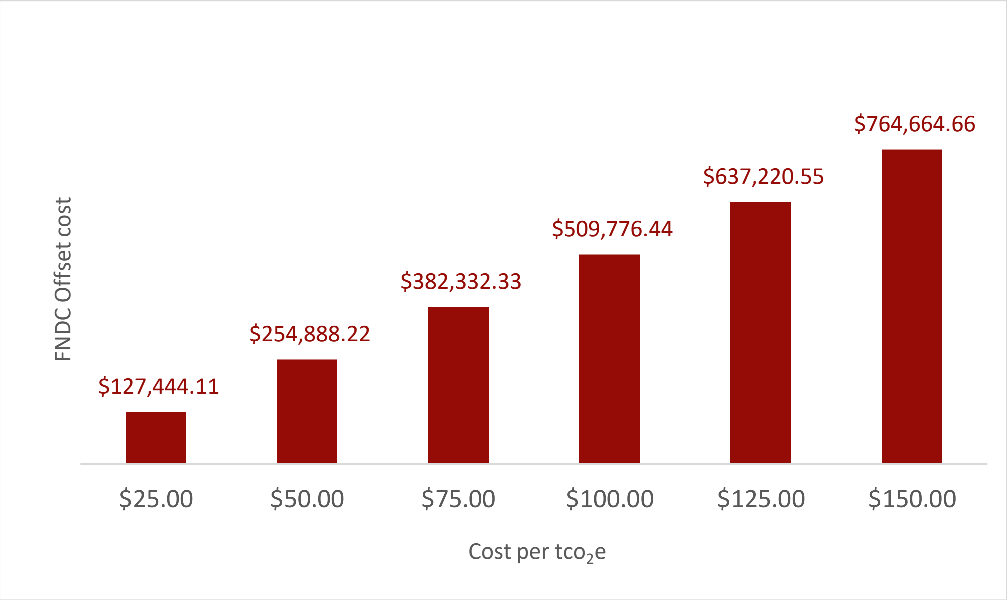


Figure 10 Cost of Carbon Offset for Scope 1 & 2 (5098 tCO_2e).

[1] Concept Consulting, Motu Economic and Public Policy Research, & Vivid Economics. 2018. Modelling the transition to a lower net emissions New Zealand: Uncertainty analysis. Wellington: New Zealand Productivity Commission.

Figure 11 Cost of Carbon Offset for all Scopes (6,241 tCO_2e).

7 Data Quality Improvement

Future emission inventories can be improved by increasing the quality and accuracy of the methods, data and collection process, inventory processes and systems, and documentation. It is recommended that subsequent inventories adhere to and aim to improve upon the data management plan which is based on the GHG Protocol Corporate Standard five accounting principles. By following and improving upon previous data collection methods, the quality and accuracy will become more accurate and reliable.

Going forward, it is suggested that FNDC annually assess the data gathering, input, tracking methods and handling activities prior to undertaking the annual emission inventory to ensure quality management and improvement for successive inventories. An annual report and check in with finance and procurement teams should also be conducted to ensure there are no gaps in the data collection process and to identify new suppliers.

We further recommend future emission management is governed by principles of Progressive Elaboration; by ensuring the inventory adapts as more valuable data and information comes to surface. By doing so FNDC will ensure its emissions management trajectory progressively becomes more attuned to emissions associated with its capex and opex spending.

7.1 Data improvements

The following data improvement initiatives could help FNDC move away from using default emissions factors. This would enable a more accurate representation of true emission sizes.

- Develop a system of tracking staff business travel, including accommodation, taxi, air travel and fleet vehicle use. The system should enable cross reference e.g. running a list of vehicle registrations against fuel cards
- Undertake an annual staff commute survey to determine kilometres travelled, vehicle type and mode type.
- Collecting vehicle type information for waste transfer station trucks and cross reference against kilometres.
- When selecting or reviewing supplier contracts include provisions so that FNDC can ask for suppliers to share data that is needed for emissions tracking, such as the fuel they used when providing their goods or services.

The following initiatives could also be considered:

- Run a finance report of all suppliers to ensure no emissions sources have been missed.
- A severe drought in 2020 made obtaining WWTP and DWTP data collection difficult in that staff were involved in a crisis management situation. It is recommended that future inventories include the use of treatment chemicals.

7.2 Long term data improvements

7.2.1 Wastewater and drinking water treatment

Collection of flow data and routine influent data for the Wastewater plants will provide a more accurate data set to estimate the emissions from each plant. This will reflect the impact of the seasonal visitors to the district on overall emissions.

It is recommended that testing is undertaken on a selection of process types to determine actual emissions in summer and winter conditions that can be used to inform decision making and refine the estimation of emissions.

It is not considered viable at this time to install continuous emissions monitoring technology across the district.

Chemicals are widely used in water treatment processes. Recording of chemical usage, through procurement, will enable improved tracking of associated emissions. Process optimisation may reduce these emissions and save operational budget.

7.2.2 Capital Projects and Council delivery

It is recommended that the carbon emission implications of FNDC's planning system are reviewed; including council strategies, infrastructure plans, district plan and zoning, growth strategies, long term plan, capital programme and asset management plans. This will identify the carbon emission impact of council plans and the opportunities to reduce emissions across capex and opex. Alongside a community wide GHG inventory, the emission projections of the planning system will offer FNDC insight into its forecast carbon performance relative to its community-wide goal of *zero carbon by 2050*. We recommend establishing emission management and tracking systems, and design and procurement support and tools to help ensure FNDC staff and systems deliver on this goal.

The benefits of this approach include:

- Confidence as to whether the Council and the Far North Community are on track with their targets
- Quantified evidence for input into low-carbon investment business cases; i.e. capex cost per tCO_2e reduced, and quantified contribution to emissions reduction goal.
- Deeper understanding of future emissions and emissions in the value chain
- Embedding a culture of low-carbon resilient thinking, innovation and delivery
- Ability to track emissions data across teams and throughout design, construction and maintenance
- Information that can feed into *Climate Related Financial Disclosure* such as TCFD disclosure
- Ability to prepare for cost-benefit analyses of opportunities.

8 Conclusion

FNDC has adopted a climate change roadmap to mitigate and adapt to a changing climate. This corporate GHG inventory is part of this roadmap, helping FNDC to 'walk the talk' and formulate a programme to achieve its emission reduction targets.

FNDC will benefit from using this baseline inventory to inform its carbon reduction activities. It is advised that these are embedded within the Long-term Plan (LTP), capital programme and asset management plans. A decarbonisation focus should be included in FNDC's WWTP portfolio which makes up 51% of FNDC's total emissions.

FNDC's approach to carbon reduction can be pragmatic and staged, but it must be ambitious, coordinated and funded.

Key recommendations include:

- Use this GHG inventory to advise the setting of Science Based Carbon Reduction Targets (absolute and/or intensity) for the Council and its departments including KPIs to assess progress against these targets,
- Engage key stakeholders to establish a long-list of interventions to reduce emissions and assess their carbon reduction potential, cost to implement, payback period and managerial, technical, commercial and procurement implementation processes (with a focus on WWTPs) to:
  - establish their value for money (emissions reduced per dollar spent, and other co-benefits)
  - enable the approval of their implementation and inclusion in Council plans and systems
- Conduct a rapid review of the FNDC policies, development guidelines, procurement systems and standards to identify how:
  - these can be revised to facilitate Council's decarbonisation pathway, and
  - approved carbon reduction activities can be included.

Next steps:

Following the release of this report a half-day workshop with key decision makers is recommended. This workshop can be used to:

1. discuss the outcome of the inventory in the context of the *FNDC Responding to Climate Change Roadmap*,
2. explore approaches to setting Council carbon reduction targets, and agree a preferred approach,
3. discuss and agree key stakeholders to be involved in the identification of carbon reduction activities,
4. identify any already apparent reduction activities to be analysed (value for money, payback period etc)

5. discuss and agree a list of council documents, plans and systems (such as LTP, capital programme, asset management plans, procurement system) to review and embed low-carbon delivery, and
6. discuss how Council will engage its people in this journey.

9 Limitations

This report ('**Report**') has been prepared by WSP exclusively for Far North District Council ('**Client**') in relation to calculating it's organisational or 'corporate' greenhouse gas (GHG) inventory for the financial year 2018/2019 ('**Purpose**') and in accordance with the with the scope of work and for the purpose outlined in the Offer of Service and Short Form Agreement dated 20/12/2019.

The findings in this Report are based on and are subject to the assumptions specified in the Report, Data Collection Spreadsheet and Offer of Service. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

The preparation of the GHG inventory follows the guidelines in the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, 2004 (GHG Protocol) and the Corporate Value Chain (Scope 3) Accounting and Reporting Standard, 2011. All emissions factors were sources from Ministry for Environment (MfE).

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

10 References

- MfE (2019) - Guidance for Voluntary Greenhouse Gas Reporting – 2019: using data and methods from the 2019 calendar year, Ministry for the Environment, Wellington, New Zealand.
- StatsNZ (2019) Population estimates - NZ. Stat table viewer, Statistics New Zealand, Wellington, New Zealand
- World Resources Institute and World Business Council for Sustainable Development (2004), The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, Revised Edition, USA.
- World Resources Institute and World Business Council for Sustainable Development (2011), Corporate Value Chain (Scope 3) Accounting and Reporting Standard, USA.

11 Glossary

Scope 1 Emissions	Direct greenhouse gas emissions that occur from sources owned or controlled by FNDC, such as emissions from the combustion of fuel in the vehicle fleet.
Scope 2 Emissions	Emissions associated with the purchase of electricity that is consumed by FNDC.
Scope 3 Emissions	An optional reporting category that covers all other indirect emissions. These emissions are a consequence of FNDC's activities but occur from sources it does not own or control. Examples include the embodied carbon in materials, air travel and waste transfer.
Carbon Dioxide Equivalent (CO_2e)	A standard unit for measuring carbon footprints. The impact of each different GHG is expressed in terms of the global warming potential (GWP) of one unit of CO_2. Standard ratios are used to convert gases into equivalent amounts of CO_2; these are based on each gas's GWP.
Carbon Footprint	A measure of the amount of GHGs emitted by a particular organisation. Typically expressed in terms of CO2e, and for a 12 month reporting period.
Emission Factor	A metric that converts a specific emission source - such as a litre of diesel - in terms of CO_2 or CO_2e.
Global Warming Potential	A measure of a gas's ability to cause radiative forcing in the atmosphere (or global warming) relative to the ability of CO_2. For example, sulphur hexafluoride has 23,900 times the GWP of CO_2, thus is 23,900 times more potent at contributing to global warming than CO_2.
Greenhouse Gas	Greenhouse gases are gases that influence the way in which the Earth's atmosphere traps heat. Increasing levels of GHGs in the atmosphere are causing the phenomenon of climate change.
Greenhouse Gas Protocol	This standard provides guidance for companies preparing a GHG emissions inventory. It defines three scopes (or operational boundaries) for accounting and reporting purposes.

Appendix A

Data Quality

Data Collection

Data Management	Measured	Derived	Estimated
Robust	M1	D1	E1
Satisfactory	M2	D2	E2
Questionable	M3	D3	E3
Unsatisfactory	M4	D4	E4

Measured = Data directly provided by a service provider, contractor or directly obtained from a monitoring device. For example, electricity invoices, contractor receipts, emissions monitoring equipment, incident reports, consultant reports etc.

Derived = Data obtained from calculations, mass balances, use of physical/chemical properties, use of coefficients and emission factors etc., for example, converting cubic meters of waste into tonnes.

Estimated = Usually, where there is no other available method for obtaining the data. Such data could be prorated on previous results, use of precedents or historical data, or even a calculated guess.

Robust = Evidence of sound, mature and correct reporting system, where room for error is negligible. Examples would include use of spreadsheets, databases and on-line reporting.

Satisfactory = Examples would include manual, but structured keeping of records, files and results. Some potential for error or loss of data.

Questionable = No logical or structured approach to data or record keeping. High potential for error and/or loss of data. Data may appear to differ from those initially reported.

Unsatisfactory = No data available or existing data may be incomplete, of poor quality, or in need of supplementation.

Appendix B

Basis of Carbon Footprint Calculations for WWTPs

To assess the emissions associated with FNDC's Wastewater Treatment Plants the following methodology was used:

For Scope 1 methane and nitrous oxide emissions, the method is based on Tier 3 methods from InterGovernmental Panel on Climate Change (IPPC, 2017) methods and uses information available for treatment plants and default values.

Methodology

- *Population Base Data*

Base population data has been obtained from the FNDC Long Term Plan. This is residential population only and excludes commercial, industrial and tourism. A nominal factor of 1.3 has been applied to the population of Kerikeri, Russel and Paihia as these locations are significantly influenced by tourism.

It is therefore expected that the overall populations equivalents are underestimated and emissions will be greater.

- *Flows*

Base flow data is taken from the Long Term Plan. To check this data, a comparative average flow calculation was used, with 200 l/hd/d. On this basis flow at Kaikohe, Kaeo, Hihi, and Kaitaia are substantially over reported. The average theoretical figures are used for these sites. Flow data is used as a basis for load of organic and nitrogen discharged from the treatment works. The accuracy in flow data will vary the impact of environmental emissions.

- *Organic Loads and Nitrogen Loads*

For each treatment plant, the organic loads has been estimated using 60 g BOD/person/d. Total nitrogen is estimated using 12g/person/d.

- *Treatment Stages*

Different treatment types and configurations will have different conditions and different emissions. To enable a comparison the treatment process is broken down into stages.

Stage 1 Anaerobic

Stage 2 (either aerobic treatment, or facultative ponds)

Stage 3 (Tertiary Wetlands)

Discharge to Environment.

Only applicable stages are used in calculations.

For each stage the reduction of carbon and nitrogen is estimated. The values used are based on IPPC default values. For Ponds, it is assumed that 50% BOD and 10% N is removed in the anaerobic ponds, and additionally 60% BOD removed in a facultative pond. Where multiple ponds are on site better BOD removal will occur, so it is assumed that two stages of 60% BOD removal occurs. 10 % removal of Nitrogen is assumed for Ponds.   These values are not given by IPPC and are based on typical pond performance. In ponds, nitrogen is converted between organic nitrogen forms to soluble ammonia and then assimilate ammonia to new algal and bacterial biomass. Very little is removed from this cycle, only when nitrates are present and through sludge accumulation will a reduction occur.

For activated sludge plants a default of 50% total nitrogen is assumed to reflect a degree of nitrification and denitrification in anoxic zones occurring.

Discharge to environment of BOD assumes 20 mg/l annual average BOD in the effluent being discharged. Analysis of works monitoring data is required to improve this estimation.

Discharge to environment for nitrogen is not routinely analysed for total nitrogen on most plants. Commonly ammonia may be monitored, but other types of nitrogen are not routinely tested, so data is unlikely to be available. As default it is assumed that the effluent from stage 3 nitrogen is derived from percentage removal rates for typical effluent.

- *Estimation of Methane*

Methane is calculated using IPPC methods. That is an emission factor associated with a process based on BOD removal. These are expressed as kgCH4/kgBOD

Emission factor = Bo x MCF kgCH4/kgBOD. (Source: IPCC 2019 amendment, volume 5 Wastewater Treatment)

For environmental discharge of methane default of 0.068 EF has been used (Tier 1).

For Anaerobic Lagoons, a value of 0.48 is used for anaerobic deep lagoon. For facultative ponds, depth < 2 metres, 0.12 is used. Where a site has both anaerobic and facultative ponds both EF are used. As the BOD is reduced by the Anaerobic pond up front, the effect is lower emissions from the facultative pond than if no anaerobic pond. Constructed wetlands are presented below (Source: 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories : Wetlands Chapter 6 Constructed Wetlands for Wastewater Treatment.)

As the nature of the wastewater entering the wetlands is unknown it is assumed that the TOC:BOD relationship is 1:1.

For the estimate it is assumed that all wetlands are surface flow design.

- *Estimation of Nitrous Oxide*

Nitrous Oxide is calculated based on the IPPC Tier 3 method.

(Source: IPCC 2019 amendment, volume 5 Wastewater Treatment)

With nitrous oxide calculations a conversion of 44/28 to convert from Nitrogen to Nitrous Oxide is required. This is applied in the results.

For all discharges it is assumed that the EF for nitrous oxide generated in the environment is 0.05 kgN2O-N/kgN.

All centralised aerobic treatment processes are treated the same. This includes activated sludge plants, SBR and plants with aerated media. Published information indicates a wide range of performance variations on these types of plants that can substantially increase the emissions factor including temperature, pH, dissolved oxygen, nature of recycle, incoming wastewater characteristics and plant configuration. No allowance has been made for this variation between plants.

- Other Assumptions

It is noted that Whangaroa is only a tank storage and removal from site of wastewater for treatment at another site. It is assumed that this wastewater is tankered to Taipa WWTP for treatment so the population of Taipa is increased to accommodate this.

Power

Sites are usually powered by mains electricity and as such are included in the overall energy figures provided elsewhere.

However, Paihia WWTP is remote and powered by Diesel Generator. As the current operation is a new installation, historic data is not available. It is therefore assumed that 10t of fuel is sufficient for 6 weeks of operation. This gives an annual diesel consumption of 87t.

Several sites have diesel generators as emergency power supply. No data is available on the usage of these generators and the fuel consumed. It is assumed that if a generator is required to be operated, it is only for 1 to 2 days per year, so will not be a significant carbon footprint impact.

Appendix C

Basis of Carbon Footprint Calculations for Russell Landfill

The Russell Landfill gas generation (and subsequent emission) capacity was derived using the LandGEM Landfill Gas Emission Model (Version 3.02). The model was developed by the United States Environmental Protection Agency Clean Air Technology Centre to quantify landfill gas emissions.

LandGEM is a first-order decay model whose purpose is purely to estimate landfill gas emissions over time within the waste mass. The model uses the decomposition of landfilled waste in municipal solid waste landfills to estimate landfill gas generation. Due to being based on the waste mass, the total lifespan of gas generation is also calculated.

The first-order decomposition rate equation is:

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} kL_0 \left(\frac{M_i}{10}\right) e^{-kt_{ij}}$$

Q_{CH_4}= annual methane generation in the year of the calculation (m3/year) i = 1-year time increment

n = (year of the calculation) - (initial year of waste acceptance) j = 0.1-year time increment

k = methane generation rate (year-1)

L_o = potential methane generation capacity (m3/Mg) Mi = mass of waste accepted in the ith year (Mg)

t_{ij} = age of the jth section of waste mass Mi accepted in the ith year (decimal years, e.g., 3.2 years)

Using site-specific data, LandGEM can generate realistic estimates of gas generation rates and becomes an effective screening tool. Consequently, limitations in available site-specific data reduces the accuracy in the estimation of the emissions potential of the landfill. Factors such as waste quantity and composition, landfill design and operating practices and other variances over time greatly affect the accuracy of the modelling output.

Critical input parameters may be tailored to the specific site using literature and guides prepared for LandGEM. Key parameters include the Methane Generation Rate and Potential Methane Generation Capacity for example. The units for these key parameters vary from other landfill gas models, and as such, the values differ significantly when input to LandGEM compared to the IPCC 2006 model for example.

For this project, the total waste mass of the landfill was used to calculate gas generation. This approach has been used to account for all possible landfill gas that may impact on the sewer line. The data provided by Far North District Council has allowed for what WSP considers to be a reasonable estimate of the rate of landfill gas emissions over time.

Note that there is currently no estimated date of landfill closure provided. Therefore, the gas generation curve is based on results up till 2019 and the model outputs presented in this letter do not extend beyond 2019/2020 time period.

The input parameters used in the LandGEM model are summarised in Table 1

Table 1 Project-Specific Input Parameters

PARAMETER	INPUT DATA	SOURCE
Waste acceptance rate	Recorded Annual Tonnages from 2009 to 2019 and average of this dataset (547 tonnes per year) for all years prior dating back to 1950	2009 to 2019 annual tonnages provided by Far North District Council. Estimated age of landfill provided by WSP New Zealand.
Methane Content	50 %v/v	Based on default methane production rates within MSW landfills (i.e. 50%CH4, 50%CO2 and trace gases).
K	0.057 $year^{-1}$	Default K value for bulk municipal solid waste in a wet climate from US EPA (2010) GHG Emissions Estimation for Selected Biogenic Source Categories - Table 2-1; accessed from https://www3.epa.gov/ttn/chief/efpac/ghg/GHG_Biogenic_Report_draft_Dec1410.pdf. Assumed wet climate based on mean annual rainfall at Whangarei Weather Station of 1,490mm (58.7 inches).
Degradable Organic Carbon (DOC)	0.2028 weight fraction wet basis	Default DOC value for bulk municipal solid waste in a moderate climate from US EPA (2010) GHG Emissions Estimation for Selected Biogenic Source Categories - Table 2-1; accessed from https://www3.epa.gov/ttn/chief/efpac/ghg/GHG_Biogenic_Report_draft_Dec1410.pdf.
PARAMETER	INPUT DATA	SOURCE
L0	99.9804 m^3 CH_4/Mg waste	Based on derived DOC multiplied by 493, as outlined in the LandGEM user guide.
Non-Methane Organic Compound Concentration (NMOC)	600 ppmv as hexane	The default LandGEM value that assumes no co-disposal of waste.