Science for Communities

From Health Sector Waste Minimisation Towards a Circular Economy

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DISCLAIMER

Photograph showing personal protective equipment in the ocean collected by a scuba diver. Image credit: Reuters

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

1.1 SUSTAINABILITY OF THE HEALTH SECTOR

Of the 1.47 billion tonnes of solid waste that is produced each year globally, 5.9 million tonnes (approx. 16,164 tonnes per day) are estimated to be a result of health care waste. This figure has increased year on year (Voudrias et al 2018; Zaman et al 2016). The COVID-19 pandemic has served as an extreme example of the challenges for sustainable health care waste. It has been estimated that globally, the pandemic has created an excess of 1.6 million tonnes/day of health care waste, with approximately 3.4 billion single-use face masks/face shields discarded daily (Benson et al 2021).

Due to early recognition of the threat and a clear strategic and operational response to COVID-19, Aotearoa New Zealand has been spared the extremes of this global waste crisis. It has however, highlighted the importance of awareness and environmental sustainability within the health care sector, as well as the need to find alternative products and to reduce reliance on single use items.

Health care facilities, in particular hospitals, are highly energy intensive, consume large amounts of resources, and produce a large amount of waste (Malik et al 2018). Health care waste also poses a number of environmental, cultural, wellbeing and health risks (European Environment Agency 2014; WHO 2018). The World Health Organization (WHO) estimates that between 75 and 90% of waste produced by health care facilities is non-hazardous, the remaining 10-25% is classified as hazardous.

Additionally, Aotearoa New Zealand's health care sector is also estimated to contribute between 3% and 8% of national carbon dioxide equivalent (CO_2e) emissions[1]. For comparison, the UK and the USA emit 4% and 10%, respectively, of their national CO_2e from health care (Eckelman and Sherman, 2016; NHS England 2008). Data from an Australian study indicates that the majority of CO_2e emissions from health care are from hospitals and pharmaceuticals ie, the pharmaceutical industry (Figure 1, Malik et al 2018).

Efforts are required to reduce waste production, landfill use, greenhouse gas emissions and unnecessary procurement costs that arise from District Health Board (DHB) activities, thus realising financial, environmental, cultural, health, wellbeing and social benefits.

[1] In a speech delivered to Counties Manukau District Health Board by Health Minister Julie-Anne Genter in 2018, https://www.nzcphm.org.nz/news-events/news/2018-02-09-health care-sector-committed-to-reducing-carbon-footprint

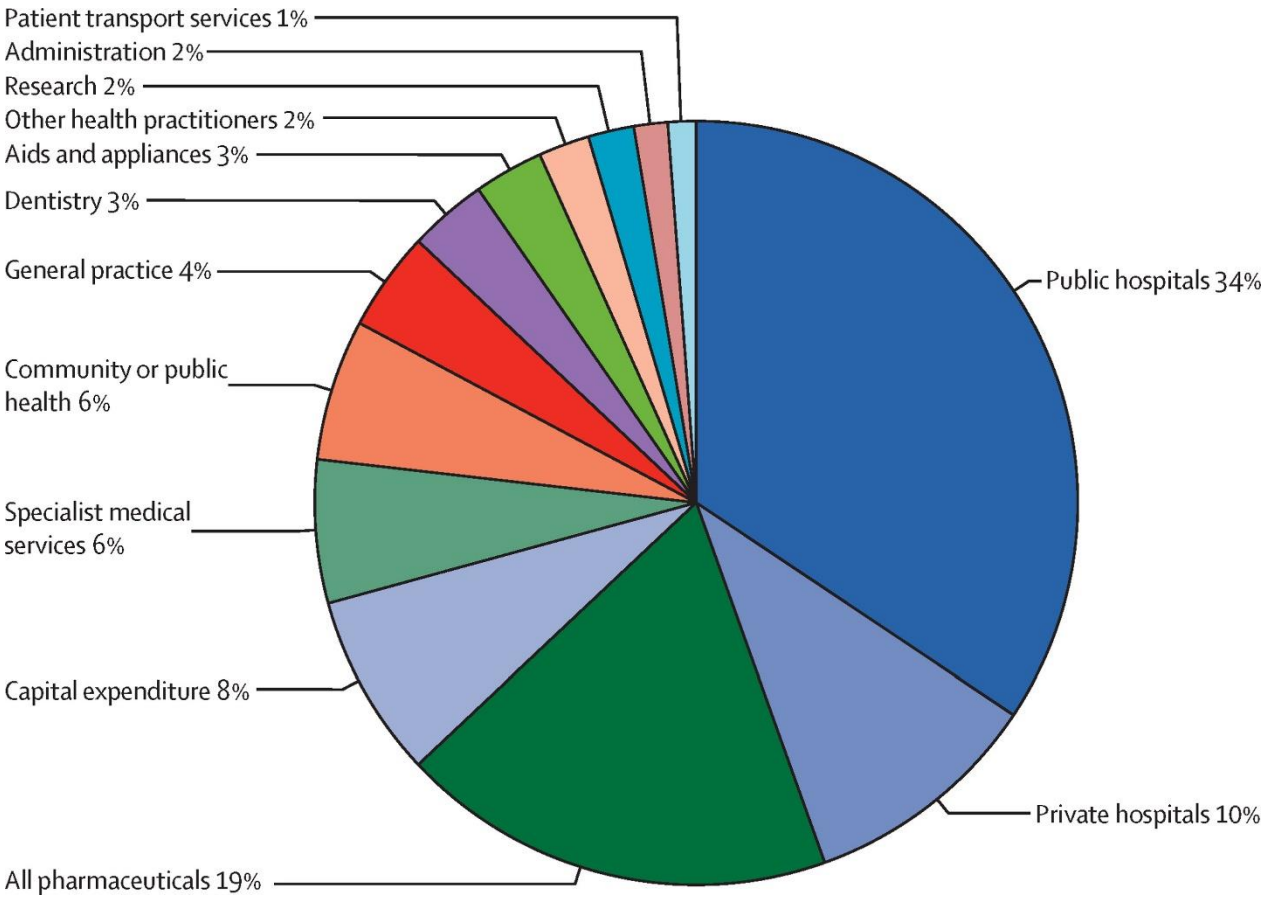


Figure 1: Total and relative CO_2e emissions for 13 health care expenditure categories in Australia. The five most important sectors in total CO_2e emissions were public hospitals (12295 [34%] of 35772 kilotonnes CO_2e emissions), private hospitals (3635 kilotonnes CO_2e emissions [10%]), other medications (3347 kilotonnes [9%]), benefit-paid medications (3257 kilotonnes [9%]), and capital expenditure for buildings (2776 kilotonnes CO_2e emissions [8%]); with referred or specialist medical services (2169 kilotonnes [6%]; see table 3 Malik et al 2018).

1.2 WHAT IS HEALTH CARE WASTE?

According to the Management of Health Care Waste Standard NZ4304:2002 (see section 1.4.2), health care waste refers to all waste generated by any health care facility and classified as either “Non-Hazardous”, “Hazardous Waste” or “Controlled”. Non-hazardous waste or general waste constitutes the bulk of waste generated by healthcare organisations and is no more of a public health risk or concern than domestic or household waste. Hazardous and controlled waste refers to health care waste which may present a public health or environmental health risk or may be considered to be offensive. It includes infectious waste which are substances known to contain, or are reasonably expected to contain, pathogens; cytotoxic waste which is waste that may contain or be contaminated with drugs or toxic compounds known to have carcinogenic, mutagenic and/or teratogenic (causing foetal and/or neonatal abnormalities) potential, and radioactive waste which is material, whatever its physical form, arising from the medical or research use of radionuclides and for which no further use is foreseen that contains radioactive substances and has an activity (or activity concentration) higher than the clearance level from regulatory requirements, and exposure to this material is not excluded by the regulatory authority.

Controlled waste may be (a) contaminated or soiled with potentially infectious human or animal body fluids which are not compressible under compaction or; (b) is not infectious but may be considered culturally or aesthetically offensive.

1.3 WHY IS DHB WASTE MINIMISATION IMPORTANT?

All waste creates consequential risks. In many cases, it is the health sector that bears the costs. For example the World Health Organisation (WHO) in 2018 outlined:

- The disposal of untreated health care wastes in landfills can lead to the contamination of drinking, surface, and ground waters if those landfills are not properly constructed. In addition, climate change also creates risks for landfills that were built near waterways or the coast.
- The treatment of health care wastes with chemical disinfectants can result in the release of chemical substances into the environment if those substances are not handled, stored, and disposed in an environmentally sound manner.
- Globally, incineration of waste has been practised under strict standards for public health and environmental protection, eg, European Union Industrial Emission Directive 2010/75/EU. However, inadequate incineration or the incineration of unsuitable materials results in the release of pollutants into the air and in the generation of ash residue. Incinerated materials containing or treated with chlorine can generate dioxins and furans, which are human carcinogens and have been associated with a range of adverse health effects. Incineration of heavy metals or materials with high metal content (in particular lead, mercury, and cadmium) can lead to the spread of toxic metals in the environment.
- Note that only modern incinerators operating at 850-1100 °C and fitted with electrostatic precipitators are able to comply with the international emission standards for dioxins and furans.

From a sustainable development perspective “development should meet the needs of the present without compromising the ability of future generations to meet their own needs.” A changing climate, changes to international and national legislation and policy, global “shocks”, supply chain reliability, and the banning of offshore waste facilities are challenging the status quo of waste treatment and management.

The Ministry for the Environment and the Climate Change Commission have advised that the creation of more opportunities to move from a linear to a circular economy (Figure 2) where resources are repeatedly used, resulting in less emissions from waste disposal, extraction, production, consumption, and transport processes (Climate Change Commission, 2021; Ministry for the Environment. 2021). Hence, reducing waste also reduces greenhouse gas emissions.

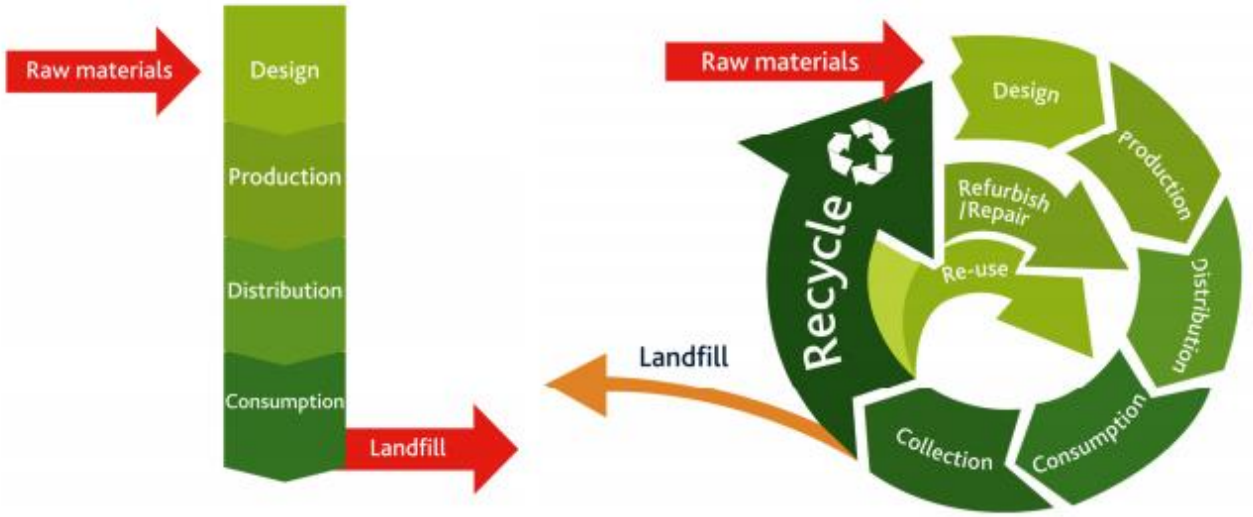


Figure 2: Linear (left) and circular (right) waste models. Source: Auckland Council

1.4 LEGISLATIVE AND POLICY FRAMEWORK

Aotearoa wishes to transition to become more clean, green and carbon neutral by building a productive, sustainable, and inclusive economy (New Zealand Government 2019). A number of other international commitments, legislation, and policies relevant to health care waste are identified in Table 1. The most relevant to this report are discussed in this section.

Table 1: Relevant legislation, policy and plans related to DHB waste minimisation

International Commitments			
Intergovernmental Panel on Climate Change	Sustainable Development Goals 2015	Western Pacific Regional Framework for Action on Health and Environment on a Changing Planet	Paris Agreement 2015
Basel Convention 1995	Rotterdam Convention 1998	Stockholm Convention 2001	
Legislation			
Resource Management Act 1991	Civil Defence Emergency Management Act 2002	Soil Conservation and Rivers Control Act 1941	Local Government Act 2002
Biosecurity Act 1993	Hazardous Substances and	Management of Health care Waste NZ4304:2002	Health Act 1956

	New Organisms Act 1996		
Land Transport Act 1988	Dangerous Goods Act 2005	Zero Carbon Act 2019	International Health Regulations 2005
Waste Minimisation Act 2008	New Zealand Waste Strategy 2010	Health and Safety at Work Act 2015	Litter Act 1979
National and regional plans and policies			
Local council waste management and minimisation plans			
District Direction Plans and Policies (District, City and Regional Councils)			
Long term Plans			
Annual Plans			

1.4.1 The Waste Minimisation Act 2008 Act

The (Act) encourages a reduction in the amount of waste we generate and dispose of in Aotearoa. The Ministry for the Environment (MfE) also promotes the shift towards a circular economy. Relevant to this report is the inclusion of reducing the amount of harmful waste produced and reversing our impacts on climate.

In 2018, a Central Government Waste Work Programme was developed in response to the Chinese government's effective ban on the import of many materials and products for recycling. Recommendations from a taskforce (Eunomia Research & Consulting Ltd (NZ) 2018) are now part of the Ministry for the Environment's work programme[2]. Recommendations relevant to this report include:

- Forming a plan to phase out low-value and hard-to-recycle plastic packaging
- Expanding and improving the waste disposal levy (landfill levy) to more of Aotearoa's landfills and improving data on waste
- Analysing where investment in innovation and resource recovery infrastructure is most needed to support Aotearoa's transition to a circular economy approach
- Developing a national circular economy strategy, starting with priority sectors where the greatest benefits can be gained from transitioning to a circular economic approach
- Implementing product stewardship schemes for problematic waste streams including vehicle tyres, e-waste (starting with lithium-ion batteries), agrichemicals and synthetic greenhouse gases

1.4.2 Management of Health Care Waste Standard NZ4304:2002

The standard provides guidelines for the disposal of human and animal healthcare waste, including generators, waste transporters and waste disposal activities. Best practice guidance is referred to as the management of health care waste, over and above legislative requirement, in order to minimise potentially acute, chronic, and accumulative environmental and human health impacts (Standards New Zealand 2002).

The standard has been considered to have the function of a policy (WHO, 2015). Several guidelines have been issued on the management and handling of health care waste, such as the Guidelines for the Safe Handling of Cytotoxic Drugs and Related Waste (Worksafe,

[2] https://environment.govt.nz/what-government-is-doing/areas-of-work/waste/

2020). There is currently no specific health care waste management strategy or national action plan on health care waste management (WHO, 2015).

The Management of Health Care Waste Standard NZ4304:2002 includes waste minimisation as a fundamental principle that includes appropriate classification and segregation at the point of generation, and longer term, reviewing health care practises and purchasing policies. This includes life cycle analysis of products used in clinical practice, such as switching to more environmentally friendly technologies/products, consideration/implementation of reuse/reusables, recycling and other waste minimisation techniques. The standard also includes an objective to ensure appropriate consultation with Māori under Treaty of Waitangi commitments.

Section 4.2 of the Standard outlines the responsibilities of the generators' (ie, DHBs), to meet the objectives of the Standard. They include:

- Developing, implementing and reviewing a waste management policy (Section 4.3)
- Developing and implementing a body parts policy (Section 4.4)
- Correctly segregating, packaging, labelling and storing all health care waste (Section 3, 4.5, 4.8 to 5)
- Pre-treating waste, where applicable (Section 7, Table 2)
- Verify transport and disposal contractors comply with contractual responsibilities, relevant legislation and/or Standards (Section 6)
- Establishing a waste tracking system (Section 4.9)
- Maintaining an emergency waste management plan (Section 9)
- Meeting the requirements of Section 7.4 if waste is compacted
- Establishing procedures for the correct handling of waste (Section 8)
- Developing and implementing waste management training programmes for staff (Section 10)

A key component of the standard is the development of a waste management policy, (Section 4.3) with a number of components that are relevant to this report, ie, waste minimisation, life cycle analysis, waste audits.

1.5 AIMS

The overall aim of this report is to collect information to support national guidance for DHBs to reduce overall waste and waste going to landfill as well as considering an appropriate platform for sharing information across DHBs at a national level.

This review examines and includes:

- A brief overview of health care waste minimisation best practice
- A review of DHB annual plan data which included questions themed on waste and procurement
- A cross-section of current waste data from DHBs including waste by weight and audit data, waste minimisation activities and carbon reduction scheme data. Data also includes waste from gases, which is typically not considered as a form of waste (ie, solid and liquid waste are predominantly the main waste streams)

- Results from a survey to sustainability managers on waste minimisation practices, barriers, and opportunities
- Indigenous views on waste management and minimisation
- Gaps in knowledge

2. Methods

The literature relevant to this project is a mixture of scientific papers, web-based information, news articles and discussion documents, usually prepared by sustainability employees and advocates. To locate this material, the following approach was taken:

A literature search using the search engines “Web of Science”, “Google Scholar”, “Google”, “Science Direct databases”, and “Pubmed” using the search terms “health care waste” together with either “minimisation” or “reduction” and “New Zealand” and limited to the years 2010-2020 inclusive was completed. Where no relevant papers were found, the search years were expanded to 2000-2020. A more general web search using the same search terms and both including and omitting “New Zealand” was carried out using Google and Google scholar to search for other relevant publications (eg, Ministry documents, DHB documents), international articles and reports and the grey literature. Each abstract was read for its applicability to this review and included where deemed relevant.

The cultural aspects of waste were also investigated. This included searching for terms “health care waste”, “minimisation” or “reduction” and “New Zealand” together with “Māori”, “iwi”, “Te Ao Māori” or “Mātauranga Māori” and limited to the years 2010-2020.

In considering timing and resourcing, the focus of the report and literature review was predominantly DHB (or health care) provider facilities which include public hospitals and other health facilities, laboratories, research centres and pharmacies and chemists. Understanding the full scope of waste across other facilities, private hospitals and non-Governmental organisation providers across the health and disability sector is outside the scope of this report.

Data was requested from individual DHBs through the Sustainable Health Sector National Network. The data requested:

- any health care waste audit data, particularly waste by volume or mass and most common use
- greenhouse gas emission reduction data that includes waste as a significant stream
- initiatives undertaken by DHBs to reduce health care waste
- barriers to reducing health care waste
- opportunities to reduce health care waste including procurement, cost and waste legislation and policies
- any other relevant data

Nine out of twenty (45%) DHBs responded to the request by providing various forms of data. In addition, online, publicly available greenhouse gas emission data was obtained for DHBs and private hospitals through carbon reduction websites. The data included the top ten greenhouse gas emissions by source as tonnes CO_2e. In some cases the raw data were not directly obtainable so estimates of the emission values (from graphs) were calculated using an online webplot digitizer[3]. To understand the waste streams associated with general health care waste, the DHB annual survey, combined waste audits, and literature review data were used. For the purposes of this report, individual DHBs have been anonymised and

[3] https://apps.automeris.io/wpd/

permission was sought to publish the anonymised data. Stakeholders from Christchurch City Council and Environment Canterbury were also interviewed specifically on health care waste and challenges with the waste system. During the writing of this report, the author was also invited to visit a DHB laundry service to discuss the reuse of textiles within a health care setting.

Data from waste audits was collected from either independent or by in-house audits. The waste audits took place in hospitals and involved the examination of compactor waste (Audit A), or waste that would be deposited into a compactor (Audits B, C). The audits included controlled waste, general waste, and clinical waste (infectious or hazardous waste) from within a 24-hour to 3-day period. These audits are useful as they provide information on the types of waste going to landfill, the proportion of waste that could be diverted from landfill, contamination issues (including streams that could be recycled or reused etc), and the areas from which most of the waste is generated.

3. Results

3.1 LITERATURE REVIEW INSIGHTS

3.1.1 Current Health Care Waste Minimisation and Disposal of Waste

Waste minimisation related literature from health care settings in Aotearoa were themed around food waste, anaesthetic gas use, unused medicines, home health care waste and more generally on opinions and behaviours towards climate, carbon, and sustainability. These areas are discussed briefly in sub-sections 3.1.2 to 3.1.6.

3.1.2 Food Waste

In a study of three Aotearoa hospital foodservices, a novel approach was used to understand reasons for hospital food waste before consumption as well as offering recommendations on waste minimisation (Goonan et al 2014). Data collection techniques included document analyses, observations, focus groups with kitchen staff, and one-on-one interviews with managers. In hospitals, food waste occurred during service as well as a result of overproduction. Exploring attitudes and practices of foodservice personnel allowed an understanding of reasons behind hospital food waste and ways in which it could be minimised. The study found an array of factors influenced food waste generation including inaccurate forecasting, attitudes, and critical consciousness of staff towards food waste, food safety legislation and interpretation, and waste measurement systems.

3.1.3 Anaesthetic Gas Use

Per mass, the anaesthetic gas desflurane has a global warming potential approximately 19 times that of sevoflurane, four times that of isoflurane, and eight times that of N_2O (Gadani and Vyas 2011). The UK National Health Service (NHS) estimated anaesthetic gases represented 5% of the carbon footprint for all NHS organisations. Commonly used anaesthetic gases in Aotearoa are sevoflurane, desflurane and isoflurane (McGain et al 2019). Ryan and Nielson (2010) estimated that 1-hour use of desflurane or sevoflurane from a modern anaesthetic machine was the equivalent of travelling 230 or 30 miles, respectively in a modern fossil fuel powered car. These gases are hydrofluorocarbons and are harmful to both the ozone layer as well as potent greenhouse gases. These gases are currently untreated and vented into the atmosphere.

McGain et al, (2020) suggest that “the most important measures anaesthetists can take individually to reduce their carbon footprint are to (a) avoid desflurane and N_2O, (b) practice low-flow anaesthesia and (c) embrace techniques to minimise the requirement for inhalational agents, such as regional anaesthesia and total intravenous anaesthesia”. There is ongoing research and development of devices to capture and either destroy or reclaim waste anaesthetic gases (Charlesworth and Swinton 2017). No such devices are in common use as yet in Aotearoa New Zealand.

3.1.4 Unused Medicines

An online survey was placed on the New Zealand National Poisons Centre website for a period of three months during 2008 and was used to examine disposal practices for unused medications (Braund et al 2009). Of the 452 households that completed the survey, 62% currently had unwanted medicines in their home. The main reason for this was that their

condition had improved. The survey and other literature found that a significant percentage of unwanted medications are disposed of via routes that have the potential to adversely affect the environment and public health such as the accumulation and spreading of antibiotic resistance (Anwar et al 2020; Cioca and Munteanu, 2019; Thomas 2017). In order to avoid this there are suggestions that excess prescribing of medications are reduced as well as education of appropriate disposal techniques and the use of take back programs (Lubick 2010).

3.1.5 Home care health related waste

Adverse health outcomes associated with home health care waste and by-products that are landfilled include sharps-inflicted injuries and toxic exposure to pharmaceutical products, in particular, antibiotics and cytotoxic drugs released into the surrounding environment. An estimate by Interwaste was that 90% of home health care waste was not currently being disposed of appropriately[4]. In 1990, a seminal report to the United States Congress (USAOTA 1990) on the management of clinical and related waste, stated that "The amount of medical waste generated by in-home health care and hospice care is under appreciated – and is expected to increase, because treating individuals in those settings is becoming more and more common" in Thornton, (date unknown). It is acknowledged that there has been, and will continue to be, an increase in patients receiving home health care. For example, in Australia, patients undergoing home dialysis increased from approximately 800 in 2005, to approximately 2,900 in 2007. It has also been predicted that there will continue to be an 8% increase in home dialysis patients year-on-year.

Reports from the grey literature also indicate that contamination of medical waste is an issue for councils[5]. Medical waste was being detected in residential waste and poses a potential health risk to staff involved in waste management collection and disposal systems, ie, kerbside collection and transfer stations etc., (pers. comm, Hazardous Substances & Waste staff, Environment Canterbury). Medical waste has also appeared in recycling centres, with those facilities requiring closure for disinfection, resulting in costs to ratepayers and lost productivity hours, as well as creating more landfill as the waste cannot be recycled. It appears that this is an issue in some regions and is in breach of the New Zealand Standard NZS 4304:2002 Management of Healthcare Waste.

3.1.6 General Opinion and Behaviours towards Climate, Carbon and Sustainability

The Australian and New Zealand College of Anaesthetists produced a Professional Document PS64: Statement on Environmental Sustainability in Anaesthesia and Pain Medicine Practice (Australian and New Zealand College of Anaesthetists 2019). The statement recognised the high carbon emitting practises and contribution to large amounts of resource, energy use and waste generation in operating theatres. The background paper to the statement paper identifies a number of activities to improve the environmental and climate impact of anaesthesia (see Table 1 in McGain et al 2019). An anonymous survey to ophthalmologists on climate change, sustainability and the role of ophthalmologists found that most practices had room to improve on reducing waste, travel, and carbon footprints (Chandra et al 2020).

[4] https://www.stuff.co.nz/dominion-post/news/93705822/needles-sanitary-waste-and-pharmaceuticals-putting-waste-workers-at-risk. Interwaste assume that medical waste is being disposed of as general waste.

[5] https://www.stuff.co.nz/national/health/123411955/ratepayers-33k-cleanup-bill-after-blood-bags-medical-waste-thrown-in-with-recycling

3.2 INDIGENOUS PERSPECTIVES ON WASTE

Te Tiriti o Waitangi (The Treaty of Waitangi) is acknowledged in the Standards of Health Care Waste and refers to the Resource Management Act s6(e). That section of the Act recognises and provides for, as a matter of national importance, the relationship of Māori, their culture and traditions with their lands, water, ancestral sites, wahi tapu, and other taonga. Section 7(a) refers to those exercising powers under the Act to have regard to kaitiakitanga (the responsibility to secure natural resources for the benefit of all – not just for present generations but for those to come), and s8 states the principles of the treaty are to be taken into account in managing the use, development and protection of natural and physical resources.

The Te Ao Māori (the Māori world) view of the relationships between humans, the environment and health, are views that share many similarities with sustainability principles (Ministry of Health 2019). The Māori worldview recognises the building of mauri (life and wellbeing sustaining capacity) within and between the natural environment and society (Reid et al 2013). For Māori identity and culture, the environment is integral and many Māori see the environment as an interconnected whole.

Aligning with Te Ao Māori, Mātauranga Māori (Māori knowledge), kaitiakitanga and the restoration of collective resources to enhance the mauri of taonga (anything considered to be of value including socially or culturally), one study specifically on waste included tuku iho (heritage, oral history) to provide a dynamic and inter-connected perspective (Pauling and Ataria 2010).

Māori knowledge and ways of knowing can be articulated in a similar way to 'systems thinking', which places greater emphasis on understanding the relationships between the components of a system (Heke et al 2019). Through the enaction of mātauranga Māori, kaitiakitanga, kotahitanga (the acknowledgement of unity and collective action), whanaungatanga (recognising the intergenerational nature of the relationships between people and the natural world) and wairuatanga (recognising spirituality) 'the mauri of both human and non-human people are more likely to be maintained and, in turn, the life-generating capacities of these entities ensured' (Prime Minister's Chief Science Advisor, 2019). Conversely, the degradation of the environment through pollution of the air and land, diminishes the connection that Māori have to the environment and from which a sense of identity and mana is derived (Ministry of Health 2019).

These principles are supported by many councils across Aotearoa New Zealand in their waste management and minimisation strategies. For example, Auckland's Waste Management and Minimisation Plan 2018 recognise the importance of Māori perspectives to ensure that they are recognised as kaitiaki (guardians). This contributes to the needs and aspirations of Māori and gives due effect to Te Tiriti o Waitangi, as well as reinforcing the messages of environmental sustainability (Auckland Council 2018). Within the Christchurch City Council's waste management and minimisation plan (Christchurch City Council 2020) is the Mahaanui Iwi Management Plan (Ngāi Tūāhuriri Rūnanga et al 2013) that guides the councils' decisions about the environment and protection of resources. The plan outlines the specific (tikanga) cultural issues associated with the disposal and management of waste. It includes waste minimisation to be a basic principle of, and approach to, waste management.

3.3 DHB ANNUAL PLAN REVIEW

DHB annual plan data was reviewed which included questions themed on waste and procurement amongst others. Several DHBs now have a dedicated sustainability employee and have completed carbon reduction schemes. These schemes allow DHBs to measure and reduce their greenhouse gas footprint or develop an environmental management system (EMS) to manage their environmental impacts.

Data collected from annual DHB plans[6] and reports (Canterbury District Health Board 2017) reveal a number of waste streams that are being diverted from landfill, or initiatives that are being developed in order to reduce waste to landfill. A number of DHBs are currently reviewing some of their waste streams in order to reflect best practice and technological advancement.

Many DHBs have reduced amounts of waste going to landfill by identifying alternative products and replacing them or incorporating opportunities for recycling. Most DHBs are recycling paper, plastics, cans, and food waste. A number of DHBs have implemented anaesthetic gas bottle and gas replacement. Some DHBs are reducing or replacing the amounts of inhaled anaesthetic agents used and/or replacing inhaled anaesthetic agents with intravenous anaesthetic. Although using intravenous anaesthetic reduces GHG emissions it is unclear what the impact of these replacements is on the environment (eg, in landfill as autoclaving does not destroy it). For inhaled anaesthetic agents, one DHB has been analysing flow rates and reducing long high-flow phases through using real-time Cloud-based data. This project is a world first and resulted in a 13% decrease in flow rates of anaesthetic gases. The literature review also revealed that new adsorptive capture and hydrothermal deconstruction technology for the removal and decomposition of toxic anaesthetic waste is being developed at the University of Auckland[7].

Some DHBs are issuing special containers to patients so they can safely collect medical items such as syringes and injection devices and be returned to the pharmacy for safe collection and disposal. However further investigation into other types of home health care waste are required to understand the amounts by mass and type, as well what the opportunities and barriers to waste minimisation progress are in these settings.

As highlighted in Figure 1, pharmaceuticals were a large proportion of the waste identified as CO_2e emissions from a study in Australia (Malik et al 2018). The life cycle costs of pharmaceuticals include manufacture, packaging, transport, use and disposal. An estimated 60 tonnes of waste is collected each year from pharmacies and chemists through DHB programmes[8]. This waste is heat treated to remove toxic qualities.

In some DHBs' efforts are underway to reduce (preventable) medical waste (in accordance with 'Waste Management' and 'Disposal of Pharmaceuticals' policies and related education) in hospitals and clinics. This includes reviewing how pharmaceutical medicines are disposed of in hospitals and how medical waste is disposed of for at home care. Training and education is also used to raise awareness and actively promote the use of pharmaceutical waste collection and disposal services in community pharmacies. An example is the DUMP campaign (Dispose of Unwanted Medicines Properly) which offers a free, safe collection and disposal service for medicines including over the counter and prescription medicines, and

[6] 2018/19 procurement and waste stocktake results, Ministry of Health
[7] https://www.auckland.ac.nz/en/news/2019/08/06/health care-massive-carbon-footprint.html
[8] https://www.stuff.co.nz/national/109853938/one-chemist-600000-singleuse-dispensing-bottles?rm=a

sharps items such as needles and cytotoxic (chemotherapy) medicines[9]. Other DHBs are using Automated Dispensing Cabinets to significantly reduce pharmaceutical waste.

Additional information from DHB sustainability managers shows that efforts are being made by investigating alternatives to sending waste to landfill, including mapping waste streams in order to identify where diversions can be made. Other DHBs are working together to reduce the use of single use plastics as well as establishing recycling initiatives and develop procurement contracts that include sustainability clauses around waste reduction. These are supported with waste management and minimisation plans, waste policies including setting targets for reducing waste to landfill, waste education and creating internal infrastructure to allow waste segregation. Many DHBs are utilising product stewardship schemes and reprocessed single use medical products eg, MedSalv. At least one DHB has employed a waste minimisation officer but there are still some DHBs that do not yet have a dedicated sustainability manager highlighting inequities across the health care system.

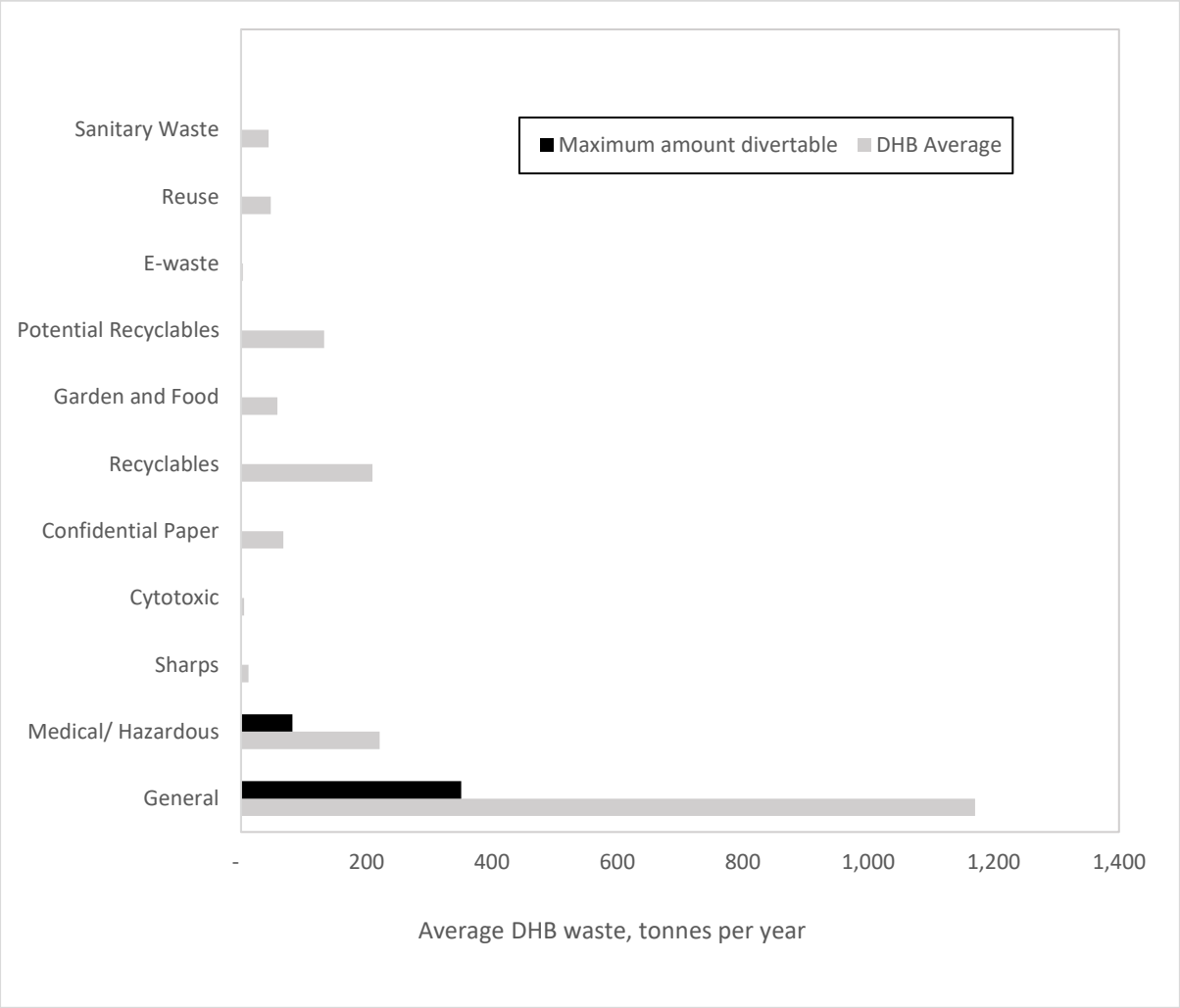
3.4 CROSS SECTION OF CURRENT WASTE RELATED DATA FROM DHBs

3.4.1 Waste Weight Data

Of the twenty district health boards, seven (35%) were able to provide data on waste by weight and nine (45%) on waste minimisation activities. Carbon reduction scheme data was either provided or acquired from the internet and comprised of nine DHBs (45%) and one private hospital. The data show that the majority of waste generated by DHBs is general waste (Figure 3). According to the New Zealand Standard Management of Health Care Waste, general waste is defined as any waste deemed disposable without control, either at landfill or to the sewer. In the waste data provided by DHBs, general waste from hospitals included waste that goes to a compactor, gantry, or front loader; inorganic waste that goes to a gantry; or inorganic waste collected by the decanting department that goes to a gantry. In some cases this included recyclable material that was manually removed (up to 40%) but it is unclear whether this is standard practice. These waste figures vary when compared to waste data from regional councils (Appendix B).

[9] http://www.saferx.co.nz/brief-updates/dump-campaign/

Figure 3: Average DHB waste streams, in tonnes per year (2018 to 2019)*



***Note that data from 2018-2019 and 2019-2020 was included for 1 DHB and data from 2020-2021 was included for 2 DHBs. Maximum divertible amounts are based on data from waste audits**. Potential recyclables includes soft plastics, paper (confidential and non-confidential) and polystyrene, which for some DHBs are not currently recyclable. Recyclables includes paper, cardboard, glass, and mixed recyclables that are currently recycled.

Medical waste and recyclables account for approximately 12% and 12% of total health care waste respectively. The majority of health care waste is sent to landfill (Figure 4). This includes landfills' with and without gas recovery. Medical waste disposal is mainly contracted out to a third party, pre-treated and then sent to landfill.

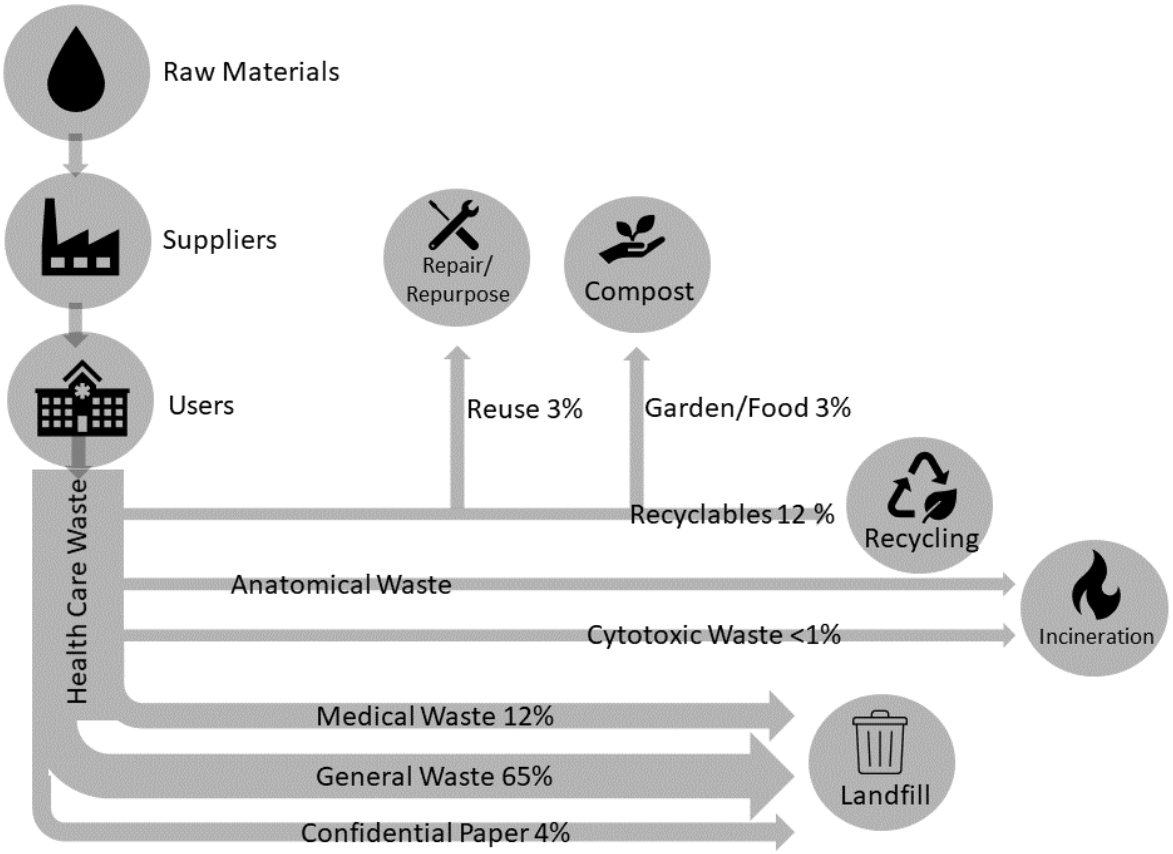


Figure 4: New Zealand District Health Board waste streams. Waste stream flows and average waste stream amounts measured in tonnes and displayed as a percentage. Based on data from 7 DHBs.

3.4.2 Cost of Waste

There was limited data available on the costs to remove health care waste, with only one DHB providing this data (this was not initially requested as the survey asked for opportunities to reduce waste including procurement, cost and waste legislation and policies).

Non-hazardous waste (general), followed by hazardous (medical waste), comprise the bulk cost of health care waste (Figure 5).

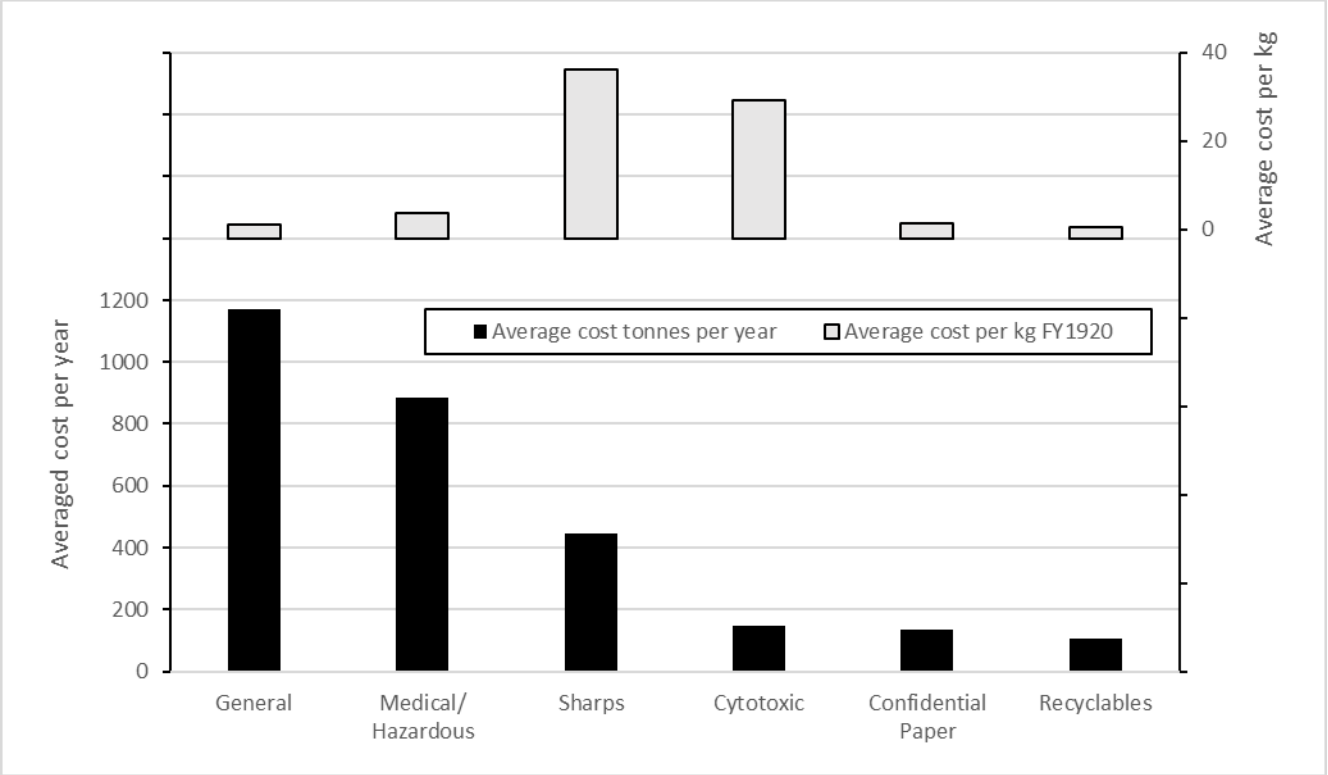


Figure 5: Example of costs per year of health care waste by waste stream for a selected DHB (bottom) and average cost per kg (top). This figure is not indicative of all DHBs due to limited data. Average cost per year was calculated using the average cost per tonne and average waste stream amount (per tonne) using all DHB weight data collected.

The survey also included comments on the cost of health care waste disposal. Many respondents were preparing for the national waste levy that will increase from $10 to $20 per tonne (excluding GST) for municipal (Class 1) landfills in July 2021, incrementally reaching $60 per tonne in July 2024. According to the DHB data provided, waste management contractors have also signalled a new pricing scheme including increasing the cost of disposing of waste to landfill, and an increase in the cost of many recycling services.

3.4.3 Waste Audit Data

Three of the twenty DHBs were able to provide waste audit information (hereafter Audit A, B and C). Audit A was undertaken by an independent contractor over a 24-hour period in 2018. Audit A examined waste collected from a hospital compactor which was approximately 90% of the total waste. Audit A also examined clinical waste that had been collected throughout the hospital and delivered to a hazardous waste facility. Audits B and C were in-house audits undertaken by waste management experts. Audit B was undertaken in 2016 over a period of 3 days. Ten white bags (general waste) and 7 yellow bags (biohazard) were audited and were collected from a number of different departments (emergency department, intensive care unit, wards, renal unit, and café). Audit C was undertaken in 2019 and examined hazardous waste bins collected from two different hospitals and included a general waste audit.

The majority of waste examined by area from Audit A was from operating theatre, intensive care units and emergency department. A significant amount of waste was also unlabelled (11%). Waste Audit A revealed that 23% of compactor waste or waste going to the

compactor could be diverted to recycling or composting. For Audits B and C, diversion rates were between 13 to 30%. The waste streams with the most potential were:

- **Paper** – Audit A revealed that approximately 7% of waste was packaging with 4% that was considered recyclable eg, paper, corrugated cardboard. A number of paper items could be replaced with an alternative such as non-recyclable paper cups and milk cartons. Paper hand towels were classified as sanitary products but could also be replaced by using electric hand driers.
- **Plastic** – Plastic items were by far the largest category of waste by weight in Audit A (33.9%). However the majority of plastic types were not currently recyclable ie, plastic numbered 3-7[10]. Only 2-4% of plastics were recyclable, such as PVC intravenous bags (through stewardship schemes) and plastics numbered 1-2. In Audits B and C common plastic items included white plastic bags, soft plastics, plastic tubing and IV bags, Ambu bag, syringes, renal solution bags, oxygen mask tubing and foam cups. A number of plastic items could be replaced with reusable items such as plastic containers from kitchen areas and medical containers that could be sterilised. A number of the plastic items in Audit B and C also included polyvinyl chloride (PVC) items that contained non-recyclable plastic and metal parts.
- **Organics** – Food waste and other organics (12%) were also found in Audit A and was mostly from hospital kitchens and cafes. Food that could be diverted was much higher in Audit B and C (30 to 40%) as there were currently no facilities to remove compostable waste.
- **Textiles** – Textiles consisted of 9% of compactor waste in Audit A, which included a large amount of kimguard (sterilisation wrap), sterile wrap, pillows, towels, and cleaning cloths.
- **Rubber** – A large number of latex gloves (6.5%) were found in compactor waste in Audit A and up to 30% in Audit B (this was location dependent).
- **PPE** – gowns and face masks were also found in Audit B.

For clinical waste, Audit A found that 85% was considered to be clinical (75.7% clinical waste and 9.6% sharps). The majority of clinical waste from Audit A originated from laboratories with a significant other portion which was unlabelled (% unknown). The audit also revealed that some areas of the hospital were better (or worse) than others at segregating waste. During the audit, waste was recovered from the clinical waste stream that did not require clinical waste disposal. By location, approx. 15 to 60% of waste in clinical bags could have been diverted from clinical waste, an expensive waste stream. The amounts were largely dependent on different services or departments/wards highlighting differential behaviour or understanding of waste segregation. A small portion of clinical waste within specific departments/areas was recyclable or compostable (2 to 30% respectively). Types of waste with the most potential to be diverted from landfill (and did not contain expressible body fluids) from Audits A to C include:

- PVC waste which could be recycled, particularly if newer advanced recycling schemes such as soft plastics, hygienic pads and organics were adopted
- Packaging materials – cardboard
- Latex gloves
- Sterile wrap
- Paper – tissues

[10] https://www.plastics.org.nz/images/documents/PDFs/pnz-id-code-web-2009-1.pdf

- Hygiene pads – diapers

The waste audits also revealed a number of unopened medical equipment that had been disposed (Fig 6). These items were thrown away due to exceeding their expiry dates.

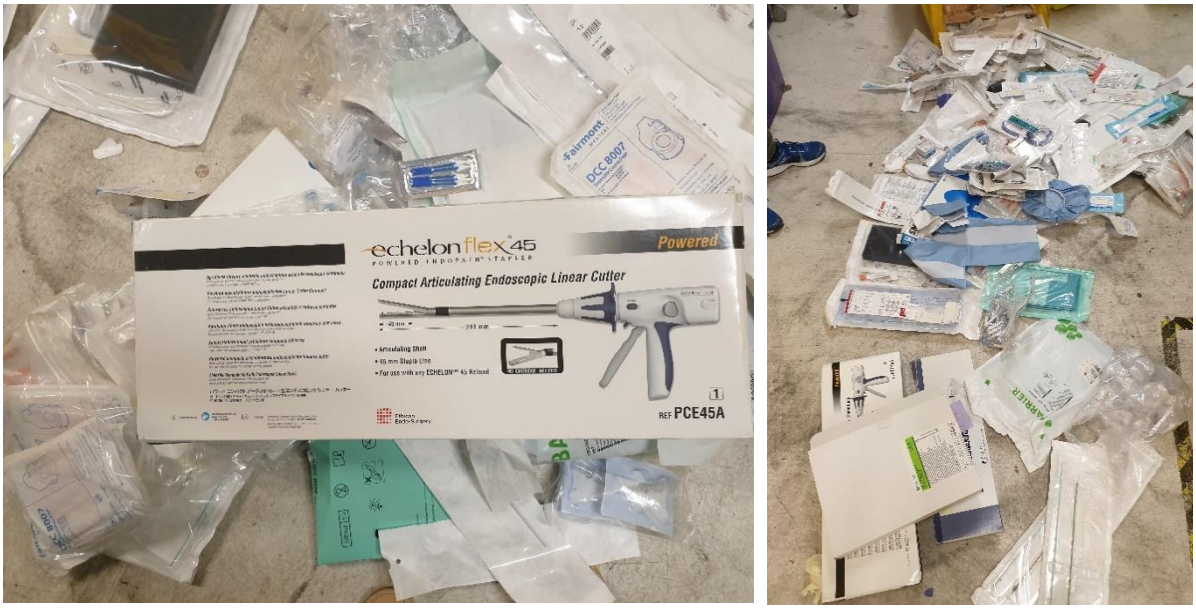


Figure 6: Example of unopened medical items found during waste audit and general waste from packaging

3.5 GREENHOUSE GAS EMISSION (GHG) INVENTORY DATA

Data from the 2018/19 stocktake showed that five DHBs had completed baseline emissions audits and report annually on emissions reductions and a further two had audits scheduled for 2019. Since the announcement of the public sector carbon neutral by 2025[11] initiative, greater efforts have been made to reduce the health care sector's main greenhouse gas emission sources (energy use, for example heating and cooling, lighting) and refrigerant replacements (NZ Doctor 2021). Additional GHG emission data was retrieved online via publicly available data provided by carbon reduction scheme websites.

[11] https://www.beehive.govt.nz/release/public-sector-be-carbon-neutral-2025

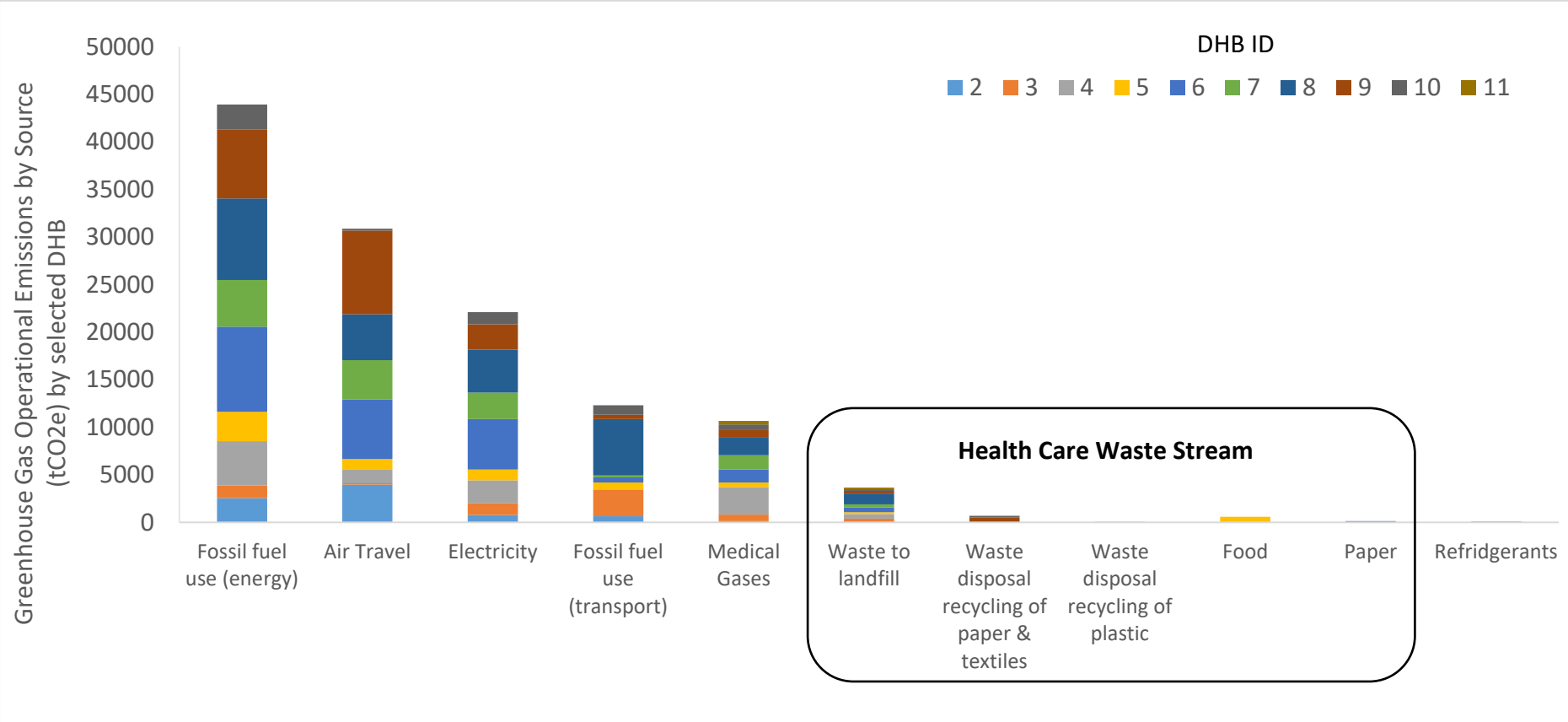


Figure 7: Simplified GHG emissions inventory of 9 DHB hospitals[12] and one private hospital. Fossil fuel use (energy) includes distributed commercial natural gas, coal and natural gas transmission and distribution (T&D) losses; air travel includes long haul (business and economy), short haul, domestic and helicopters; electricity includes distributed T&D losses; fossil fuel use (transport) includes fleet fuels, commercial diesel, petrol, taxis, trucks, transportation goods and patients; medical gases includes nitrous oxide and desflurane; waste to landfill includes waste landfilled garden and food, mixed waste, paper and textiles.

[12] Some emission inventories include additional facilities for example, for large regions it may include more than one hospital. Some inventories also include dental clinics, health centres, accommodation, allied laundry services and community sites.

From a climate change perspective, waste generation remains a smaller yet significant portion of health care's total greenhouse gas emissions profile. The majority of CO_2e emissions according to the GHG emission inventories are from transport (air travel and ground transport) followed by energy use (natural gas and electricity use) and medical gas use (Figure 7). Given that waste that is landfilled still appears in the top 10 of emissions (boxed area in Fig. 7), an added benefit of waste reduction would be a reduction in greenhouse gas emissions. Additionally, these figures may change when procurement is included in GHG emissions calculations (see Section 4.2.2).

3.6 SUSTAINABILITY PERSPECTIVES ON HEALTH CARE WASTE

Several key themes emerged from the sustainability survey in terms of barriers and opportunities to reduce waste (Appendix A). Each of these responses has been thematically coded and are summarised in the following sections.

3.6.1 Current barriers for health care waste sustainability

The barriers identified from both the annual plan survey and sustainability managers' survey included **infrastructure (external and internal), behaviour and education** and **procurement.**

External infrastructure was a barrier with many respondents stating issues with limited recycling options versus landfill and lack of alternatives. There were also economic challenges to recycling versus landfill. Recycling options were a particular issue in the South Island and with specific waste streams nationally such as food waste and plastics.

"Lack of NZ infrastructure for some recycling activities eg, full range of plastic cannot be recycled; cytotoxic waste transported to Australia for destruction; sanitary waste is landfilled; medical waste is landfilled".

"No commercial composting available and food waste, [it] is a large content of our waste".

"Price to landfill still cheap so recycling initiatives hard to implement".

Internal infrastructure was also a barrier with respondents reporting a lack of resources to implement waste segregation or current issues with labour required to sort existing waste streams.

"Limited resources for incorporating processes for the removal of new waste streams. Eg, the removal of compostables from departments to the bins at the dirty dock. The orderly's workload and limited space [does not] allow effective segregation and controlled waste".

"Lack of space for infrastructure"

"Lack of sterile services capacity means lower capacity to sterilise reusables".

Behaviour and Education issues were identified from staff to senior leadership. Lack of training was seen to lead to confusion and contamination of waste streams.

"Lack of a sense of urgency by the organisation"

Respondents also stated that the current procurement process did not include sustainability and that this meant that single use items and instruments were being procured when alternatives were available. There were also issues with how the cost of preferred products (alternatives to single use items) were often prohibitive.

"Product Evaluation Healthcare New Zealand (PEHNZ) is not endorsing reprocessing – groups with no government delegations are not aligned with zero waste goals and Government procurement rules."

"PHARMAC and other national suppliers must implement sustainable procurement, reduce waste".

3.6.2 Opportunities to improve health care waste sustainability

The opportunities identified from both the annual plan survey and sustainability managers' survey included **procurement, policy,** and **resourcing**.

Many respondents identified opportunities at the **procurement phase** with suggestions to include sustainable procurement criteria requirements for suppliers. Others noted that more acceptance of reprocessing opportunities was required and education to break down barriers for uptake of alternative products. Other opportunities included improving ordering of stock and whether items could be used beyond their expiry dates.

"We are currently seeing a lot of usable/unopened medical equipment being thrown out due to overordering and equipment having 'expiry dates'."

Procurement was strongly correlated with **policy opportunities** eg,

"Policies targeting product packaging materials and medical suppliers [needed]".

"Provisions for reusable PPE and guidance on disinfection."

Policy opportunities had the highest number of responses, with many respondents preferring reporting, auditing, benchmarking and key performance indicators as methods to enforce sustainability practice across DHBs.

"Create a State of the Environment Sustainability Report prepared by MoH which details each DHB's sustainability status."

"MoH to audit DHBs (for example annually, every two years thereafter) in terms of compliance with all sustainability associated directives: waste, procurement etc."

“Integration of sustainability/waste minimalisation into organisation-wide policies (especially procurement and infection prevention control).”

The next section highlights the insights collected from these data within a circular design framework. A theoretical circular design model can be used to frame the health care sector waste. In this model there are four circular designs for longevity, leasing or service, re-use in manufacture and material recovery. Other relevant parts of the circular design loops such as policy-making and research are also discussed.

4. Discussion

4.1 CURRENT HEALTH CARE WASTE DATA

According to the World Health Organization, most hospital waste is non-infectious, and a bulk of that is recyclable, yet most of these materials are either landfilled or incinerated.

This figure is similar to the data collected in this report. Of the seven DHBs that reported their waste by weight data, the average percent of hospital waste that is being landfilled is 65%. Of that waste, according to the limited waste audit data, it is estimated that up to 30% of general waste could be recycled, up to 60% (in some departments) diverted from clinical waste, with additional reductions in waste through policies, procurement, education, resourcing, and improved infrastructure (Table 2). There are however some barriers to realising these reductions which include wider infrastructure limitations, resourcing, education, and increased costs.

Table 2: Waste streams that could be diverted from landfill, either through improved segregation, reduced contamination, or opportunities to improve waste infrastructure

Waste Stream	Examples of waste minimisation and circular economy initiatives
Paper/Cardboard	Increase recycling of packaging such as paper and cardboard
	Replace paper hand towels with electric hand dryers where suitable
Plastic	Replace plastics number 3 to 7 with alternatives where possible
	Create opportunities to reuse, repurpose or recycle plastics numbers 3 to 7
Organics	Create opportunities to divert food waste from landfill where national infrastructure does not exist
Textiles	Replace single use textiles with reusable alternatives where possible
Rubber	Create opportunities to reuse, repurpose or recycle rubber
PPE	Create opportunities to find alternative products, for example, face masks that are compostable or reusable

Higher up the waste hierarchy (Figure 8), there are opportunities to create a more circular health care waste economy through a systemic change both at the health care sector level, but more widely across the waste sector. Areas within the health care sector's control include the adoption of higher procurement standards, the use of product stewardship schemes, uptake of reusable items and medical equipment, innovation to reduce waste streams reaching landfill, reduction and replacement of single use items, using technology to reduce waste, and creating opportunities to reduce GHG emissions. Reducing DHB waste could also include initiatives such as increasing telehealth, Health Information Technology (HIT) and increasing the use of green prescriptions. Other approaches include increased public health spending to promote healthier lifestyles, such as active transport, smoking

cessation and healthy eating that reduce the need for people to visit health care facilities and thereby reducing waste. The current proposed restructuring of the health system has the potential to offer health gains through a focus on population and indigenous health (Health and Disability System Review, 2020).

Figure 8: Te Pūnaha Whakarōpū Para - The Waste Hierarchy

The waste audit data suggests that theatres, operating suites, and laboratories produce most of the waste in a hospital setting, but more data is needed to ascertain whether this is common across all hospitals. In an Australian study, a quarter of all hospital waste was from theatres with up to 25% derived from anaesthetic services (McGain et al 2019). The same study also found that approximately one quarter of operating room waste could be recycled. Per tonne recyclables are half the cost of general waste, so increasing recycling capability will save DHBs waste related costs.

4.2 GUIDING FRAMEWORKS: TE AO MĀORI AND THE CIRCULAR ECONOMY

It is important to note that waste minimisation and the circular economy should be viewed within a holistic framework of sustainability. The circular economy and Te Ao Māori share similar perspectives. The contemporary concept of para kore (zero waste) is a customary practice that brings mātauranga Māori (Māori knowledge and expertise) and tikanga into the sustainable waste management sector. It recognises the extrinsic costs of waste on the aquatic and terrestrial environments, such as the leaching of hazardous substances into the ground from landfills and acknowledges that people or generations to come will inherit these costs. In the circular economy context, exercising kaitiakitanga safeguards the future by preserving intrinsic value (ie, not being wasteful) whilst retaining options we might not yet know exist (Prime Minister's Chief Science Advisor, 2019). The Ministry for the Environment's concept of circular economy shares similar aims to create a safe and environmentally friendly way that designs out waste and pollution, keeps products and materials in use and regenerates natural systems (Ministry for the Environment, 2021). If managed well, and within limits, resource recovery and waste infrastructure can protect our environment by making sure waste materials don't contaminate our land, water and air whilst also saving costs.

4.2.1 Circular Design in the context of Health Care Waste

Circular design requires holistic systematic thinking alongside conversation and collaboration with experts such as scientists (including chemists), waste managers and systems engineers amongst other experts (see Figure 9). This section describes some of the elements of the circular design model, as applied to health care waste. The challenge starts at the beginning where products are identified that are not useful or are wasteful, analogous to **refusing** single use items, as per the waste hierarchy (Figure 8).

The net environmental effect of reusable versus single-use equipment is a complex calculation and in a healthcare setting can pose a number of questions. For example, in some practices single-use protective equipment and single-use medical equipment are understood to be safer. However, it is possible, (and was previously normal practice), for medical equipment to be routinely cleaned, sterilised, and reused. Respondents to the survey noted that the use of some single use items and issues around infection prevention control needed to be addressed at the research and procurement level, for example see Day (2004). Single use items are perceived to cost less upfront, than supplies which need to be maintained carefully to prevent infection and early wear and tear.

However, the cost of single use products fails to account for the externalities included in those procurement decisions both up and downstream of the supply chain, from resource extraction, energy, water, labour, transport, pollution, and disposal management, to the longer-term cost of constantly replacing products and devices.

It may be worth considering a life cycle analysis (LCA) of some more commonly used single use items versus their alternative **(reusable)** counterparts, which is also suggested in the NZ Healthcare Standard. For example, in a generic LCA of reusable vs. disposal surgical drapes used during theatre, although the reusable drapes (which can be used 1000 times), used more transport fuels for transport and cleaning at the laundry, nonetheless, taken over the whole supply chain, they used about 60% less energy and 78% less material over their lifetime than the disposable drapes. Most of the energy use of reusable drapes was in the laundry facility (Vozzola et al 2018, Figure 8.3). Other LCA show similar environmental benefits (Vozzola et al 2020; Overcash, 2012). There are opportunities to investigate LCA of DHB laundry facilities, that are expected to perform much higher than the example given here, due to more efficient energy use and adopted new technology.

Food was identified as a waste stream with the potential to make operations more carbon friendly and reduce overall waste if composting facilities were available. One DHB had identified that 80-85kg of plate waste was generated daily from patients in hospitals and were working towards reducing this. In the carbon reduction scheme data, food was a smaller, yet important waste stream that could avoid landfill. Some of the challenges around achieving this include lack of infrastructure for composting organics. The infrastructure commission identified that food waste reduction and having better infrastructure in place to capture and use biogenic methane from organic materials (eg, via anaerobic digestion) were important for Aotearoa's transition to net-zero by 2050 (New Zealand Infrastructure Commission Te Waihanga 2021). Yet some DHBs are innovating by collaborating with local marae and schools to collect and compost food waste which would be used in community food gardens (Bennett and King, 2018). Bennett and King suggest that DHBs could then commit to purchasing food from those gardens thus reducing greenhouse gas emissions and food waste. This would support local Māori economic development and provide education opportunities to learn about composting and growing food/kai.

Technology can also help accurately forecast the amount of food to purchase and prepare based on trend information of actual patient meal orders. The same technology can be applied to forecast products and thus improve stock rotation. Management of stock volumes

allows for less wastage of expired and outdated stock which was an issue identified in waste audits.

Where products or packaging are necessary **(Design for Longevity)** should allow for products and users to work together to create products that can be reused and have their raw materials fully recoverable to their maximum value or divert them from landfill for as long as possible. This aligns with the waste hierarchy **(Reuse tier)** with fewer products being purchased as they are reused for as long as possible.

Ideally, once these products have reached the end of their usefulness, they could then be **re-purposed**, rather than being landfilled. This is a challenge for some waste streams in the health care sector such as textiles and plastics, which currently do not have a clear pathway for reuse or material recovery (Casey and Johnston, 2020; Prime Minister's Chief Science Advisor, 2019).

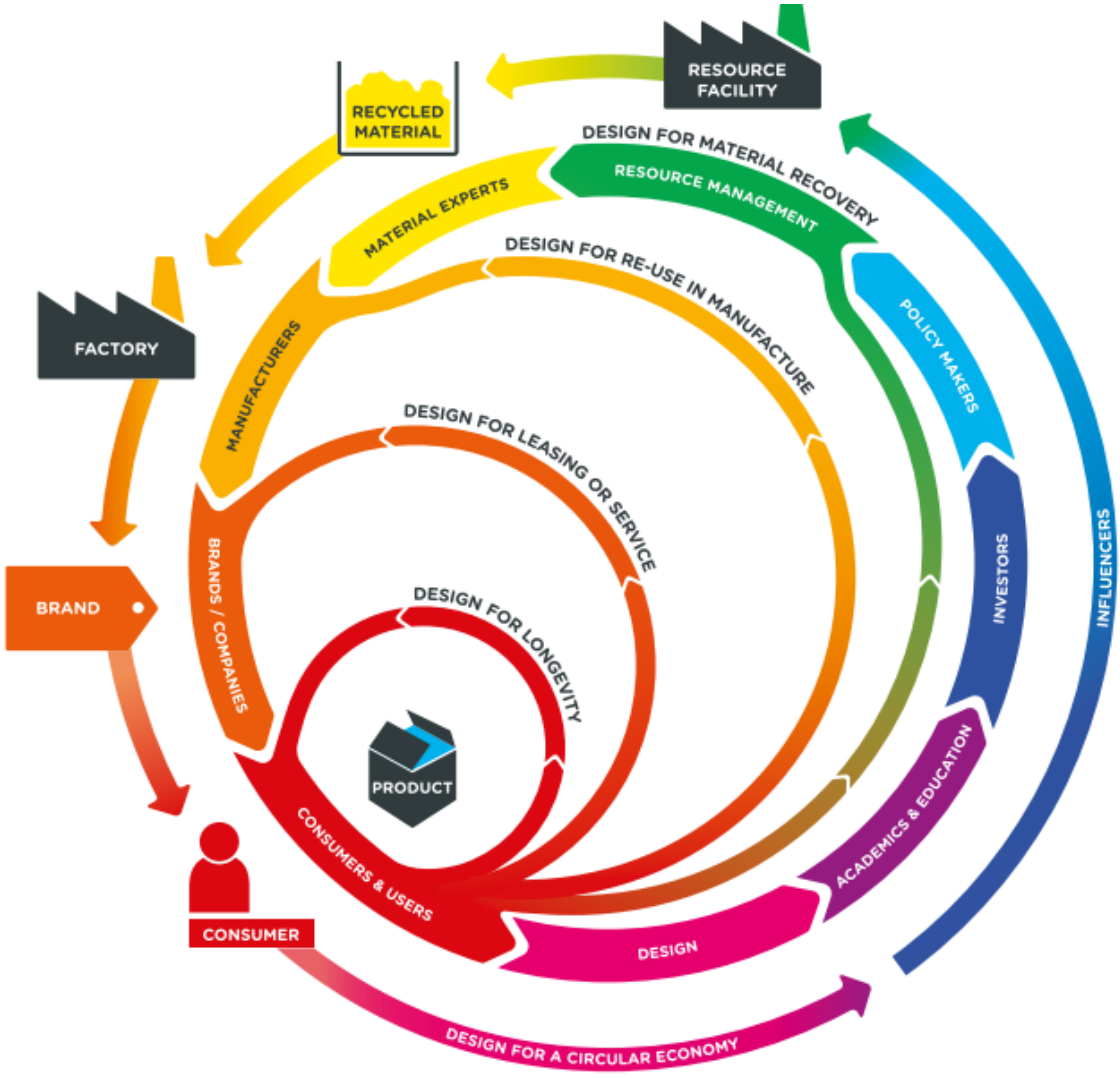


Figure 9: An example of the circular economy, from a four circular design model perspective. Source: https://www.the-ies.org/sites/default/files/journals/world-wakes-up.pdf

There was a lack of data on refurbishing, remanufacture or reprocessing within health care waste streams. Product stewardship schemes exist for some medical items eg, IV bags which are recycled. As this report found, there are still issues around contamination that need to be resolved (see section 3.6).

In the USA, there are established programs where used medical products are sent to third-party re-processors (Karidis 2018). A rebate or repurchase at a reduced cost is given. However, space, education, time, and energy is required to make the programs work. These challenges are not dissimilar to those identified in this report which included resourcing and labour.

Working with suppliers and clinicians is also important to avoid unnecessary waste. Some hospitals are reformulating operating (theatre) rooms kits with suppliers to include only what clinicians need (Zygourakis et al 2001). Sterilisation wrap and other packaging can be targeted as they can be replaced with reusable items such as ComPel™, a material that can be laundered and reused up to 100 times before it reaches the end of its life. Some DHBs are collecting, decontaminating (via third party) and recycling single use metal instruments. However, there are challenges to replacing these with reusable items such as sterilisation capacity and cost.

When a product is designed for the longest use possible and can be easily maintained, repaired, remanufactured, or recycled (or used, composted and nutrients returned) it is considered to have a circular life cycle. Consideration should be made as to how the circular economy is fuelled, ideally by renewable energy (eg, solar, hydro, wind and tidal power, and biofuels) and what materials and resources (including types of labour) are involved in the manufacturing of the product.

4.2.2 Net Zero Health Sector and Procurement

Waste was found to be in the top ten of hospital GHG emissions according to the greenhouse gas emission inventories provided. However, many of these inventories do not consider emissions from procurement. International data from the UK shows that emissions from procurement can be up to 70% of total emissions (McGain et al 2014). It is therefore likely that GHG emissions from waste are being underestimated. Reducing emissions can start from the reduction of waste upstream. This means that procurement need to work with suppliers to reduce unnecessary waste, including packaging, materials that cannot be recycled, towards more circular uses of materials in a health care waste setting. This will reduce both GHG emissions and overall waste and should be a priority.

4.2.3 Other critical levers that can support health care waste minimisation

Councils/local agencies have key roles through coordinating and leading waste minimisation initiatives, and greater sustainability could be achieved if councils/local agencies used their influence more effectively. Ideally the circular economy should identify opportunities to create new pathways for waste minimisation, reuse etc by using innovation, research, and design. This can include academics and industry as well as investors and Government funding strategies.

Investors can include businesses, venture capitalists, entrepreneurs, scientists and engineers, researchers and the health sector itself. For example, this report identified that

DHB laundry services not only reuse heath care textiles but also reinvest back into the health system through profits. With careful planning, the profits made from DHB owned assets could be used to innovate, research, and financially support other sustainability initiatives. In the same manner, saving from climate mitigation measures could be reinvested back into sustainability initiatives.

4.2.4 Policy Makers

A shift in social practices requires the support of policies focused on shifting towards a circular economy rather than waste management (Chan et al 2020). Ideally, this would be facilitated by policy makers who are themselves critically conscious of the need for sustainability, and apply systems thinking and indigenous knowledge principles.

It is important that DHBs work with iwi, policymakers, councils, suppliers, contractors and other relevant stakeholders to raise awareness around waste minimisation and circular economic goals. Councils review their waste minimisation strategies regularly and some DHBs have demonstrated the need to work with councils, marae, and schools to recycle or repurpose waste and develop more recycling opportunities within communities.

4.2.5 Resource Management - Infrastructure

Effective management of healthcare wastes relies on good segregation of the waste at the point of generation. The survey showed that internal infrastructure appears to be a challenge, including physical segregation containers, availability of staff and physical space. In addition, hospitals also have challenges in contamination of waste (what waste belongs where), which hinders recyclability. Therefore, periodic training will help to improve compliance with segregation and reduce contamination of waste streams.

Nationally, Aotearoa lacks the onshore processing infrastructure to manage some of the waste streams created by the health care sector. The survey revealed that access to recycling facilities varies across the country (Eg, recycling plastics numbered 3 to 7, commercial composting that include materials that are considered biodegradable, cytotoxic waste transported to Australia for destruction; sanitary waste is landfilled, medical waste is landfilled), creating equity issues but also raising the issue of how some unique healthcare waste streams cannot be recycled onshore (eg, cytotoxic waste) and general (eg, plastic numbered 1 to 2). However, shifting to a circular economy may have implications for investment in waste infrastructure. For example, there needs to be some stability in the competition for waste as well as the level of demand for the materials that can be recycled or recovered from waste (New Zealand Infrastructure Commission Te Waihanga 2021). The commission noted that the types of waste that are created can undermine certainty in long-term investments or have the potential to make some infrastructure less useful.

4.2.6 Material Experts and Manufacturing: Innovation

Financial savings could be seen by working with existing suppliers, businesses, universities, crown research institutes etc, to find solutions to reduce or replace these waste streams that are currently being landfilled or incinerated. These could be supported by innovation funds not dissimilar to MfE’s waste minimisation fund.

4.2.7 Green, Sustainable, Centralised Procurement

Health care sector waste reduction can start with procurement by including sustainability criteria within the procurement process. This includes preferentially choosing local and/or socially and environmentally responsible, low carbon, safer products, switching from disposable to reusable, reduced packaging and include the re-use, recycling, or end of life options (Ministry of Health 2019). This aligns with the Government's broader outcomes[13] that recognises that "procurement activities offer a unique opportunity to achieve broader cultural, economic, environmental and social outcomes for New Zealand" and "should be used to support wider social, economic, cultural and environmental outcomes that go beyond the immediate purchase of goods and services".

The most relevant priority outcome of the broader outcomes initiative is transitioning to a net-zero emissions economy and designing waste out of the system. These expectations are set out in Rule 20 of the Government Procurement Rules (4th edition), which requires that mandated agencies deliver minimum requirements in designated contract areas.

A number of DHBs are working towards or incorporating sustainability specifications in their procurement processes. DHBs have already banded together to form common procurement organisations (HealthAlliance is an example of this).

However, information which is shared across a centralised database system is required to standardise procurement across the DHBs. This includes:

- Developing criteria for environmental screening of products including product selection, product use, product disposal, and environmental and community health impacts
- Environmental performance indicators that are incorporated into the evolving definition of quality for health care (Kaiser et al 2001)
- Identifying suppliers that are not transparent about their raw materials, energy use and sustainability policies
- Identifying and prioritising products that are made from recycled materials, that are repurposed medical items or reusable items over recyclable or single use items
- Identifying products or services that are Māori businesses or enterprises
- Identifying suppliers that are able to reduce packaging

In terms of national procurement, agencies such as PHARMAC will need to use their purchasing power to include low or zero carbon products and consider whole of life design (and supply chain) costs in their purchasing decisions eg, introducing LCA and circular economy considerations into the procurement chain could be useful when considering purchase of (pharmaceuticals), medical and dental treatments (Alshemari et al 2020; Antoniadou et al 2021); medical devices and products (Kane et al 2017; MacNeill et al 2020).

It is important to note that alternative products are demonstrated to have equal or superior environmental and clinical performance. For example, a polyolefin intravenous (IV) bag does not contain chlorine, so it has less potential to produce dioxins through incineration than an IV bag containing polyvinyl chloride (PVC) (Kaiser et al 2001).

[13] https://www.procurement.govt.nz/broader-outcomes/

4.3 HOW CAN THE MINISTRY OF HEALTH ACTIVELY PROMOTE AND ASSIST DHBS IN THIS WORK?

Utilising these insights within a circular and Te Ao Māori framework, there are a number of possible pathways in which the Ministry of Health can support DHBs in minimising and creating a circular economy around health care waste, in particular they include:

1. **Collecting national health care waste data** to support policies to reduce waste by identifying areas that would have the highest impact within the waste hierarchy (Figure 8). Lack of data at a national level can make it difficult to measure success and plan infrastructure and resourcing. As described in the waste audit data (section 3.4.3) contaminated waste streams can be costly. However there was limited data across the DHBs on how much contamination was occurring and where specifically it was occurring. There was also limited data regionally on contamination with home medical waste such as kerb side waste collection and recycling centres. The survey revealed that there was often confusion generated by changing rules around what can/can't be recycled (particularly plastics) and staff apathy about correct recycling. Educating staff about waste separation and providing multiple bins with effective signage in locations of consumption can encourage waste separation. It was also suggested that high-level waste training program directives were regularly used, that included community nurses and pharmacies who can play a significant role in educating patients and their families/whānau in the community about treatment-related waste minimisation procedures (recycling, reusing, take-back schemes and community sharps disposal). However, this should be in conjunction with longer terms plans to phase out waste streams such as packaging and single use items (see number 2).

2. **Creating a national procurement standard and centralising purchasing power.** Collectively DHBs have huge purchasing power and influence eg, PHARMAC, and other groups need to be aligned with zero waste goals, eg, Evaluation Healthcare New Zealand. It is important that suppliers are able to ensure that goods and services are produced in an environmentally sustainable way. In conjunction with the NZ Government broader outcomes, similar advantages can be applied to the local purchase of many other consumables including office equipment. Additionally, procurement decisions can be supported using national health care waste data, that includes economic, social and environmental costs and where possible LCA. Since procurement is likely to be a major source of GHG emissions (Section 4.2.2), then there is also an imperative to seek low carbon procurement options.

3. **Creating policies based on national health care waste data. Figure 4 shows** that general waste is the largest proportion of health care waste, with a significant proportion with the potential to be reduced, reused, repurposed and recycled, avoiding landfill. There are opportunities to DHBs to understand their waste streams in more detail, including contamination issues. Utilising waste audit activities, as specified in the NZ Waste Management Standard can achieve this although may require outsourcing this service. Other examples of policy to reduce health care waste include: working with MfE to create national waste legislation and policies that support health care waste reduction, in particular product stewardship schemes for health care materials that are difficult to replace, reuse, repurpose or recycle and setting targets for organics, recyclables, and general waste. This could be done as kg/patient or by some other metric and compared to international literature. For

example, healthcare waste generation rates in selected countries range from 0.44 kg/bed/day (Mauritius) to 8.4 kg/bed/day (USA) (Minoglou et al 2017). The same study found health care waste generation rates were correlated with life expectancy and CO_2 emissions. These waste streams can then be monitored and reported on an annual basis. For example, Christchurch City Council currently has waste reduction targets on a kg/per person basis (Table 3). Given that most health care waste is general, aligning targets with the local or regional council is one way to consider setting goals in the short-term. However, this means that some DHBs will be more limited than others. In the longer term, a move towards a circular economy ie, by reducing waste initially, and by working with other DHBs to create innovative solutions to share, reduce, reuse, repurpose and recycle. Some DHBs are already composting food waste, which could be used to grow food and supply to the hospital, supporting a circular economy as well as reducing significant GHG emissions. The Ministry of Health may also consider penalties or incentives for reaching targets.

Table 3: Christchurch city council's waste targets (kg/person/year) by waste stream

Waste Stream	Target (kg/person/year)	Current Performance (kg/person/year)
Organics	30	11.5
Recyclables: paper and cardboard	30	18.5
Recyclables: plastics	None set	12
Waste to Landfill	80	115

4. **Create a mandatory reporting mechanism** eg, Sustainability reports combining all DHBs sustainability data on an annual basis including benchmarking. This would include information on key focus areas such as waste, procurement, transportation, energy, building performance, green spaces, water and food use etc. The reporting mechanism can be used to share waste information across DHBs, create key performance indicators and targets.

5. **Auditing in terms of compliance of sustainability directives** including compliance of the Waste Management of Medical Waste Standard NZS 4303:2002 which is a component of the Standard.

6. **Update the current Management of Medical Waste Standard NZS 4303:2002**. The current standard limits segregation of defined medical and controlled waste. DHBs are finding a dedicated full-time Waste Management and Minimisation Officer (required by the Standard) challenging due to FTE capping. There is also lack of innovation for efficient tracking of waste which is currently a time-consuming manual process and is also high-risk in terms of infection or other exposures. Cytotoxic waste according to the standard must be incinerated (not landfilled although there is an option for sewer disposal). The national air quality standards and RMA does not allow high temperature incineration of cytotoxic waste in NZ (but it does allow incineration at crematoriums). There were 3 consented high temperature incinerators in the RMA but they are no longer operating. Therefore currently, all healthcare cytotoxic waste is shipped overseas for incineration. The incinerators used are in

Australia, and are shipped in conjunction with the Basel Convention[14]. In 2019, 80 metric tons of cytotoxic waste (H6.1) and 138 metric tonnes (H6.1 and H11) were shipped to Australia for destruction. However the convention also includes an article that states countries should ensure adequate disposal facilities (Article 4 and 13)[15] and ensure that the generation of hazardous wastes and other wastes within it is reduced to a minimum, taking into account social, technological and economic aspects. The standard also states that infectious waste can be cremated (also sewer and incineration are options) but that does not appear to be occurring (it is treated and landfilled). The health care standard would also benefit from guidance of culturally appropriate ways to manage body parts, and Te Ao Māori frameworks more generally that support health care waste minimisation and kaitiaki.

Finally, it is important to acknowledge that many DHBs are resource constrained and have many competing priorities. Therefore, any actions that increase workload need to be carefully considered. For example, this report has shown that a key barrier is internal infrastructure and staffing (orderly workload and the availability of expert staff such as sustainability managers). Moreover, the health and disability sector reform will change the structure of the health sector. The reform is likely to have implications to the insights described in this report, but may also be an opportunity to streamline and increase efficiencies across the health care system such as including environmental sustainability alongside safety, timeliness, effectiveness, efficiency, equity and patient-centredness as the seventh dimension of the quality of healthcare (Atkinson et al. 2010; Connor and O'Donoghue 2012).

4.4 KNOWLEDGE GAPS

Knowledge gaps identified in the report include:

- How much refurbishing or remanufacture of health care products within DHB waste streams is occurring, in particular e-waste, and medical equipment.
- Whether the current guidance on home medical waste needs updating to increase waste minimisation and what opportunities exists to increase waste segregation rates and shift towards a more circular economy, within a Te Ao Māori guiding framework
- What opportunities exist for minimising/creating more circular waste opportunities at other major sources of health care waste such as: other health facilities, laboratories and research centres, mortuary and autopsy centres, animal research and testing laboratories, blood banks and collection services, nursing homes for the elderly.
- How to create opportunities to create more DHB owned waste treatment facilities such as co-ownership of composting facilities. This could me be in conjunction with Māori, within a Te Ao Māori guiding framework.

[14] http://www.basel.int/TheConvention/Overview/TextoftheConvention/tabid/1275/Default.aspx

[15] **Article 4 2**. Each Party shall take the appropriate measures to: b) Ensure the availability of adequate disposal facilities, for the environmentally sound management of hazardous wastes and other wastes, that shall be located, to the extent possible, within it, whatever the place of their disposal; **Article 13 3**. The Parties, consistent with national laws and regulations, shall transmit, through the Secretariat, to the Conference of the Parties established under Article 15, before the end of each calendar year, a report on the previous calendar year, containing the following information: (g) Information on disposal options operated within the area of their national jurisdiction

- What drives innovation in the medical waste sector and how is it supported.
- What the research needs were to develop biodegradable and environmentally friendly alternatives identified in this report including plastics, rubber (latex gloves) and personal protective equipment such as face masks which are becoming a global issue.
- How to work with suppliers and clinicians to develop more sustainable products and to identify items that are no longer used in theatre that can be reported back to manufacturers and procurement.
- What solutions are available to reducing cytotoxic, sharps and medical waste and/or maximising efficiencies eg, Waste to Energy plants.
- How to create more partnerships to develop new waste streams from products that have reached their end of life eg, textiles, plastics.
- Equitization of Mātauranga Māori as a leading source of knowledge and practice along with western scientific techniques for health care related waste reduction and circularisation.
- How climate change may impact on global supply chains and extreme events may impact on the availability and delivery of services, including the procurement of new equipment or supplies.
- How a circular economy can be used to restore the environment from both a western science and a Te Ao Māori perspective.

4.5 CONCLUSION

As Aotearoa New Zealand's population both expands and lives longer there is likely to be an increase in the generation of health care waste. Major changes to move to a circular economy of health care waste will require clear incentives to reduce waste but also information that supports changes to the systems eg, data, infrastructure, knowledge as well as the resources (people, finance, will) to do so (Bentley et al 2008).

Some issues appear to be systemic such as plastic recovery or composting infrastructure. Some waste streams are still reliant on processing or removal to offshore sites which could be processed in Aotearoa. Initiatives have been largely left to DHB providers and sustainability employees, yet it appears that not every DHB has this resource. There needs to be more effort to look at impact on Māori given that health outcomes include health equity for Māori and other groups. Sustainability also needs to include how system shocks eg, pandemics, climate change may impact supply chains in the future and how natural disasters or weather events may impact on the availability and delivery of services, including the procurement of new equipment or supplies. Finally, sustainable development units exist in the UK and the question has been raised by DHBs and sustainability groups as to whether Aotearoa should have a national sustainable development unit that drives policy, legislation, innovation, regulation, and initiatives for the health sector.

In keeping with a circular economy and Te Ao Māori principles, there appears to be little information on how a circular economy can be used to restore the environment. Keeping products within a circular system maximises the efficiency of those initial raw materials but fails to recognise the resource depletion that has already occurred for several decades.

Although restoration is a better-defined concept than regeneration, it needs conceptual re-enforcement relative to the biological/ecological aspects of the circular economy. A study by Morseletto (2020), suggests looking in the direction of restoration ecology, a well-established branch of ecological research to define restorative protocols.

Identifying opportunities to increase restoration of the environment will be key to maximising the benefits of the circular economy, with health and wellbeing gains.

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6. APPENDIX A

Barriers to Reducing Health Care Waste

Theme for Barrier	Barrier
AWARENESS	Not enough buy-in from the top (Executive Management level and Board)
	Poor staff awareness
	Lack of high-level leadership
BEHAVIOUR	Behavioural issues
	Contamination and cleaning of recyclables
	Staff attitudes
	Strengthening the relationship of procurement and waste
CONFLICTING GOALS	Toitu carbon reduce certification focuses on carbon emission and not reduction of landfill waste – for example recyclable paper and cardboards carry high emissions despite its diversion from landfill
EDUCATION	Reducing paper use minimises waste eg, Setting the default setting on printers to double-sided printing can reduce paper use by about 15 percent
	Absence of high-level waste training program directives from MoH
	Education and awareness – large organisation, varying shifts, and staff, etc.
	In public areas a lot of contamination in recycling bins
	Composting and recycling reduces methane emissions by limiting waste that ends up in landfills. Educating staff about waste separation and providing multiple bins with effective signage in locations of consumption can encourage them to separate waste.
	Community nurses and pharmacies can play a significant role in educating patients and their families and whānau in the community about treatment-related waste minimisation procedures (recycling, reusing, take-back schemes and community sharps disposal).

	Confusion generated by changing rules around what can/can't be recycled (particularly plastics) and staff apathy about recycling correctly.
RESOURCES/FINANCE	Budget constraints
	Lack of a sustainability "team" or even one more person to lead waste minimisation. There is one person to deliver sustainability strategy, advice & operational tasks for the whole organisation
	Orderly services – lack of FTE
	Cost of alternative products
	Lack of orderly resource
	Lack of resource (funding, human and facilities – eg, bin washing facilities)
	FTE capping – We are not able to employ additional FTE for a dedicated full-time Waste Management and Minimisation Officer (required by NZ Standard – Healthcare Waste Management).
INNOVATION	Lack of innovation for efficient tracking of waste – currently manual process which is time consuming
	Product stewardship
INFRASTRUCTURE (EXTERNAL)	Limited recycling options, only plastics 1-2.
	Costs of recycling which in some cases are more expensive
	Costs of sustainable alternatives (compostable/recyclable)
	Items that have no current recycling value
	Insufficient amounts of recycling to be economical
	Lack of recycling options in the South island
	Lack of NZ infrastructure for some recycling activities eg, Full range of plastic cannot be recycled; cytotoxic waste transported to Australia for destruction; sanitary waste is landfilled, medical waste is landfilled
	No commercial composting available and food waste is large content of our waste.

	Absence of waste recycling facilities (for example glass is transported to Auckland for recycling) in Taranaki region
	Regional location – lack of alternative waste streams for recyclables/compostables
	Price to landfill still cheap so recycling initiatives hard to implement.
	The capacity of the Recycling market within NZ and overseas to accept certain plastics
INFRASTRUCTURE (INTERNAL)	No option to divert all of the biodegradable products (like paper pill cups, bio coffee cups and food packaging)
	Recycling is fine but NZ lacks the ability to utilise products that need recycling on shore. We need innovation & thought to go into recycling
	Space restrictions (crowded and cluttered and too small sluice rooms on wards for example) to house the various waste streams
	Absence of waste register limited space to allow effective segregation and controlled waste
	Lack of sterile services capacity (means lower capacity to sterilise reusables)
	Lack of space for infrastructure
	lack of infrastructure (for sorting etc)
	limited resources for incorporating processes for the removal of new waste streams, eg. The removal of compostables from departments to the bins at dirty dock. The orderly's workload is at capacity, we would require an extra FTE role
	If possible, employers should provide electronic devices to enable paperless recording.
	To minimise waste, replace single-use items such as plastic water bottles, pill cups and drinking cups with reusable items. If you cannot source reusable products, consider using biodegradable or recyclable products.
	Anaesthetic gases contribute greatly to the carbon footprint of the health care sector (Gadani and Vyas 2011). Using Blue-zone

INFRASTRUCTURE/POLICY	technology can help hospitals to make economic savings on anaesthetic gases while preventing emission of harmful greenhouse gases.
POLICY	The current Management of Medical Waste Standard limits segregation of defined medical
	Inadequate labelling on products, ridiculous amounts of packaging
	There is no penalty if DHBs do not reduce waste.
LEADERSHIP	Not enough guidance/direction from the Ministry of Health – particularly directed to the Board and Executive Management level
	Lack of a sense of urgency by the organisation
	Absence of a National Waste Management and Minimisation Plan (WMMP) prepared by MoH – key document to refer to by each DHB particularly in developing WMMP in regional level.
PROCUREMENT	PHARMAC and other national suppliers must implement sustainable procurement, reduce waste
	Procurement – single use packaging and instruments
	Product Evaluation Healthcare New Zealand (PEHNZ) is not endorsing reprocessing – Groups with no government delegations are not aligned with zero waste goals and Government Procurement Rules.
	Also preferred products most of the time still too expensive to justify product change.
	A lot of medical supplies come from abroad so difficult to influence changing products to better alternatives.
SAFETY	Infection Protection & Prevention Control (IPPC) needs to be taken into consideration
STANDARDISATION/POLICY	Inconsistencies in recycling rules – hospital is different to Napier/Hastings, which both used to be different to each other

Opportunities to Reducing Health Care Waste

Theme for Opportunity	Opportunity
EDUCATION	Education and awareness of staff – significant reductions available, see waste audit info for detail

	More awareness of the problem.
INFRASTRUCTURE (EXTERNAL)	If we have commercial composting we can divert more
INFRASTRUCTURE (INTERNAL)	Provide a centralised database of medical records where each DHB can also log in their medical records
	Providing subsidised reusable drinking cups, reusable glass drinking bottles
	Purchasing products that can be returned to suppliers for reprocessing and purchasing them back for a lesser cost than a new item
	Provide a centralised on-line asset register where each DHB can also register their assets
	We are currently seeing a lot of usable/unopened medical equipment being thrown out due to over ordering and equipment having 'expiry dates'
	Strong emphasis on telehealth – beneficial for rural healthcare services
INNOVATION	Investigating surplus equipment and items – currently, the process is informal
	Reprocessing trials – SCD sleeves and HoverMatts
	Alternatives for plastic made products that cannot be reused
MAINSTREAMING SUSTAINABILITY/POLICY	Align MOH directives with Ministry for Environment requirements, and all environmental associated legislations: Resource Management Act, Zero Carbon Act, Waste Minimisation Act, etc
	Emphasis on the application of sustainability in all of the operations of DHBs including pandemic, endemic, emergency responses
	Strengthening the alignment of sustainability related policies and strategies with other government agencies like councils, etc
	Strengthening the role of external partnership and engagement
POLICY	Penalties, enforcement actions

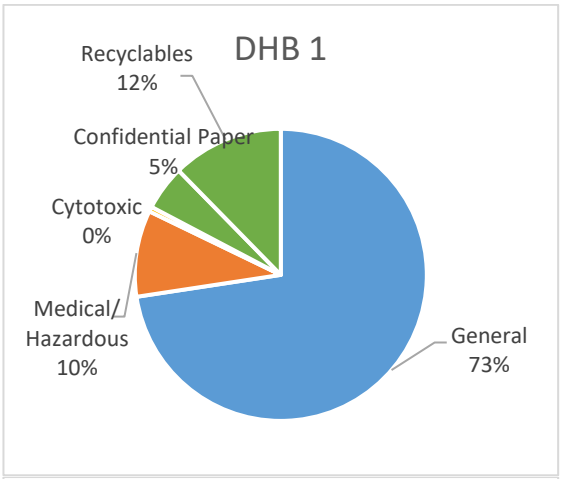
	Confirm the sustainability focus areas: waste, procurement, transportation, energy, green buildings, green spaces, water, food.
	Consistent KPIs, targets, benchmarks, etc for all DHBs to meet
	Create a State of Environmental Sustainability Report prepared by MOH which details each DHBs sustainability status; all DHBs will feed into this report; similar to State of the Environment prepared by Regional Councils which feeds into the Ministry for the Environment
	Directives to utilise low emission refrigerants, anaesthetic gases, etc
	Integrated management – holistic approach linking sustainability focus areas
	MoH to audit DHBs (for example annually, every two years thereafter) in terms of compliance with all sustainability associated directives: waste, procurement etc
	Provisions for reusable PPE and guidance on disinfection, reprocessing, etc
	Scope of WMMP – includes review period
	Set targets per period (staged approach): (First Tier) Sustainability Policy (Second Tier) Sustainability Action Plan (Third Tier) Waste Management and Minimisation Action Plan; Sustainable Procurement Action Plan; Active, Shared & Public Transportation Action Plan; Energy Action Plan; Green Buildings Action Plan; Green Space Action Plan; Food and Water Conservation Action Plan; etc (Fourth Tier) Measures and Targets/KPI/Benchmarks (Fifth Tier) Reporting, Monitoring, Enforcement, etc (
	Integration of sustainability/waste minimalization into organisation-wide policies (especially procurement and IPC)
	National waste legislation and policies – especially product stewardship schemes (requiring suppliers to take their packaging back would be a tremendous help)
	Policies targeting product and packaging materials of medical supplies
	Reprocessing opportunities, eg, MedSalv – need to continue to work to break down barriers to uptake in DHBs

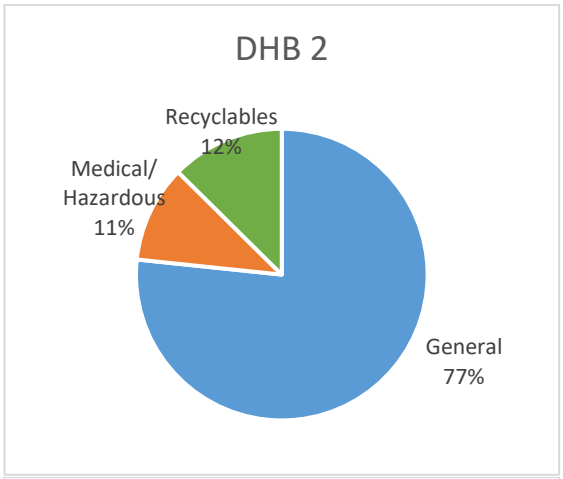
PROCUREMENT	DHB roles and responsibilities – include development and implementation of Sustainable Procurement Action Plan (SPAP) and Waste Management and Minimisation Plan (WMMP)
	Change to reusable sharps bins instead of single use bins
	Learnings from COVID-19 – security and sustainability of the supply chain
	Review waste and procurement associated legislations and policies to reflect the following:
	Scope of SPAP
	Sustainable procurement criteria for suppliers, contractors, etc to meet – include set of questionnaires to be completed for tendering, quotes, contract management
	Huge opportunities in procurement phase
	Looking to include more sustainability criteria in the procuring phase
	Working with procurement to ensure sustainability is considered during procurement decisions, eg. The purchase of quality furniture that will last
PROCUREMENT/INNOVATION	Blue wrap for years high on the list to do something about, high volume product.
	Procurement, labelling & product stewardship needs to be addressed in a radical manner.
	Some companies are able to use soft plastic & syringes that then get turned into posts.
RESOURCE	More products come to market so more affordable products become available
	Allocate funding for all sustainability associated work, innovation, resourcing, FTES for each DHB
	Each DHB has no FTE for environmental policy planner to review, make submissions on sustainability associated policies, etc – this is currently defaulting to Sustainability Managers
	Requirement for each DHB to employ a suitably qualified Waste Management and Minimisation Officer, Sustainability Officer, Energy Officer, Transportation Officer, etc
	Set aside annual sustainability budget for all DHBs to implement legal and MOH's directives

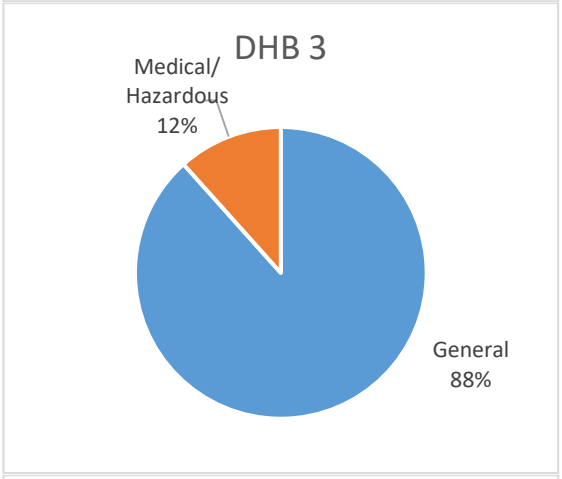
RESOURCE/POLICY	Formalise Sustainability Roles and FTEs – For example, Sustainability Manager (one appointed in each DHB with overall responsibilities to look into set of focus areas); Waste Management Officer (one in each DHB to report to Sustainability Manager); Energy Officer (one in each DHB to report to Sustainability Manager), etc
	Currently working on a carbon action plan

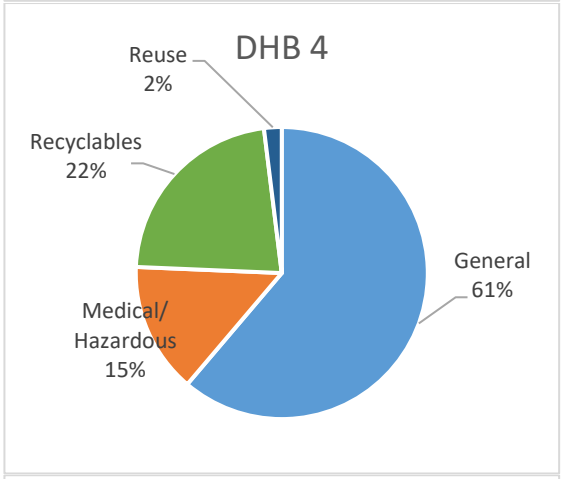
7. APPENDIX B

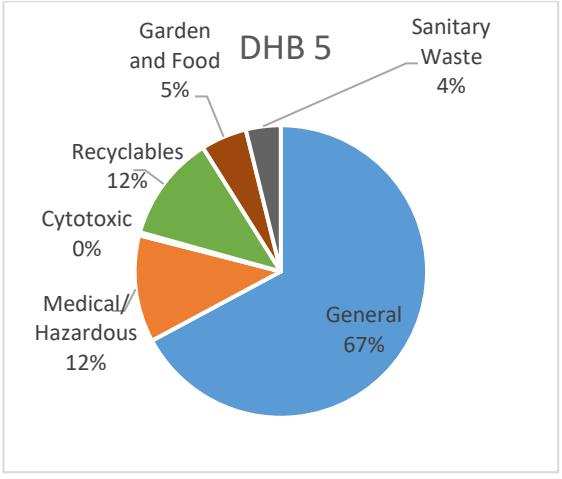
Percentage of annual waste (2018-2019) by volume of selected waste streams for 5 DHBs and 3 city councils.

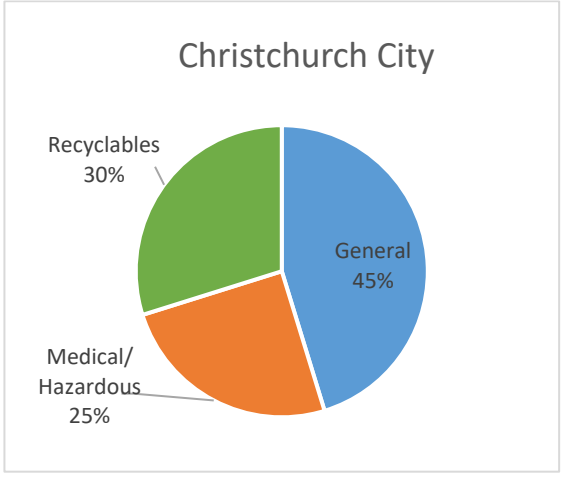


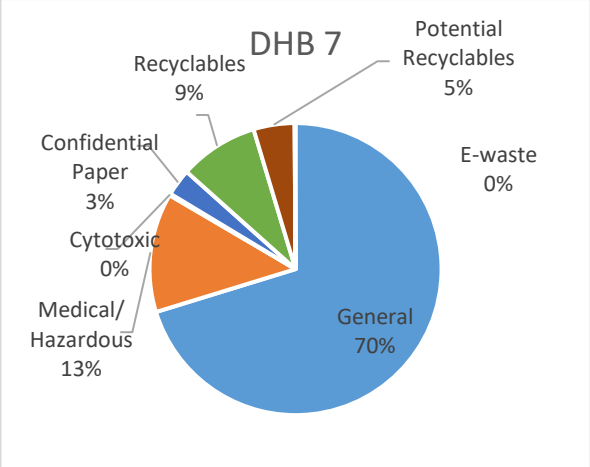


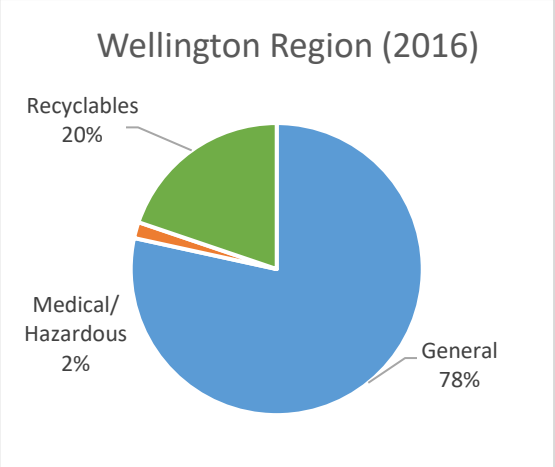


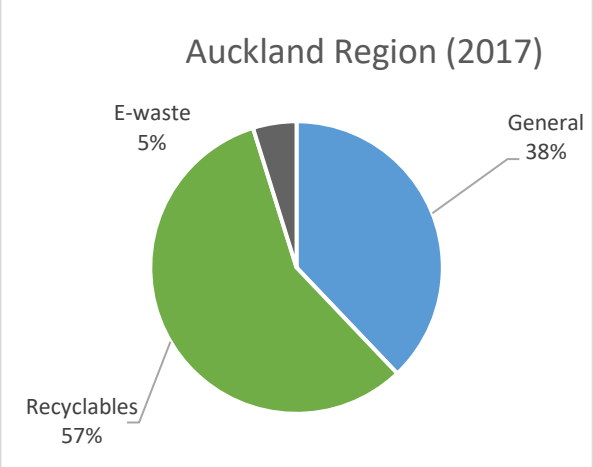







DHB 7
Recyclables 9%
Potential Recyclables 5%
Confidential Paper 3%
E-waste 0%
Cytotoxic 0%
Medical/ Hazardous 13%
General 70%


Wellington Region (2016)
Recyclables 20%
Medical/ Hazardous 2%
General 78%


Auckland Region (2017)
E-waste 5%
General 38%
Recyclables 57%

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