Sensitivity: General

New Zealand Construction and Demolition Waste Baseline & Tracking Methodology Report

Final Report

Prepared for The Ministry for the Environment - Manatū Mō Te Taiao
Prepared by Beca Limited

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Contents

Appendices

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Executive Summary

Construction and Demolition (C&D) waste is a significant component of total waste generated in New Zealand, with previous estimates of around 50% of landfill waste estimated to originate from C&D activities. However, this disposal estimate is not considered fully reliable, because numeric material flow data and scenarios used for disposal baseline measurements are limited, and do not sufficiently provide evidence to comprehensively evaluate, measure, and track changes in this waste material stream. This means that government policy makers, territorial authorities, industry, and the public do not have visibility on the status of C&D waste in Aotearoa New Zealand, and visibility on how change in policy and practices is impacting, or will impact, C&D waste material flows.

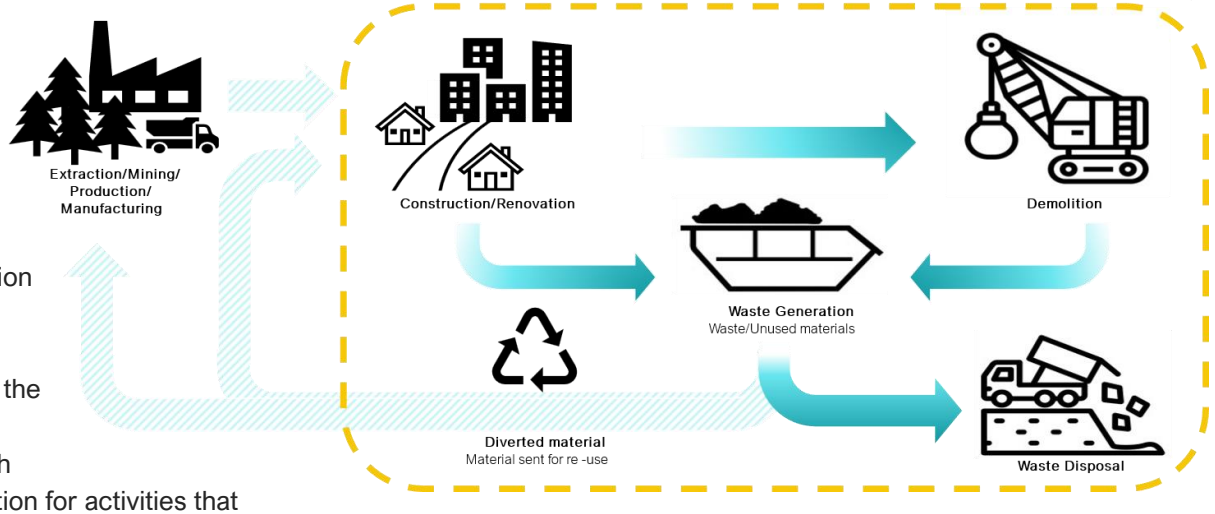
Key gaps and limitations in historic studies to track and measure C&D waste material flows include:

- Previous estimates of waste baselines have been limited to Class 1 landfills, while C&D waste is received in Class 1-4 disposal facilities;
- Class 2-5 disposal facilities have received comparatively fewer studies in the past and have only recently had requirements for waste disposal levy tonnage reporting, which means that C&D waste is less understood than municipal waste;
- Limited availability of Class 2 disposal facilities anecdotally results in large amounts of C&D waste being diverted to Class 1 facilities, while soil and other materials from building infrastructure are often sent to Class 3-5 facilities;
- Composition of C&D waste has been poorly documented and inconsistently applied, with significant C&D material types like concrete, asphalt, brick waste and tiling not distinguished in reporting.
- Inconsistent definitions and data reporting approaches for C&D waste and soil have led to discrepancies in data reporting, which affects the transparency of the sector;
- C&D waste that is sent directly to recovery facilities (without first going to a landfill) is not publicly tracked;
- Illegal dumping practices are poorly understood and not measured.

Developing a national picture of C&D waste material flows, including generation at source, diversion and disposal, is critical to develop targeted actions for reduction and diversion of this waste away from disposal. This supports New Zealand’s transition to a low-waste, low emissions economy by 2050.

Study Purpose and Approach

The purpose of this work was to determine a baseline for construction and demolition waste for the calendar year of 2023, and to identify key gaps in data and recommend how these gaps can be addressed through either policy or industry action.



To accomplish this, a Material Flow Analysis (MFA) was conducted – disposal, generation of waste from C&D site-based activities, and diversion of C&D waste was broken down into key C&D activities (for example, residential building construction waste generation and Class 2 landfill disposal) which were each assessed based on their frequency and then the waste (tonnage, composition) associated with each C&D activity. This analysis was supported by a data review of C&D waste case studies both domestically and internationally, using the recently new regulated definition for activities that generate C&D waste.[1]

Throughout this analysis, external academic peer reviewers, Ministry for the Environment data and policy analysts, and external C&D sector participants (including Council C&D advisors, construction contractors, property developers, researchers, C&D resource recovery and disposal operators) were engaged via workshops to support baseline development.

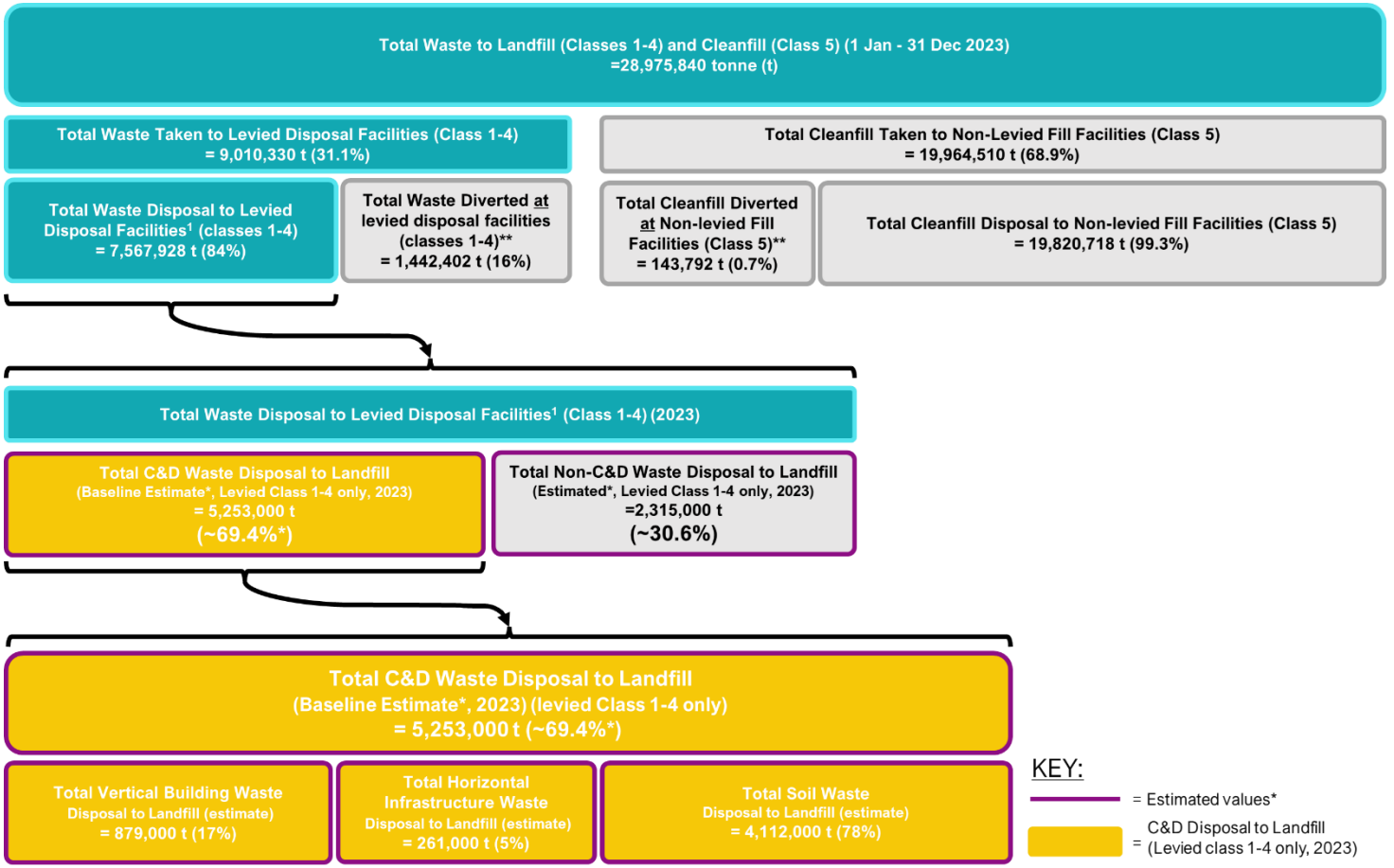
[1] Activity categories specified in Schedule 3 of Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Amendment Regulations 2023

Results; An Updated C&D Waste Disposal Baseline

After a review of information available to conduct these three baseline assessments of Generation, Diversion and Disposal, the study determined that there is not enough data available to produce a baseline for C&D waste generated or C&D waste diverted at this time. Therefore, only a baseline for C&D disposal is presented in this report.

Key findings from the disposal baseline are below:

- Across levied and non-levied facilities (Class 1-5), 28.98 million tonnes of waste was sent to disposal facilities in 2023.
- The majority of this (19.96 Mt) was cleanfill waste to Class 5 non-levied disposal facilities. Class 5 cleanfill is difficult to trace back to C&D activities, so this has been excluded from our baseline calculations.
- An estimated 5.25 million tonnes of C&D waste was disposed at levied facilities (Class 1-4), which represents 69.4% of all waste disposed at levied facilities
- Only 6% of C&D waste was sent to Class 2 - Construction and Demolition Fill sites. The rest went to Class 1 landfills (21%) and Class 3&4 disposal facilities (73%).
- 18.5% of C&D waste received at disposal facilities was successfully diverted (recycled or re-used, including re-use as cover on-site).
- Of all levied C&D waste disposed (Class 1-4), materials associated with vertical infrastructure (residential, commercial, industrial buildings), horizontal infrastructure (utilities and transport infrastructure), and soil waste contribute 17%, 5% and 78% respectively.



[1]Total waste disposal to levied disposal facilities (class 1-4) is used as the Benchmark for the estimated C&D waste disposal Baseline

*The estimated percentage of C&D waste at Class 1-4 facilities is uncertain with a 10% plausible spread for each, ranging from 24-44% for Class 1 and 90-100% for Class 2-4, impacting the C&D waste disposed at levied facilities range to be between 59% and 74% of all waste disposed at levied facilities, with precision expected to improve as more data becomes available.

**Diversion at facilities is not representative of total waste diversion for the baseline year of 2023 as diversion can occur both directly from C&D sites or at resource recovery facilitates. Refer section 5.4 for more detail.

- Including non-C&D waste to Class 1 landfills, soil volumes represent over half of all waste disposed to levied facilities (Class 1-4). Of the total 27.39 million tonnes of material disposed to Class 1-5 facilities, 87% of this is soil/cleanfill.

The generation assessment (focusing on sources of C&D waste across Construction, Renovation and Demolition) was able to account for 1.36 million tonnes of C&D waste (approximately the same tonnage as vertical infrastructure waste disposed), but due to limits on sources investigated and data availability was unable to account for the majority of C&D waste disposed to landfill.

Available diversion assessments at sources of C&D waste reported that more than 75% of C&D waste was successfully diverted from landfill – this is not substantiated when applied across all expected generation. More work is needed to understand generation at source, and combined diversion outcomes alongside diversion at disposal sites.

Gaps and Opportunities to Improve the C&D Waste Data

The conclusions of the disposal baseline were most affected by the following findings/assumptions:

- Access to renovation and demolition activity data – renovation data across all build types + demolition data for some build types was a gap in the generation assessment;
- Distributed data ownership – the data needed to inform this assessment is owned and managed by different government agencies and private organisations – not all was able to be accessed;
- Specifications and reporting requirements are changing – reporting practices are changing rapidly, meaning data across recent time periods can be hard to use/combine;
- Representative case studies – case studies were generally found to be reporting high diversion and low disposal; likely that reporting requirements drive these outcomes;
- Regional variation in waste outcomes – case studies were Auckland-specific, and not able to reflect regional differences in access to infrastructure/recovery pathways.

To improve the C&D waste baseline from generation through to disposal, the following key recommendations should be prioritised, along with other recommendations presented later in this report:

Recommendation	Description	Responsible
Additional auditing of OWL and SWAP reporting to make sure data is high quality	This analysis found possible differences in how measurements are reported and noted that rules for reporting waste diversion are not applied consistently at disposal sites. Nationwide auditing could make data more accurate.	Ministry for the Environment / Disposal facility operators
Embed material tracking and diversion standards into construction activities	Adopt international practices to embed material tracking and diversion standards in construction activities. For example: • Issue building consents with reference to material and waste estimations at design phase.	Local government

Recommendation	Description	Responsible
	• Require architects and engineers to provide materials breakdowns at the consent stage, for building renovation and demolition, so that data is recorded throughout the property's lifetime.	
Expand project data collection framework	Expand the data collection framework used for this project for use by external agencies to develop comprehensive datasets and enable tracking of C&D waste data over time, and include additional government agencies with involvement in other vertical and horizontal infrastructure build projects.	Ministry for the Environment
Implement mandatory site waste management plans consistently across New Zealand	Implement mandatory site waste management plans consistently across New Zealand and amend requirements to include onsite waste generation records and supplementary data such as weights/volumes and photos of skip bin/truckloads of waste.	Local/ Central government
Consider ways of collecting demolition waste data through procurement mechanisms, future regulatory controls or reporting requirements	Demolition activities have less regulatory oversight or permitting requirements than construction, especially below certain project sizes, so there is lots of data not being collected under standard consenting and reporting frameworks that could contribute to generation modelling. Local or central government could consider ways of collecting demolition waste data through procurement mechanisms, or when considering any future regulatory controls or reporting requirements for demolition.	Local/ Central government
Establish a waste and resource recovery licensing scheme	Access to resource recovery facility material flow data, including material tonnages received and recovery rates, needs to be established. This could be made available if the central and or local governments impose regulation for a waste and resource recovery facilities (facility licencing scheme).	Ministry for the Environment

Conclusions

This study has developed a baseline for C&D waste to landfill in 2023 of an estimated 5.25 million tonnes, which at approximately 69% is a higher proportion than previously estimated. This study has also identified a range of current data gaps in C&D waste generation, diversion and disposal with associated recommendations as to how some of these can be addressed either by the Ministry, local government or industry. Comprehensive data on C&D waste will enable clearer policy intervention as New Zealand transitions to a low waste economy.

1 Introduction

Construction and Demolition waste constitutes a significant proportion of total waste generated in New Zealand, with estimates suggesting that around 50% of landfill waste comes from these activities[2]. Understanding of C&D waste in New Zealand continues to change and evolve due to data gaps caused by insufficient and inconsistent data, despite continued advances in data reporting to make quantification of C&D easier.

This report aims to bridge these gaps by providing a detailed analysis of C&D waste generation, diversion and disposal In New Zealand for the calendar year of 2023. Accurate baseline data is essential to understand the scope of C&D waste generation, and to develop targeted actions for reduction and diversion of this waste away from landfill and disposal facilities. This project also aligns with New Zealand's broader policy goals under the first Emissions Reduction Plan (ERP 1) and the National Waste Strategy, which emphasise the reduction of waste and emissions as part of the country's transition to a low-waste, low emissions economy by 2050.

C&D waste from different activities with varying compositions is sent to disposal facilities ranging from Class 1 landfills through to Class 5 cleanfill facilities, but comprehensive data on waste volume and composition is lacking across different sources or disposal facilities. Current systems, like the Online Waste Levy System (OWLS), mainly track landfill disposal, offering limited insights into waste generation and diversion for reuse or recycling. This incomplete data hinders informed decision-making by policymakers and industry. Key data issues identified in this work and previous works on the topic of C&D waste tracking include the following:

- Historically, the composition of C&D waste has been poorly documented, with analysis limited to materials like plastics, soils and metals, and significant types of C&D materials like concrete, asphalt, brick waste and tiling not distinguished in reporting.
- Inconsistent definitions of C&D waste across regulations have led to discrepancies in data reporting, complicating effective waste management.
- The limited availability of Class 2 disposal facilities, anecdotally, results in a significant portion of construction waste, such as building materials, being diverted to Class 1 facilities, while soil and other materials from building infrastructure are often directed to Class 3-5 facilities.
- Outside of levied and non-levied disposal facilities, C&D waste that does not end up in landfill due to either diversion from landfill at source or due to illegal dumping practices is poorly understood.

The project outlined in this report aims to address these issues through two key objectives. First, to establish a reliable baseline measurement of the amount of C&D waste generated, diverted and disposed in New Zealand. This includes a detailed analysis of waste at different stages of the C&D lifecycle, from waste generated during building and infrastructure projects to final disposal in various landfill classes. The baseline covers different types of construction projects, materials and waste phases, providing a view of the current state of C&D waste management in New Zealand at different levels. This is primarily supported by relevant data sourced from the Ministry for the Environment, other government agencies, territorial authority reporting, and private sector industry organisations and operators.

The second objective is to assess options for a long-term framework for tracking and measuring C&D waste. This future framework allows stakeholders to monitor waste flows over time, assess the impact of policy interventions and make data driven decisions to improve waste management practices. The framework supports New Zealand's goal of

[2] Published by Ministry for the Environment in "Reducing waste: a more effective landfill levy – consultation document" (2019)

transitioning to a resource-efficient economy, where materials are reused, recycled and kept within the economic system for as long as possible. This phase includes a review of international best practices, offering insights into how other countries manage C&D waste and identifying adaptable models for New Zealand.

Recent amendments to the Waste Minimisation Act (WMA) 2008 (see Section 3) included the addition of waste activity source definitions. This project uses the definition of C&D activities, as defined in the WMA: “Waste derived from the construction or demolition of buildings, structures, and infrastructure. This includes residential, industrial, and commercial structures, pipelines (above- ground and underground assets), roading, land development (including site clearance for building or subdivision construction), and regular slips or other debris not associated with a major natural hazard.”[3]

It is essential to acknowledge that the Ministry for the Environment has a range of improvements underway to address the limiting factors for accurate C&D data such as new waste disposal levy reporting requirements for Classes 2-5 disposal facilities, as well as focused investigations into C&D waste composition from different facility classes. Additionally, from July 2024 facility operators will be mandated to record and report the sources of tonnage received, categorised under standardised classifications. Territorial authorities will also be required to collect and report information related to council-operated resource recovery facilities.

By providing a clear and quantifiable baseline, along with options to include in a framework for long-term tracking, this report enables the sharing of transparent information on waste flows and supports continual improvement of C&D material flow reporting systems.

[3] Waste Minimisation (Information Requirements) Amendment Regulations 2023, Schedule 3

2 Glossary

Construction and Demolition Waste	Described as, “Waste derived from the construction or demolition of buildings, structures, and infrastructure. This includes residential, industrial, and commercial structures, pipelines (above-ground and underground assets), roading, land development (including site clearance for building or subdivision construction), and regular slips or other debris not associated with a major natural hazard”. As defined in Schedule 2 (new Schedule 3) Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Amendment Regulations (2023).
Rubble	This is a primary category for waste in the 2002 Solid Waste Analysis Protocol (SWAP) that includes a broad range of secondary category C&D waste streams that require new or alternative categorisation, including plasterboard, soil including clean fill and low-level contaminated soil, concrete, brick and ceramics. The analysis conducted in this report sought to refine the secondary categories where possible. These modifications and how this will affect how materials currently classified as “rubble” are tracked and recorded in SWAP based data collection for both Class 1 and Class 2-5 disposal facilities, are discussed in Section 4.3.1.
MFA	Material Flow Analysis (refer to Section 4.2)
Disposal facility	A facility, including a landfill, at which waste is disposed of; and at which the waste disposed of includes household waste; and that operates, at least in part, as a business to dispose of waste; and any other facility or class of facility at which waste is disposed of that is prescribed as a disposal facility. As defined in Section 7 of the Waste Minimisation Act (2008). [Further information on disposal and cleanfill facilities can be reviewed in the Technical Guidelines for Disposal to Land, Revision 3, Waste Management Institute New Zealand, October 2022].
Resource recovery facility	A facility that “collects, sorts, or processes material, or extracts materials or energy from material (or carries out any combination of those activities), for the purpose of recovering components for recycling or reuse”. This definition also extends to sites that recover energy. As defined in Schedule 2 (new Schedule 3) Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Amendment Regulations (2023).
Class 1 landfill	Municipal Disposal Facility - Facilities, including landfills, that accept for disposal, waste that is or includes household, commercial, industrial, or institutional waste, green waste, or waste that is not accepted at other classes of facility. As defined in Section 3B(2) of the Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Regulations (2009). This class is subject to monthly tonnage reporting and levy obligations.
Class 2 landfill	Construction and Demolition Fill Disposal Facility - Facilities, including landfills, that accept waste that is or includes solid waste from construction and demolition activity source. As defined in Section 3B(2) of the Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Regulations (2009). This class is subject to monthly tonnage reporting and levy payments.
Class 3&4 disposal facility	Managed or Controlled Fill Disposal Facility - Facilities that accept inert waste material from construction and demolition activities and or inert material from earthworks or site remediation for disposal. As defined in Section 3B(2) of the Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Regulations (2009). This class is subject to monthly tonnage reporting and levy payments.

Class 5 disposal facility	Cleanfill facility - facilities that accept only virgin excavated natural material (such as clay, soil, or rock) for disposal. As defined in Section 3(1) of the Waste Minimisation (Information Requirements) Regulations (2021). This class is subject to quarterly tonnage reporting but not waste disposal levy payments.
Levied waste	Waste received at Class 1-4 disposal facilities, which are subject to the Waste Levy. This waste is either reported as diverted or disposed via OWLS, and if disposed is subject to the levy.
Non-levied waste	Waste received at Class 5 disposal facilities, which are not subject to the Waste Levy. This waste is either reported as diverted or disposed via OWLS.
Activity Source	Refers to Activity categories specified in Schedule 3 of Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Amendment Regulations 2023. Construction and Demolition activity source (waste) is defined as above.
OWLS	Online Waste Levy System
SWAP	Solid Waste Analysis Protocol. The most recent version was published in 2002, a revision has started but is currently paused.
BRANZ	Building Research Association of New Zealand
Activity type data	Data describing the number of discrete construction, renovation or demolition activity types occurring in a specific time period e.g. the number of apartments built in 2023. Combined with a Waste Generation Factor (defined below), this data can be used to assess waste generation from an activity.
WGF	Waste generation factor; a factor that estimates the amount of waste produced per an individual activity type e.g. waste generated by building an apartment.
Waste Generation	Waste Generation refers to materials generated by C&D activities that require either reuse, diversion or disposal. In this report, waste generation data refers to waste tonnages reported at construction, renovation (including renewal, maintenance and fit-out) and demolition sites.
Vertical Infrastructure	Above-ground building infrastructure assets including commercial, residential and industrial buildings and structures.
Horizontal Infrastructure	Above- and below-ground service and transport infrastructure assets including utility and roading/rail systems.
Soil waste generation	Excavated soil waste material (contaminated and non-contaminated) generated by Vertical and Horizontal Infrastructure projects.
Waste Disposal	The final (or more than short-term) deposit of waste into or onto land set apart for that purpose, or the incineration of waste. As defined in Section 6(1) of the Waste Minimisation Act (2008). In this report, waste disposal data refers to waste tonnages reported as disposed (net tonnage) at levied and non-levied disposal facilities.
Waste Diversion	Material that is no longer required for its original purpose and, but for commercial or other waste minimisation activities, would be disposed of or discarded. As defined in Section 5 of the Waste Minimisation Act (2008). In this report, Diversion is used to refer to materials diverted at

	landfill/disposal facilities, and also materials diverted at locations of construction, renovation, and demolition activities. The difference between these definitions is explained further in Section 5.4 of this report.
Waste Reduction	Refers to activities that minimise the quantities of waste at construction, renovation or demolition sites which affects waste volumes in both waste generation data and waste disposal data.
Resource recovery	Extraction of materials or energy from waste or diverted material for further use or processing. As defined in Section 5(1) of the Waste Minimisation Act (2008).

3 National and International Context

3.1 Legislative Summary

There are a range of policies and legislation in place that shape the C&D sector and its future development (Figure 1). The national legislative context is critical for driving and supporting waste reduction and diversion initiatives. The most significant legislation, policies and government action pertaining to C&D waste are summarised below, including recent changes that reflect the evolution of C&D waste management in New Zealand.

3.1.1 The Waste Minimisation Act 2008 (WMA)

The purpose of the WMA is "to encourage waste minimisation and a decrease in waste disposal in order to protect the environment from harm; and provide environmental, social, economic, and cultural benefits."[4] Provisions of the Act include:

- Product stewardship to place responsibility for a product's life cycle and waste management on manufacturers, importers, retailers and users, rather than communities, councils, neighbourhoods and nature;
- A waste disposal levy to fund waste reduction initiatives and encourage resource recovery. Half of the levy is provided to territorial authorities to support their waste management and minimisation efforts. The waste

C&D Legislative Environment					Other Tools
Waste Minimisation Act 2008	Local Government Act 2002	Climate Change Response Act 2002	Resource Management Act 1991	Building Act 2004	
Bylaws		Emissions Reduction Plans	National Environmental Standards	Efficient and sustainable use of materials and reduction of waste generation	Central government guidelines, codes of practice and voluntary initiatives
New Zealand Waste Strategy	Long-Term Plans				
Waste Management and Minimisation Plan		National Adaptation Plan	District and Regional Plans	Proposed changes: site-specific waste minimisation plans	Regional Infrastructure Fund
Waste Disposal Levy		Emissions Trading Scheme	Resource Consenting		International conventions and research
Waste Minimisation Fund					
Product Stewardship					
Other regulations					

Figure 1: C&D Legislative Environment

[4] Waste Minimisation Act 2008

disposal levy is the key mechanism for collecting waste disposal and transfer data, including C&D waste. The levy is detailed in Part 3 of the Act which includes:

  - Record keeping and reporting provisions (s86)
  - The ability of the Minister to approve funding of projects to promote or achieve waste minimisation, such as the waste minimisation fund, or to provide for the remediation of a contaminated site, such as the contaminated sites and vulnerable landfills fund, (section 38)

- Defining the role of territorial authorities gives them the responsibility for promoting effective and efficient waste management and minimisation. This includes the requirement for territorial authorities to prepare waste management and minimisation plans (WMMPs) to state objectives, policies and methods for waste management and minimisation within the district;
- A waste advisory board to provide independent advice to the Minister for the Environment on matters relating to the WMA.

In April 2024, Cabinet agreed to a new investment approach aligned to government priorities via an amendment to the WMA. Investment will be prioritised towards resource recovery infrastructure including C&D and the contaminated site remediation. Key amendments to the WMA, relevant to C&D waste include:

- Broadening of the allocation of levy funds to include a wider range of environmental activities;
- Incremental increases in the waste disposal levy of the next three years to encourage organisations and individuals to find more effective and efficient waste to manage their waste. Territorial authorities will continue receiving 50% of the levy.
- Improvements to the tracking and management of data from waste levied facilities.

Following recent amendments, regulations under WMA include:

- Waste Minimisation (Calculation and Payment of Waste Disposal Levy) Amendment Regulations 2023,
- Waste Minimisation (Information Requirements) Amendment Regulations 2023,
- Waste Minimisation (Microbeads) Regulations 2017,
- Waste Minimisation (Plastic Shopping Bags) Regulations 2018.

The Waste Minimisation (Information Requirements) Amendment Regulations 2023 now include a definition for C&D activities: “Waste derived from the construction or demolition of buildings, structures, and infrastructure. This includes residential, industrial, and commercial structures, pipelines (above- ground and underground assets), roading, land development (including site clearance for building or subdivision construction), and regular slips or other debris not associated with a major natural hazard.”[3] This definition is the basis for the materials that ‘define to scope’ for the project.

Additionally, reporting of tonnages at Class 2 disposal facilities started in January 2022 and at Class 3-5 disposal facilities in January 2023, which is helping to build the picture of total waste flows to non-Class 1 disposal facilities across New Zealand.

3.1.2 Resource Management Act 1991 (RMA)

The purpose of the RMA is to set out how we, as a country, manage our environment and promote the sustainable management of resources.[5] It provides the framework for controls such as district and regional plans, resource consents and National Environmental Standards, and is the key piece of legislation controlling landfills and waste management facilities in NZ.

Under the RMA, territorial authorities are required to prepare plans to support the management of the environment in their district/region. These plans set rules about what activities can or cannot be done in the area and how to minimise adverse effects of development. Projects involving activities not explicitly allowed within district/regional plans must be issued a resource consent by the territorial authority. Landfills have a range of resource consents that are monitored by the territorial authority. Specific consent requirements are dependent on the class of landfill, site location and district/regional planning provisions. Construction projects of scale, such as those that produce high levels of C&D waste, typically require a resource consent.

The Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 outlines a set of nationally consistent planning controls for ensuring land affected by contaminants in soil is identified and assessed before being developed. When necessary, the standards dictate that land be remediated or contaminants contained to make the land safe for use. Contaminated soils and those above local soil background concentrations may fall under the controls in this regulatory standard.

3.1.3 Building Act 2004 (BA)

The purpose of the BA is to set regulations and requirements for the construction, alteration, demolition and maintenance of new and existing buildings.[6] The BA includes sustainability principles relating to the efficient and sustainable use of materials and reduction of waste generation throughout the construction process.

Changes to the BA were proposed in 2022 and included requiring a waste minimisation plan for certain building and demolition works. While the legislative activities associated with implementing this change are currently paused due to the recent change in government.

3.1.4 Emissions Reduction Plans

New Zealand's first emissions reduction plan (ERP 1) was published in May 2022.[7] It outlines emissions reduction actions for the 2022-2025 period to achieve the first emissions budget and contribute to the global effort to limit global temperature rise to 1.5˚C above pre-industrial levels. The plan introduces sector-specific actions, including for the Building and Construction sector and Waste sector, to enable focused emissions reduction efforts.

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[5] New Zealand Government. (1991). *Resource Management Act 1991.*

[6] New Zealand Government. (2004). *Building Act 2004*

[7] New Zealand Government. (2022). *Aotearoa New Zealand's first emissions reduction plan*. Ministry for the Environment.

Chapter 15 outlines emission reduction actions for the waste sector, including three actions within Focus Area 3 (Reduce and divert C&D waste to beneficial uses.) MfE continues to progress these actions, as described below:

- Action 15.3.1: Support the building and construction sector to minimise waste through research and improved capability,
    - Cross government work over the past three years includes research into cost-effective, safe and sustainable solutions for C&D materials, implementation of training programmes to build capability to support the transition from demolition to deconstruction.

- Action 15.3.2: Invest in sorting and processing infrastructure for C&D waste,
    - This is actioned through investment signals for the waste minimisation fund and the contaminated sites and vulnerable landfills fund.

- Action 15.3.3: Enable the separation of C&D materials,
    - MfE is reviewing their legislative frameworks and exploring enabling powers for regulating reuse, recycling and recovery options.

Chapter 12 outlines emissions reduction actions for the building and construction sector. Action 12.1.3 aims to reduce whole-of-life emissions by implementing waste minimisation initiatives and programmes, exploring circular economy opportunities, and addressing barriers to the reuse, repurposing, and recycling of building materials.

In addition to the waste specific focus areas, actions and key initiatives, an overarching theme of the emissions reduction actions cross-sector is enabling and driving behaviour change to support emissions reduction behaviours. Behaviour change can occur at the individual, community, commercial and government level and is understood to be essential for transitioning to a low-carbon economy. Actions that enable behaviour change, such as building awareness and reducing barriers can support waste reduction efforts.

This project is one of the initiatives that will help deliver the ERP actions by establishing the necessary baseline data to enhance, and increase accuracy of, our understanding of how much C&D waste is in our system and how we can track and measure change in the long term.

3.1.5 NZ waste strategy

The New Zealand Waste and Resource Efficiency Strategy, released in March 2025, outlines the Government's priorities for reducing waste and improving waste management practices. It replaces *Te Rautaki Para*, the previous national waste strategy adopted in March 2023. The new strategy focuses on achieving outcomes, including reducing waste disposal per person, increasing the reuse and recycling of materials and products, minimising emissions and environmental harm from waste and litter, managing resource recovery and disposal facilities to reduce their environmental impacts, and addressing the harm caused by contaminated sites, including legacy sites.

3.1.6 New Zealand Government Procurement and Property Greenstar Requirements

Procurement mandated agencies are required to use a sustainable building rating tool when building a new government owned, non-residential building with a capital value of more than $25million. The New Zealand Green Building Council’s Green Star NZ Design and As Built rating can be used for most non-residential buildings within scope of

these requirements. The Green Star ratings include credits regarding the use of responsible building materials, responsible construction practices and percentage of C&D waste.

3.1.7 Other construction and demolition waste data actions

Several improvements to C&D waste data currently being actioned by MfE are summarised below:

- Developing a national solid waste data collection programme, including C&D waste. The proposed intent is to focus on developing the methodology and filling data gaps (in particular, waste composition at Class 2-5 landfills)
- Developing a Solid Waste Analysis Protocol (SWAP) specifically for landfills that receive C&D waste, as part of a wider review of the 2002 SWAP;
- Publishing of NZ's first online waste data platform, making disposal and diversion statistics available at a national level to the general public along with a list of Class 1-5 facilities, industrial monofils and transfer stations.[8]

3.2 New Zealand Context / Research

Notable and significant pieces of NZ-specific research on C&D waste that have influenced and been utilised by this report are discussed below.

3.2.1 Sector State of Play: Resource Recovery and Waste (New Zealand Infrastructure Commission Te Waihanga, 2021)

Sector State of Play: Resource Recovery and Waste by the New Zealand Infrastructure Commission Te Waihanga was prepared to document the current state of resource recovery and waste sector in New Zealand with a focus on the infrastructure used to manage New Zealand's waste.[9] This includes landfills, material recovery facilities, and processing facilities. The report estimates that in 2015, 4.4 million tonnes of waste (29% of NZ's annual waste) originated from C&D sources, with a 28% recovery rate of C&D both based on The New Zealand Waste Disposal Levy: Potential Impacts of Adjustments to the Current Levy Rate and Structure (Eunomia Research & Consulting, 2017). The report calls to attention that without sufficient data, it is difficult to confirm these figures.

Additionally, the report states that there is large regional variation in access to C&D recycling facilities, with most being in Auckland. The lack of access to C&D waste diversion and recycling infrastructure is a key barrier to beneficial reuse.

[8] Waste statistics (2023) (environment.govt.nz)

[9] New Zealand Infrastructure Commission Te Waihanga. (2021). *Sector state of play: Resource recovery and waste*.

3.2.2 The New Zealand Waste Disposal Levy - Potential Impacts of Adjustments to the Current Levy Rate and Structure (Eunomia, 2017)

The New Zealand Waste Disposal Levy – Potential Impacts of Adjustments to the Current Levy Rate and Structure is a report for a consortium of public and private organisations, including territorial authorities and recycling businesses.[10] The report aims to understand the impact of potential changes to the waste levy would have on waste diversion rates. Four scenarios were used to model the impacts of changes in levy rate by different magnitudes on a range of variables including waste disposal and recycling. Scenario modelling found that increasing the waste levy and an additional energy from waste levy could incentivise higher rates of recycling as it becomes the more cost-effective option over landfills and incineration.

The numbers produced rely heavily on assumptions and previous work, as the research was conducted before Class 2-5 landfills started reporting tonnages through the Online Waste Reporting System (OWLS). The data for Class 2-5 landfills was estimated using 2013 data and the application of waste growth equivalent to the real change in GDP. Recent data shows the ratio of tonnages by class in this report over-allocated waste to Class 2 disposal facilities and under-allocated waste to Class 3 – 5 facilities.

This report also reiterates the barrier posed by large regional variations in access to C&D recycling facilities, leading to most C&D waste being sent to landfills.

3.2.3 Preliminary Materials Flow Analysis (Amiomio, 2022)

Preliminary Materials Flow Analysis was conducted to assess the materials flowing through the building construction sector and focussed on residential dwellings, using a Material Flow Analysis (MFA) methodology.[11] The research had a particular focus on the materials going into the construction sector which was compared with the known used materials for a building to calculate the waste from construction. This was the first application of the MFA methodology to C&D waste in NZ.

This report estimated that the residential construction sector produced 347 thousand tonnes of waste in 2021, of which 267 thousand tonnes were expected to go to landfill. The assumptions applied in this report around material generation for C&D, demolition etc. were reviewed and critiqued in a later report (see Section 3.2.5), but Amiomio's report was instrumental in starting the research to match C&D waste disposed to its source.

3.2.4 Annual State of the Building and Construction Sector (Ministry of Business, Innovation & Employment, 2024)

This report details the findings of the annual monitor (2022-2023) of Building/construction sector business owner or managers in NZ in regard to assessing the current state of the building and construction sector.[12] The survey discussed the methods building professionals use to prioritise waste reduction:

- by minimizing material waste (19% Always, 27% Often, 27% Sometimes);
- standardizing dimensions (17% Always, 31% Often, 25% Sometimes);

[10] Eunomia. (2017). *The New Zealand waste disposal levy: Potential impacts of adjustments to the current levy rate and structure*.

[11] Amiomio. (2022). *Preliminary materials flow analysis for Aotearoa New Zealand's building construction sector*.

[12] Ministry of Business, Innovation & Employment. (2024). *Annual state of the building and construction sector*.

- providing shop drawings for cutting plans, selecting products with ability to recycle and reuse excess (10% Always, 20% Often, 35% Sometimes); and
- measuring waste feedback (7% Always, 10% Often, 17% Sometimes).

Efficient material management is crucial in the construction industry and larger businesses and those with longer industry tenure show a stronger commitment to these practices. At the time of publication, the survey showed a possible future growth trend in the construction industry in the coming years, with 38% of businesses looking to grow and 47% expecting to stay the same size. 61% of large businesses (50+ employees) were anticipating growth, indicating an opportunity for more commitment to efficient material management.

3.2.5 Resource use and waste generation in Aotearoa New Zealand (NZ Parliamentary Commissioner for the Environment, 2024)

Resource use and waste generation in Aotearoa New Zealand is a literature review produced by the Parliamentary Commissioner for the Environment (PCE) to help understand how much resource extraction and waste generation is associated with economic activity and to what extent resource and waste footprints might increase in the future.[13]

The review largely discusses resource use rather than waste generation, which was a key differentiator in focus compared to reports previously discussed. Waste is grouped and reported by sector/activity, in a departure from typical waste reporting practices. One of the key observations of this report is the discrepancy in estimated waste not aligning with the resources invested in NZ. This report states this discrepancy can be attributed to the fact that resources remain within the New Zealand economy for a considerable duration with aggregate, steel, cement, and copper used in infrastructure and construction projects adding to an 'above-ground resource stock" and only transitioning into waste when the associated product reaches its end-of-life stage. This observation challenges the findings of previous reports such as the Amiomio study and identified some key challenges for future research to overcome; considering material use and disposal in the context of built environment/material lifecycle.

3.2.6 Others

Table 1: Additional NZ Context and Research

Research	Summary
Residential Construction Waste Reduction: Case Studies and Resources (Beacon, 2014)	This report consolidates national case studies of residential construction projects aimed at improving waste management practices. The case studies include: • Source separation bins trialled on a large construction site in the Auckland region, resulting in diversion of 50% of construction waste (by weight and volume) from landfill and a 19% financial saving over standard disposal practice; • A 6-month, four case study, trial of construction waste minimisation opportunities in Christchurch City. The trial focused on training 16 site foremen in identifying and segregating wastes. All four case studies reduce waste disposal costs, with one site saving 84% of the potential waste bill through salvaging valuable materials to offset disposal costs;

[13] New Zealand Parliamentary Commissioner for the Environment. (2024). *Resource use and waste generation in Aotearoa New Zealand: A literature review*.

Research	Summary
	• A conference paper identifying methods of reducing the building sector's C&D waste through design and procurement practices, on-site separation to recover reusable and recyclable material and good 'housekeeping' on-site; • Application of REBRI guidelines to construction projects resulting in reduced disposal costs, reduced spending on over-ordered materials, revenue from the sale of salvaged items and improved on-site processes; • Monitoring of ten house constructions to gather data to inform future waste management methodologies; • A demonstration project in which the construction of a house was used to demonstrate methods for reducing the amount of waste produced and diverting as much as possible from landfill.
Barriers, enablers, and approaches for a more circular economy (Ministry of Business, Innovation and Employment, 2024)	Ministry of Business, Innovation and Employment published a study attempting to understand and develop measures for a circular economy transition in New Zealand. The study identified the key barriers to transition to a circular economy for the built environment, those relevant to C&D waste include: • Lack of circular economy legislation and strategy; • Lack of infrastructure for reverse logistics and storage to move up the waste hierarchy; • Sector labour gaps; • Insufficient collaboration across supply chain; • Lack of end-of-life options for copper chromium arsenic (CCA) treated timber. Enablers include: • Innovative policy; • Drivers beyond low carbon, e.g. resilient construction, the housing crisis; • Increased support for R&D; Opportunities include: • Incentivising and enabling the recovery and reuse of C&D materials through the use of physical and digital tracking; • Develop infrastructure to enable the reuse of building components; • Stimulate the use of secondary materials in construction; • Implement material passports to track where materials come from and where they go post-demolition (see Section 3.3.2.1).
Briefing on reducing construction and demolition waste going to landfill (Environment Select Committee, 2023)	The briefing was initiated to examine current and best practice for reducing and avoiding C&D waste going to landfill. This was done through research and stakeholder engagement with a range of individuals and organisations. Ministry for the Environment provided evidence for the data presented in the briefing, including: • C&D activities are responsible for 40-50% of all material going to landfill; • 33% of waste in Class 1 landfills is C&D waste.

Research	Summary
	• The recommendation from the briefing is that there is to be greater emphasis on the diversion, recovery and appropriate reuse of C&D waste. Additionally, it was noted that a lack of comprehensive data about C&D waste is a barrier to achieving the recommendation.
BRANZ Bulletin: Reducing construction and demolition waste (Issue 671) (BRANZ, 2022)	This bulletin is aimed at the C&D sector and serves as an educational resource on methods for reducing waste, such as: • The 5 Rs: Reject, Reduce, Reuse, Repair, Recycle • Designing to reduce waste • Developing site-specific waste management plans • Managing waste on-site • Deconstruction rather than demolition • The waste levy
National Waste and Recycling Snapshot (Waste & Recycling Forum, 2023)	The National Waste and Recycling Snapshot is an annual review of the waste sector's performance. Data from the Waste & Recycling Industry Forum (WRIF) is collated and used to understand waste activities. The report estimates 124,313 tonnes of C&D waste in August 2023 (16% of all waste collected), however the data source was not included.

3.3 International Context

This section provides a summary of key international work focusing on C&D waste information tracking and outcomes, particularly using similar Material Flow Analysis techniques, as well as policy interventions and industry-led actions which support the overall shift to a circular economy. This section gives an overview of some learned lessons and insights from international case studies that could help shape NZ's approach to improving C&D material outcomes.

3.3.1 United Kingdom

In the 2023 UK Construction Industry Waste Report, it was reported that C&D waste contributes about 62% of the country's waste generated but 32% of waste landfilled. This is because the UK achieves 87% diversion of C&D wastes from landfill, although this is below their target of 99% diversion.

Business operators in the UK are required to identify and classify all waste before sending it for recycling or disposal.[14] This ensures that the waste is handled properly by both the business operator and the recyclers/contractors engaged to manage the materials. EWC (European Waste Catalogue) codes are used to identify and classify different types of waste materials, including C&D waste. Using EWC codes to categorise C&D waste, it becomes easier to collect accurate and consistent data on the types and

[14] Waste classification: Guidance on the classification and assessment of waste (1st Edition v1.2.GB) (2021)

quantities of waste generated within the construction industry. This data can help identify trends, highlight areas of concern, and inform waste management strategies as well as generating consistent data on C&D waste over time, making it possible to measure progress in waste reduction efforts.

3.3.2 European Union

The EU has some of the most stringent reporting requirements for C&D waste flows internationally. All EU member states report data on their alignment with circular economy, covering material use, consumption, recovery and recycling as well as disposal via Eurostat.[15] The associated monitoring framework tracks trends such as material footprint per capita, resource productivity, recycling rates (rather than diversion rates) for all waste excluding mineral wastes, as well as import dependency and even numbers of waste management patents registered. This broad reporting framework gives excellent insight on both material outcomes at end of life, but also material efficiencies and waste sector development/industry resilience over time.

The C&D management policies implemented under the European Green Deal include:[16]

- Pre-demolition audit requirements and selective demolition practices, helping to better manage hazardous wastes and maximise material recovery;
- Material Passports, to record the origin and quality of materials through their lifecycle in support of better re-use and recovery;
- Standards for secondary materials, as well as green procurement policies in the public sector to promote the use of recovered materials in delivery of contracts;

These systems and policy levers are helping to drive better outcomes for C&D materials, extending their useful life, making them easier to recover and recycle, and promote the uptake in secondary materials in markets. Interestingly, adoption of more circular materials management systems is also moving the EU away from waste-to-energy, which both disconnects the energy sector from the waste sector and retains more value in materials.

3.3.2.1 EU Digital Product Passports

The EU is currently developing first-of-its-kind digital material passports[17] to create transparency and give consumers access to information about a product over its entire lifecycle. The regulations required to implement this system of material tracking and system management is currently in draft, with final approval expected this year and first product group implementation expected in 2026/7.

Material passports will support effective deconstruction for reuse and efficient recycling, by capturing information on material properties and pathways for effective processing at end of life.

[15] Indicators used in the EU monitoring framework on the circular economy (Accessed 2024) (ec.europa.eu)

[16] The European Green Deal (Accessed 2024) (commission.europa.eu)

[17] The EU Digital Product Passport shaped the future of value chains: What it is and how to prepare now (2022) (wbcsd.org)

3.3.2.2 Critical review of the recovery rates of C&D waste in the European Union (Waste Management and Circularity, BOKU, Austrian Construction Materials Recycling Association, 2022)

In December 2022, researchers from the Institute of Waste Management and Circularity, BOKU alongside the Austrian Construction Materials Recycling Association published a report on how the Eurostat system could be developed or modified in order to support meaningful changes to data-led decision-making processes.

Key observations of this report include:

- The difficulty of defining and auditing consistent methodologies for measuring and reporting waste could influence the trends and data used by policy makers to direct support and report on progress;
- The definition of "backfilling", a waste management process where excavated or demolished material is used to fill voids left by excavation, which did not require reporting. There was concern that differences in interpretation around which disposal operations would count as backfilling, and which materials could be backfilled, meant that waste volumes risked being lost from the reporting system.

The researchers recommended that consistency in measurement and reporting requirements, as well as clarifications on the scope and definitions of C&D waste management and indeed C&D waste were critical in supporting beneficial C&D waste outcomes.

3.3.3 Australia

In 2020, Australia generated approximately 25.2 million tonnes of C&D waste, 61% higher than it was it 2006.[18] This is Australia's largest single source of waste to landfill (44% of all waste), but in 2020 76% of this material was recycled. While these results are quite positive, there is a growing need to expand processing capacity and maintain beneficial outcomes for waste materials.[19] It is important to note that this definition of C&D waste excludes soil/cleanfill.

C&D recycling and recovery performance varies across the different states, potentially due to differences in policies and support available to divert these materials from landfill. For example, NSW has specific guidelines for managing C&D waste including tracking requirements, while WA's 2030 strategy for resource recovery sets specific targets for C&D waste reduction.

Two reports that discuss on C&D waste mapping for Australia are presented below.

3.3.3.1 Material flow analysis to progress to a circular economy (CSIRO, 2024)

[18] National Waste Report (2022) (dcceew.gov.au)

[19] Australia needs construction waste recycling plants — but locals first need to be won over (2021) (theconversation.com)

In March of 2024 a study on the circularity of the Australian economy was published by Australia's National Science Agency CSIRO. The report tracked not just solid construction materials through the economy but also included energy products, minerals, biomass and waste products from industry and consumers alike. This ambitious report provided insights into the material intensity of the Australian economy, and how the country was trending both at a national and per-capita level.

The report found that domestic materials use across the Australian economy amounted to 418 million tonnes over the year of 2019. 343 million tonnes worth of material were embedded or invested in buildings, roads and other infrastructure over this time period, representing stock change for the key types of activities reviewed in this C&D waste MFA study. The report estimated that:

- 7 million tonnes of metals were recovered from building stocks, and of the total 11 million tonnes of metals captured around 2 million tonnes were recycled;
- Around 20 million tonnes of non-metallic minerals (i.e. rubble, plasterboard) were recovered from building stocks, and of the total 45 million tonnes of non-metallic minerals captured by the waste sector around 19 million tonnes were recycled.

Further information on the fate of C&D materials like timber, soil and plastics was not available in this report.

3.3.3.2 Construction and demolition waste management in Australia (Waste Management and Research, 2021)

In 2021 researchers from Central Queensland University published a paper[20] reviewing techniques and policy employed throughout states and territories across the country to evaluate the influence and impacts of different interventions on C&D waste outcomes. The report discusses generation, disposal and recovery of C&D waste across different regions, leveraging existing Australian literature conducted at the state and federal level.

Key insights were on the impact of differing regional or territorial approaches to management of disposal facilities, levies and data tracking requirements on waste outcomes, but also how differences in requirements can drive cross-jurisdictional movement of waste, leading to increased costs, emissions and environmental/social impacts of C&D waste management. It also highlighted the importance of intervening early in the construction lifecycle (i.e. at the design phase), and how early interventions such as standards and waste minimisation targets for projects reduces downstream costs of diverting wastes.

3.3.4 United States

In the USA, the reported tonnage of C&D waste generated each year was approximately 600 million tonnes in 2018,[21] which is higher on a per capita basis than many of the other countries or regions profiled in this report. The main reason for this is that the EPA includes soil, trees and earth cleared from sites in its reporting of C&D waste, which is different to the reporting frameworks used by the EU, UK and Australia. Because of this, the USA reports that over 90% of its C&D waste comes from demolition and less than 10% from construction activities. Around three quarters (455 million tonnes) of C&D waste is directed towards next use instead of landfilling. Each state manages its C&D waste system differently through the use of state and local legislature, but some examples include:

[20] Construction and demolition waste management in Australia: A mini-review (2021)

[21] Sustainable Management of Construction and Demolition Materials | US EPA (2024)

- Refundable performance deposits provided to permit applicants to encourage C&D waste diversion in Long Beach, CA; and[22]
- Specific materials are restricted from being disposed to landfill from C&D operations in Austin, TX;[23]

Below are a number of relevant case studies from high-performing cities and municipalities in North America leading the way on C&D waste recovery, as well as relevant research cases.

3.3.4.1 Portland – An example of policy-driven C&D waste outcomes

Portland has consistently been upheld as an example of a city with a leading approach to management of recycling requirements.[24] In 1993 it set its first target of 50% of commercial waste recycling or diversion from landfill supported by contractual requirements for businesses and fines for non-complying facilities/businesses. In 2009 this expanded into the Enhanced Dry Waste Recovery Program (EDWRP), which targeted C&D waste specifically and required all C&D waste streams to be processed through a Materials Recovery Facility (MRF) prior to C&D streams being taken to disposal facilities.

Since 2016, Portland has required demolitions for specific projects to follow a deconstruction methodology instead of mechanical demolition. This has raised the standards on demolition practices and helped to separate materials at source for reuse and recovery.

3.3.4.2 Estimation of regional building-related C&D debris generation and composition: Case study for Florida, US

In 2006 researchers from academic institutions across Florida collaborated on a study estimating building-related waste generation and flows across the state originating from residential and non-residential construction, demolition and renovation.[25] Drawing on information available from different studies completed across Florida, specific to local C&D practices, they identified the most common building and demolition activities and built representative material output profiles for each activity type. This included, for example, variations in typical construction practices in different regions of Florida to respond to typical weather and climatic conditions, as well as material availability.

The report pointed to how changes in level of construction activity and changing stock of housing influenced levels of waste generation reported per capita across regions, as well as compared to national standards. It also discussed the variation in reporting requirements across different activities, and the influence of this on accuracy of different parts of the analysis.

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[22] Construction & Demolition (C&D) Debris Recycling Program (Accessed 2024) (longbeach.gov)

[23] Construction and Demolition Recycling Ordinance (Accessed 2024) (austintexas.gov)

[24] History of Portland's garbage and recycling system (Accessed 2024) (portland.gov)

[25] Estimation of regional building-related C&D debris generation and composition: Case study for Florida, US (2006)

4 Establishing a Baseline for C&D waste

4.1 Scope for Baseline Assessment

4.1.1 Boundary of Baseline Assessment

Construction and Demolition activities, including horizontal infrastructure developments (e.g. utility and transport systems, both above- and below-ground) and vertical infrastructure developments (e.g. commercial, residential and industrial above-ground buildings and structures), generate a range of waste materials. How this waste is generated, captured, diverted and disposed is not well understood, and better understanding is needed across the C&D material system to help monitor, manage and reduce waste.

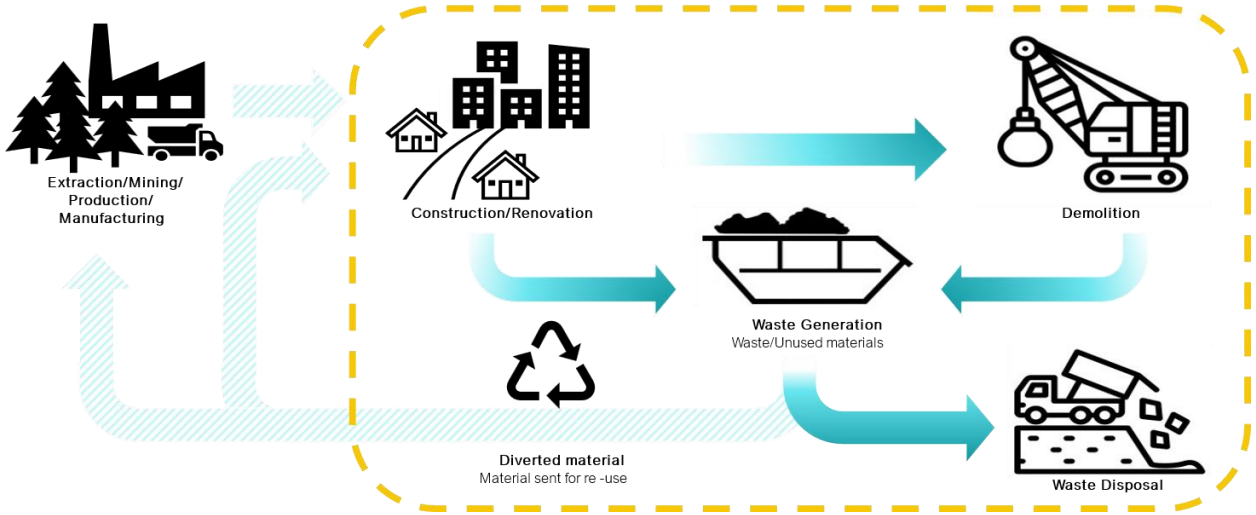


Figure 2: Scope of generation, disposal and diversion baselines

The scope of this assessment is centred around establishing a current and relevant baseline to quantify waste from the C&D sector. The methodology presented below specifically targets the following:

- Waste generated during construction, renovation, and resulting from demolition;
- Waste disposed to landfills and other disposal facilities;
- Waste and materials that are diverted towards beneficial reuse or reprocessing from locations of C&D waste generation and disposal facilities.

By assessing both data available covering the generation of waste alongside reported disposal data, gaps can be identified in the national data and waste reporting landscape from C&D projects. Comparing data from different sources can support the identification of inconsistencies or missing information at a national level. Discrepancies between waste generation data and waste disposal data may indicate areas where reporting systems need improvement, or where additional efforts are required to ensure a comprehensive understanding of material systems. Assessing reported diversion performance at generation and disposal points can help to evaluate the performance of existing diversion practices.

To achieve this, a material flow analysis (MFA) approach was undertaken to assess waste quantities and material compositional flows throughout the generation, diversion and disposal cycle. The baseline presented is for the calendar year of 2023 to capitalise on new OWLS and SWAP reporting modifications, which provided a full calendar year of data from Class 2-5 disposal facilities (a crucial source in producing waste disposal estimates).

As displayed in Figure 2: Scope of generation, disposal and diversion baselines, the scope of this assessment includes the following:

- For Disposal, only Class 1-5 disposal facilities are considered. Industrial monofils, which are also required to report disposal under the OWLS framework, are not considered, alongside transfer stations and other facilities not required to report under the OWLS framework. Temporary disaster waste management facilities (e.g. Silt Recovery Taskforce sites in Hawkes Bay and Gisborne) are excluded.
- For Generation, only waste produced at sites of Construction, Renovation and Demolition are considered. Upstream waste generated by the building materials manufacturing sector is excluded.
- For Diversion, only diversion reported from sites of Construction, Renovation and Demolition activities and diversion recorded at considered disposal sites is included. This assessment has not considered final diversion achieved after reception, sorting and processing of materials diverted at C&D activity types.

This is discussed further below in Sections 4.2.3 and 4.2.4.

4.2 Methodology for Baseline Assessment

4.2.1 MFA Principles

MFA is a systematic approach used to quantify and analyse the flow of materials into, through and out of various stages of a system. This is generally performed by splitting a system (in this case, the C&D waste sector) into different activities or flows, and estimating the contribution of each activity type/flow by deriving two pieces of information for each:

- The number of each discrete activity types performed in an agreed timeframe (e.g. the number of single-storey houses built in New Zealand in 2023);
- The Waste Generation Factor (WGF) associated with each type of activity type (e.g. waste per m^2 of a new single-story house constructed).

The application of this quantification methodology is adjusted across the Generation and Disposal estimates and discussed later in this section.

4.2.2 Staged MFA Methodology

The following methodology was followed to deliver the baseline assessment of C&D Waste Generation, Diversion and Disposal:

1. **Initial Engagement and Data Collection** – As part of setting scope boundaries and study objectives, the first step was to engage with subject matter experts to map and investigate data sources needed for an estimate of C&D waste generation and disposal. For the disposal data analysis, national waste reporting systems administered by MfE were the cornerstone of the assessment; OWLS data provided the basis for tonnages of materials received at Class 1-5 disposal facilities, and associated SWAP analyses helped to categorise these tonnages by composition and activity type. Waste Generation analysis relied on Stats NZ C&D activity data, adjusted for relevance, alongside extensive stakeholder datasets to understand the impacts of various C&D activities.
2. **Preliminary Analysis and Gap Identification** - Once initial estimates from both waste generation and waste disposal approaches were compiled, they were compared to evaluate completeness. This highlighted where alignment gaps could be minimised, providing opportunities to minimise gaps further in future baseline

data assessments for generation, diversion and disposal of C&D waste with further research and engagement. Discussions with expert peer reviewers and Ministry for the Environment specialists shaped a second analysis phase to address these issues. The remaining assumptions and quality concerns are detailed in Section 4.4.

3. **Targeted subject matter expertise workshop, modelling refinement** - Towards the end of the MFA process, an online workshop was conducted with key C&D sector participants - Council C&D advisors, construction contractors, housing developers, researchers, C&D recyclers, and operators - to refine the model outputs. The workshop aimed to discuss data sources, test preliminary findings and data, gather feedback on results and explore improvements in modelling accuracy over time.
4. **Explore Further Refinements** - Following the workshop, a shortlist of recommended actions emerged to enhance C&D waste monitoring precision and outcomes. These recommendations drew from international research insights, local case studies from NZ sector experiences, and observed MFA data results.
5. **Technical and government officials' peer review and finalisation** - A final peer review was undertaken with technical experts and government officials to validate and finalise findings effectively.

4.2.3 Disposal Baseline

Waste disposal data reported via all levied facilities (Class 1-4) under the OWLS framework is the most accurate and complete picture of total waste tonnages in New Zealand today. Levied facilities (Class 1-4 disposal facilities) are required to report tonnages received and disposed/diverted, and this information is aggregated and presented at a national level covering all reporting facilities. Data reported by non-levied facilities (Class 5 landfills) is also included in the disposal baseline assessment, but this data is understood to be less reliable given the differences in reporting requirements between levied and non-levied facilities. For the purposes of this assessment, the Disposal Baseline presented should be considered the most accurate and representative baseline of the sector.

Also available from disposal facilities are estimates of waste composition received, sometimes this is presented based on overall tonnages, and occasionally this is available by different sources of waste that dispose waste to the facility. Compositional data sourced from audits and sample-based reporting is constantly evolving, and is affected by individual facility locations, operations etc.

Disposal data is discussed further in Section 4.3.1.

4.2.4 Generation Baseline

Construction and demolition generates a range of waste from both horizontal C&D activity types (e.g. utility and transport infrastructure and subsurface materials such as soil) and vertical construction activity types (e.g. commercial, residential and industrial above-ground buildings and structures). Across these different infrastructure categories, waste is generated by a) construction of new assets and buildings, b) renovation, fitout and maintenance of existing assets and buildings, and c) demolition of existing assets and buildings at end of useful life. Each type of asset and building requires different C&D practices, and for this reason, the waste generated by the construction, renovation and demolition of each type of asset and/or building varies.

A definition of the key building types that were investigated as part of the waste generation and diversion assessment is given below:

- Commercial buildings: This category includes non-residential structures such as office buildings, retail spaces, schools, and hospitals.
- Single-level dwellings: Referring to standalone residential units comprising only one level.
- 2-3 story townhouses: Representing multi-unit residential buildings typically consisting of two to three stories.
- Multistorey apartment buildings: Encompassing larger residential complexes with multiple floors or levels.
- Roads: Focusing on the C&D activities related to transportation infrastructure, including roads, highways, and bridges.

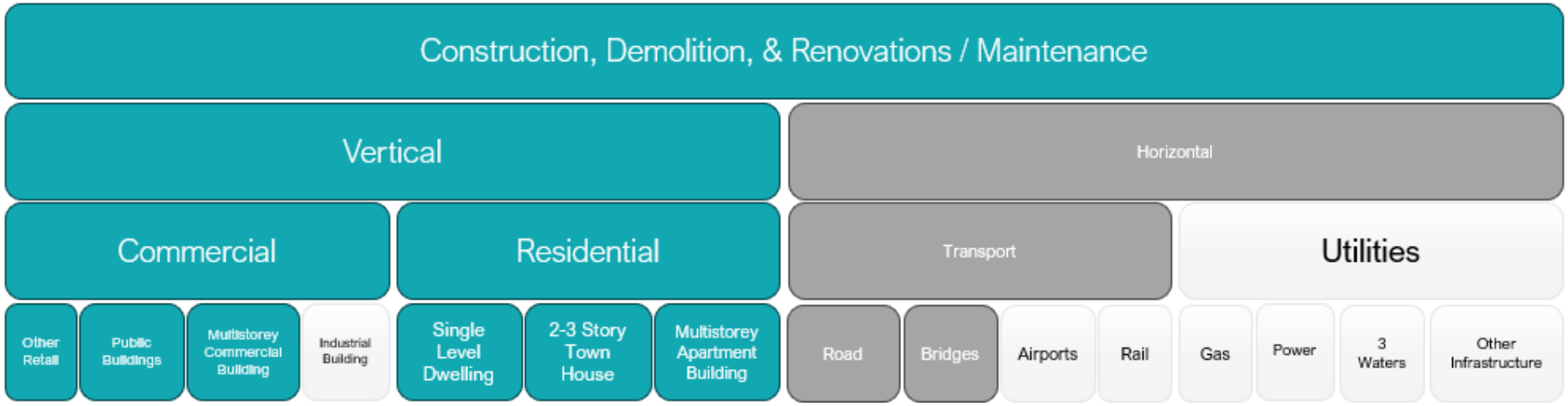


Figure 3: Mapping of C&D sector into infrastructure types and build types; highlighted (blue and grey) sub-sectors are the focus of the generation analysis presented.

Other categories such as Industrial Buildings and all other types of Horizontal Infrastructure except for roads were excluded from the scope of this analysis.

The waste generation source-based MFA analysis conducted does not include an assessment of waste generation from the manufacturing of material or inputs into the C&D sector (e.g. waste from material extraction and other building methodology types such as pre-fabrication).

4.2.5 Diversion Baseline

Diversion of C&D waste can occur at multiple stages through the system assessed. Material on site can be immediately sent for re-use elsewhere, sent to a material recovery facility, or diverted at disposal facilities.

Diversion rates for waste sent to disposal facilities and transfer stations are reported via OWLS, but this does not include waste sent directly to resource recovery facilities. To capture this, diversion data recorded at sites of C&D activities assessed in our Generation assessment is used to calculate these quantities. Figure 4 shows how different definitions of diversion are connected back to different flows of waste between Generation sources, Recovery infrastructure, and Disposal facilities.

In existing data, diversion rates for waste sent to disposal facilities and transfer stations are well known, but this does not include waste sent directly to resource recovery facilities, which would be required for a fulsome picture of waste diversion. A complete and representative C&D waste diversion baseline will be a combination of both diversion at landfill and diversion at source.

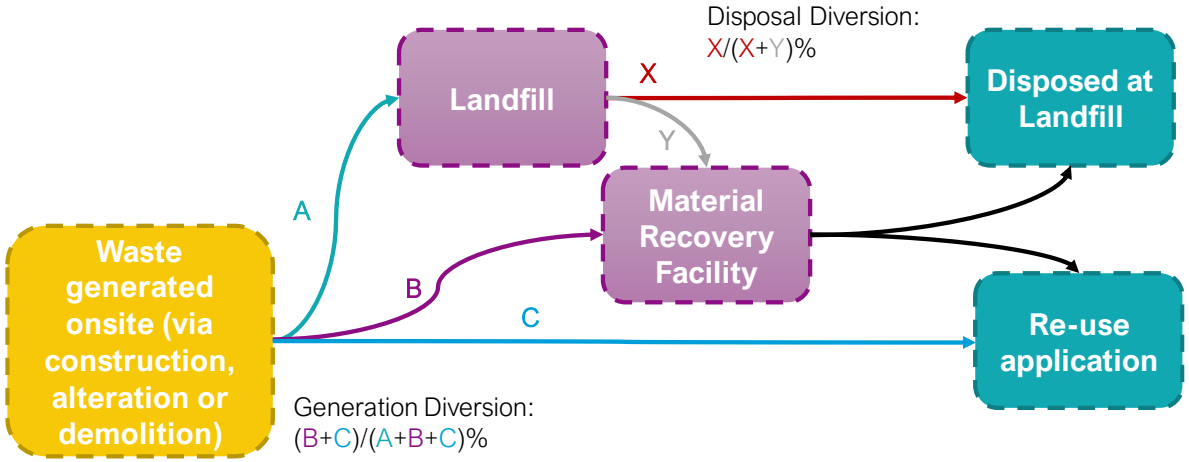


Figure 4: Definitions of diversion calculation methodologies referenced in this report

4.3 Data – Availability, Quality, Key Risks and Unknowns

Prior to presenting the results of the MFA analysis, below is a high-level discussion on the main features, assumptions and limitations on the aggregated data sources used for both the generation and disposal waste baseline analysis. More information on the specific sources utilised is included in Appendix A.

4.3.1 Waste Disposal Data

One of the two major data sources used in the disposal baseline modelling was OWLS data, provided by the Ministry for the Environment. OWLS data is compiled under waste levy reporting processes, where disposal facilities must report gross, net and diverted tonnages managed within their sites.

Disposal data provided via OWLS was fairly comprehensive and the best representation of waste tonnages at disposal facilities nationwide available at the time of this study. Although the OWLS data is the best representation currently available, this data does come with some caveats and limitations. A major limitation of the OWLS data used is that the reporting of data for Class 2, 3, 4, & 5 disposal facilities was only undertaken post-2022, resulting in limitations on the baseline year for this analysis. This also reduces the ability to sense check how accurate/representative this data is compared to previous years, with major data-altering events within proximity to this time frame such as COVID-19 lockdowns, material supply constraints, industry disruptions and high volumes of disaster waste.

The second caveat with this data is the open interpretation of reporting "diverted" waste tonnages with this category being defined as *"Tonnage of waste or diverted material that enters the facility but is reused, recycled or removed from the facility within six months of it arriving. Diverted tonnage may include waste deliberately burnt at the facility to recover energy from it but not waste burnt at the facility to destroy it."* This means that material that is "reused" as landfill cover can potentially fall under this definition while still remaining at the landfill. Additionally, operators have the option to report cover material as diverted material, so some "diverted' material is still being disposed of at landfill for use as cover. This issue is similar to the observed issues with the EU definition of backfilling waste, where room for interpretation creates potential inconsistencies.

The other key source of data that was utilised in conjunction with the OWLS data was relevant SWAP data. SWAP data consists of sample-based reporting of both sources of waste and composition of waste received at a disposal facility. The SWAP data used within this analysis for material breakdowns for different facility types also involves caveats and limitations.

This first limitation within standard SWAP reporting for disposal facilities is that the SWAP reporting framework was set up for common Class 1 landfill material categories (majority putrescible wastes from municipal, commercial and industrial waste collections) meaning there are few categories or subcategories in the default template for the wide variety of construction and building materials disposed to Cass 2 facilities (such as plasterboard, concrete, clean fill, topsoil and contaminated/hazardous material).

To resolve this, further composition categories are in the process of being added to both the Class 1 and Class 2 – 5 disposal facilities as recommended by MfE. These additional categories expand on the definition of "rubble" by splitting out the category into applicable material categories which can be used to further analyse waste from C&D activities. The use of these additional categories allows for further analysis from a generation perspective with generation from vertical C&D often producing differing waste compositions to both horizontal infrastructures and soil-generating activities. These classifications have been used in new audits of Class 2-4 facilities which this report has used (discussed below).

Supplementary data from unpublished work completed for MfE was used to inform assumptions around activity source breakdowns for Class 1 disposal facilities. This data was derived from seven reports of waste composition spanning the country from 2018-2023. As part of composition assessment protocols (SWAP), observers would make assumptions about which incoming vehicles were carrying waste from C&D (and other) activities based on vehicle type, branding, materials etc. over the course of about a week. The material classifications used to define the composition of C&D waste at disposal facilities can be seen in Table 2.

Table 2: Material Composition Categories

Class 1 - Material Composition Categories	Class 2 to 5 - Material Composition Categories
Paper/cardboard	Paper/card
Plastics	Plastics
Putrescibles/Organics	Putrescibles/Organics
Ferrous metal	Ferrous metal
Non-ferrous metal	Non-ferrous metal
Glass	Glass
Textiles	Textiles
Timber	Timber
Rubber	Rubber
Rubble - Plasterboard	Rubble - Plasterboard
Rubble - Cleanfill	Rubble - VENM
Rubble - Other	Rubble - Masonry Blocks, Bricks and Pavers
	Rubble - Ceramics (Bricks and tiles)
	Rubble - Clay Pipes
	Rubble - Concrete
	Rubble - Asphalt
	Rubble - Peat
	Rubble - Topsoil
	Rubble - Topsoil (without grass)
	Rubble - Topsoil (with grass)
	Rubble - Sorted rubble
	Rubble - Unsorted/Mixed Rubble
	Rubble - Uncharacterised soil (may be contaminated)
Rubble - Contaminated	Rubble - Contaminated
-	Potentially hazardous

Other specific limitations that should be kept in mind when reviewing the results for the disposal baseline analysis are given below:

- The activity source split at Class 2-4 disposal facilities has been assumed to be 100% for each. While this assumption is highly applicable to Class 2 data, this also introduces some uncertainty around Classes 3&4 which may receive waste from mixed industrial commercial and institutional activities. This data will improve as Class 3-5 disposal facilities are required to report tonnage by activity source from July 2024. In the results section, this data is presented in a number of ways to provide different perspectives on the data.
- It has been assumed that the diversion percentages presented for total Class 1 landfill waste can be applied consistently across different waste sources with varying compositions, including C&D waste. Similarly, for Class 2-4 disposal facilities an activity source for diverted materials of 100% C&D has been applied to match the assumption that all waste recorded comes from C&D activities as above.
- Class 5 disposal is presented with the lowest overall data confidence, as these facilities receive material from mixed activity sources and are not required to report under the strict requirements of levied facilities (Class 1-4). The assumption that all Class 5 waste is from C&D sources is incorrect as material disposed at these facilities can be derived from other activities such as mining and disaster waste; the actual proportion of waste disposed to Class 5 facilities generated by C&D activities is unknown.
- OWLS data is reported in tonnages, however in reality, the figures reported are split between weigh bridge recordings of weight and volume-to-weight conversions which can lead to some unreliability in this data.

4.3.2 Waste Generation Data

The generation data compiled for this analysis comes from a variety of sources across different years, presenting significant challenges related to consistency and reliability.

To gain more accurate data across each building type, the analysis split each of these into three activity types to separately determine the waste produced annually for each. Following standard Material Flow Analysis practices, each building type/activity type was investigated to generate two pieces of data: 1) The number of ‘activities’ occurring over the 12-month baseline period; and 2) a Waste Generation Factor (WGF), linking a quantity of waste to each activity type. These three activity sources are construction, demolition, and renovation (which includes alterations, additions, internal fit-out and maintenance), with WGF in kg/m^2 for C&D and kg/$ for renovations.

The data sources available for each activity type (i.e. the number of build activities or dollars spent on activities annually) across the build types varied in quality and quantity which impacts the results of this analysis.

Each generation factor dataset varied in terms of completeness, accuracy, and methodological rigor. Where relevant data was unavailable locally, international case studies were used to supplement waste generation data for build types. These supplementary sources were weighted based on an assessment of their quality to ensure as much accuracy as possible. The data quality analysis was applied to all data sets used for this assessment individually, and was conducted using four categories:

- Recency (how recent the data is);
- Sector representation (how well the data reflects standard practices);
- Locality (whether the data covers the entire country, specific regions, or international), and;
- Overall data confidence based on methodology, sample size etc.

More information on the results of the assessment of individual data sources (anonymised where required) can be reviewed in Appendix A. This highlights specific features of the sources utilised that have been accounted for in the presentation of the Generation results.

Other specific limitations and assumptions that must be kept in mind when reviewing the results are below and are discussed in Section 4.4.

4.3.3 Gaps in available data

The presence of gaps in this assessment can be attributed to several key factors, including a general lack of publicly-available datasets, limited willingness from stakeholders to share organisation-specific data outside the public domain and time constraints for engagement.

The most significant gaps in the datasets and the MFA analysis are discussed below:

- **Roads data** – The data that was available via public and private sources for roading construction/demolition data was not able to contribute towards the totals in the MFA. While excellent data was available for the number of roading projects delivered, and how these activities were split between new roads, roading repairs, roading demolition etc., the WGF data available through accessible case studies was so varied that it was not able to be incorporated into this MFA report (see Appendix D). This is especially unfortunate, as much of the data recorded as being disposed at landfills was cleanfill/soil which is likely to be associated heavily with horizontal infrastructure development like roading projects rather than vertical infrastructure.
- **Commercial building and apartments demolition data** – The most significant gap in the assessment of vertical infrastructure is the assessment of waste generated from the demolition of commercial buildings and apartments. These demolition activities are less common than demolition of single or multi-unit dwellings and for this reason there is much less data available on how many demolition activities occur annually across these build types, as well as how much waste is generated. It is expected that this waste source is significant, given that across other build categories demolition waste generation exceeds construction waste generation.
- **Renovation, alteration and additions** – Across build types, renovations, alterations and additions (both consented and non-consented) is a gap in current understanding. There is limited data to understand how many alterations or renovations occur annually across these build types and the associated waste generated. NZ specific research has been conducted to estimate the annual spend on these activities but there is little basis to be able to convert this into an estimate of waste generation, given the variety of types of renovation works (from bathroom re-designs to entire building fit-out projects).
- **Accurate soil/clean fill data from generation data** – Different case studies or reporting frameworks for onsite construction waste reporting specify different reporting practices for soil and cleanfill waste generated by onsite excavation/site preparation etc. Additionally, it is often a separate contractor that prepares the site to the contractor managing the building construction, so in some cases there is nothing left to report by the time construction begins. This is a significant gap in source-based modelling and the impacts can be clearly seen when looking at the different waste compositions across the disposal vs generation baseline reporting.
- **Activity source data at Class 2-5 landfills –** The assumption that all waste disposed to Class 2-5 landfills comes from C&D sources is a broad assumption that potentially exacerbates or inflates the contribution of C&D activities towards NZ's national waste issue. Typical C&D waste materials that are the focus of measurement and tracking overseas such as metals, plastics, gypsum/plasterboard, aggregate and cement represent a small fraction of waste received at Class 2-5 landfills, while the vast majority of materials disposed is excavated soil. The benefits of tracking, measuring and diverting non-soil materials towards reuse and recycling, as well as the required policy actions that could encourage or promote these outcomes, are vastly different to the types of interventions needed to better manage soil waste.

4.4 Limitations and Assumptions of Utilised Data

Other specific limitations and assumptions that must be kept in mind when reviewing the results are below:

- Due to the lack of information regarding the number of demolition activities across all build types within the scope of this baseline assessment, an estimate of 10,000 demolished dwelling units annually provided by BRANZ has been used. To apply this across the five building categories it has been assumed that all demolitions are residential and fall into the categories of single-story and two to three-story town housing with the split of demolitions between the two being proportional to the annual consents for these build types.
- Utilising data from waste studies and audits often introduces certain biases regarding the amount of waste generated. These studies are typically part of specific case studies that inherently aim to achieve waste minimisation targets and high diversion rates. The focus on improving waste management practices in these cases means that the data collected may not accurately reflect average or typical conditions, but rather optimised scenarios. Consequently, the findings tend to showcase better-than-average performance, which can skew the overall interpretation of waste generation metrics. However, it is important to note that this is not the case for all data used in the assessment; some datasets come from a broader range of sources and capture more typical waste generation patterns.
- Different studies use different waste categorisation systems in their reporting, so sub-categories like soil and rubble need to be captured into generic categories when presented together and combined. This limits the ability of this assessment to comment on the prevalence of particular types of rubble and soil produced and validate the categorisations from individual studies.
- Diversion numbers are expected to vary depending on region and access to recovery facilities. Availability of data for differences in waste outcomes based on diversion infrastructure available at a regional level was not available leading to most of the diversion data that was obtained for this study being from Auckland, which currently has access to more C&D recovery facilities. Exploration of the data through a regional lens is not yet possible in New Zealand given the national-level reporting baseline for many activity type data sources.
- Some international research reports state that there are changes in WGF figures when it comes to multi-storey buildings over 2-3 stories which, if substantiated by research in NZ, might affect the estimates provided for a selection of build types analysed in this study, however no conclusive data was available within the timeframe of this study.
- International data sources can influence the applicability of WGFs, as construction and demolition practices can vary significantly by location (due to availability of materials, access to material processing infrastructure, ground and weather conditions etc.). In areas where international case studies have been used to support findings this should be considered.
- Tonnage reports for Class 1-5 disposal relies on the accuracy of reporting from disposal facility operators; there is room for error or unintended mistakes in reporting categories. While there may have been inadvertent errors in disposal data aggregated in this analysis, MfE expects such errors should reduce over time, as new July 2024 regulated reporting requirements become embedded.

5 MFA findings - C&D disposal baseline estimate

5.1 Overall summary of findings

This assessment aimed to benchmark the generation of waste, diversion of waste and disposal of C&D waste for the baseline year of 2023 using available data. After a review of information available to conduct these three baseline assessments, it has been determined that there is not enough comprehensive data available to produce a baseline for C&D waste generated or C&D waste diverted at this time. Therefore, only a baseline for C&D disposal is presented in this report (refer Section 5.2). While data for generation and diversion was not comprehensive enough to form a baseline, this data is still presented for discussion and comparison against disposal data in Sections 5.3 and 5.4 below.

5.1.1 Disposal – findings summary

Disposal data, both in terms of tonnages disposed to Class 1-5 disposal facilities and composition of disposed C&D waste, is the most well-understood part of the C&D waste system. Supported by regulated reporting, tonnages are regularly provided by facility operators and aggregated. Ongoing work by MfE is supporting improved data collection on composition by way of new site audits for Class 2-4 disposal facilities.

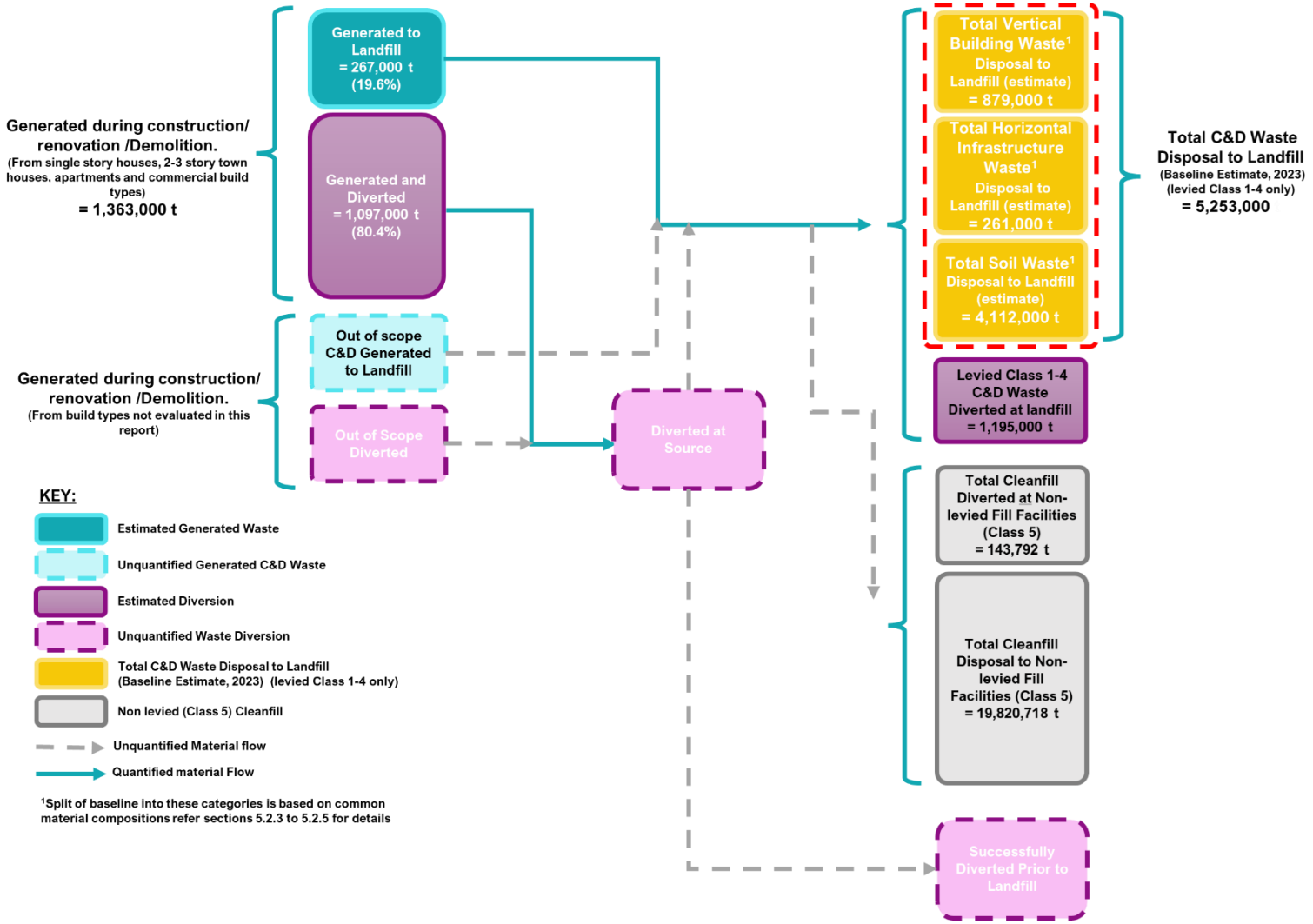


Figure 5: Summary of generation, diversion and disposal findings (within the selected baseline calendar year - 1st of January 2023 to the 31st of December 2023)

However, Class 5 (non-levied) facility tonnages are understood to be less accurate than Class 1-4 levied disposal facility tonnages, and the disposal numbers in Figure 5 do not account for any C&D waste disposed outside of Class 1-5 facilities (for instance, any miscategorised waste disposed to other facilities or illegally dumped waste).

5.1.2 Generation – findings summary

Overall, only a small fraction of disposed waste can be traced back to source through this analysis. The majority of waste that could be estimated at source is classified as diverted, but the breakdown of how much of this waste is successfully reused or reprocessed is unknown. Most of the flows between sources of generation, diversion pathways and disposal sites are not able to be accounted for.

As described in Section 4.2.4, since this source-based analysis could not consider all sources of C&D waste (most Horizontal Infrastructure build types were excluded; some Vertical Infrastructure activities like renovation, commercial demolition etc. were unable to be evaluated), the numbers presented can only represent part of the total C&D waste generation. The gaps in this source-based assessment, and how key materials associated with analysed generation sources appear in the disposal baseline, is discussed in Section 5.3.

5.1.3 Diversion – findings summary

The diversion estimates presented in this assessment cannot fully quantify a baseline for diversion, since diversion calculated at generation and diversion calculated at disposal are not additive. The methodology implemented in this report is unable to estimate how much of the C&D waste disposed at landfill was originally diverted towards reuse or reprocessing at the generation site, or how much waste diverted at landfill may have originally been intended for disposal. This is a gap in the scope of this study that should be investigated further in future works.

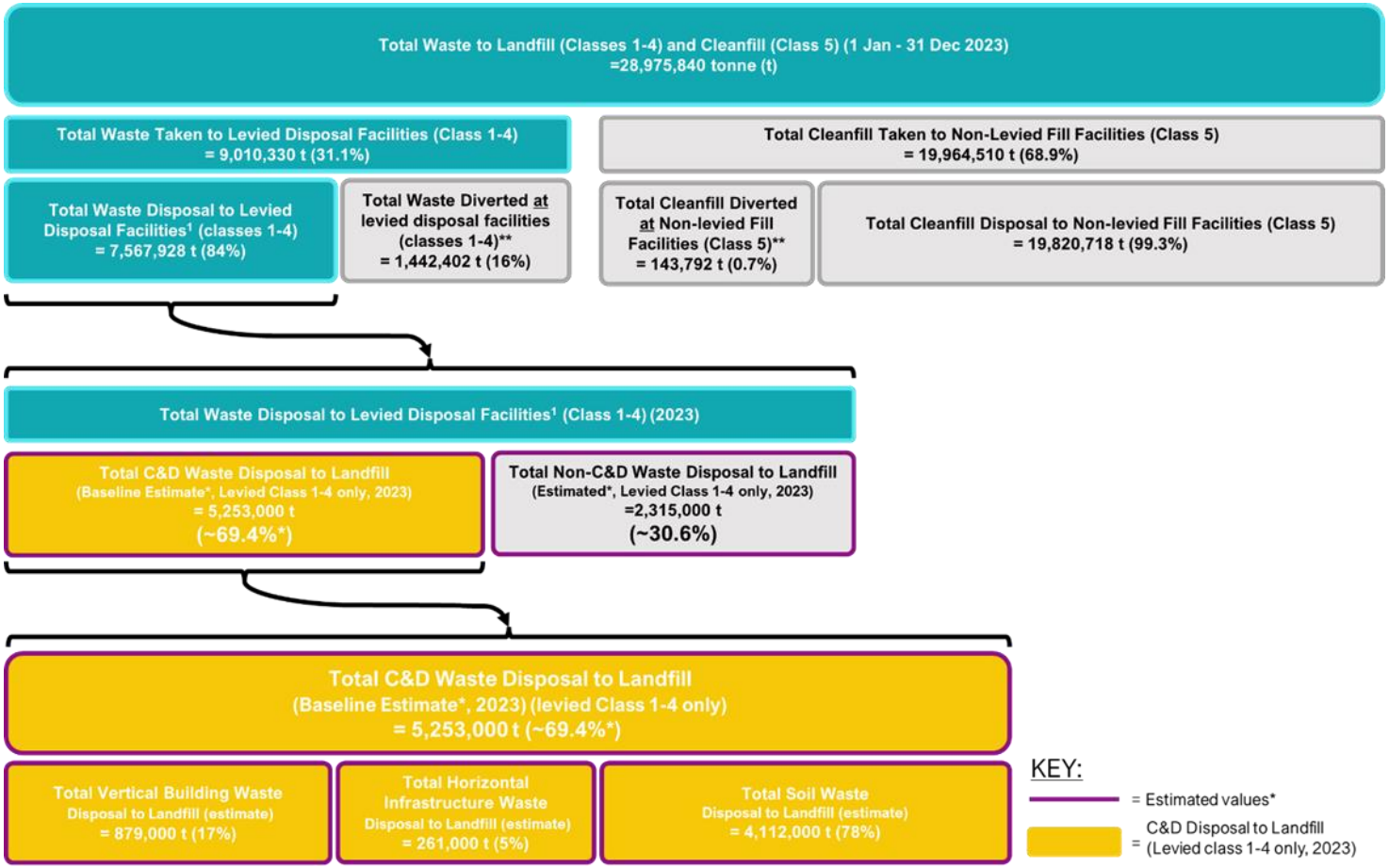
5.1.4 Key Results from Assessment (discussed in detail below)

- Waste generated by C&D activities during the baseline year of 2023 made up 69.4% of all material disposed of at Class 1-4 disposal facilities.
- During this period the majority of waste received at landfill was cleanfill waste to Class 5 non-levied disposal facilities (19.96 Mt). Class 5 cleanfill is difficult to trace back to C&D activities, so this has been excluded from our baseline calculations.
- Of all the levied C&D waste disposed of, materials associated with vertical infrastructure, horizontal infrastructure, and soil waste contribute 17%, 5% and 78% respectively. Outside of Class 5 facilities, soil volumes still represent over three quarters of all waste disposed. Of the total 27.39 million tonnes reported as disposed, 87**%** of this material is soil/cleanfill.
- While a conclusive baseline cannot be determined for waste generated, the approximated quantity from construction, renovation and demolition, considering build types included in scope, is 1,363,000 tonnes, of which 80.4% was reported as diverted at site. This diversion rate has multiple caveats and is discussed further in section 5.4.2.

5.2 C&D Waste Disposal Baseline Results

Within the baseline calendar year (2023), Class 1 to 5 disposal facilities received 28,975,800 tonnes of material. Of this, all levied disposal facilities (Class 1-4 facilities) received 9,019,330 tonnes, comprising 31.1% of the total received material.

For this baseline, it is crucial to treat Class 5 waste separately due to uncertainty about its origins, as these sites are not levied or audited under the WMA compliance regime. Because of this, the activities that generate this waste and recorded tonnages (however, less so than activity source) are less certain than material received at levied facilities (Class 1-4). Additionally, cleanfill is often seen as 'surplus soil' rather than waste, allowing for potential reuse after disposal at Class 5 facilities. Given the high uncertainty of Class 5 data and unclear C&D activity contributions, the analysis will mainly focus on levied waste separately from non-levied Class 5 waste. The proposed baseline will include C&D waste from Class 1 to 4 disposal facilities, as a proportion of the total 9 million tonnes of total waste received at Class 1- 4 facilities.



¹Total waste disposal to levied disposal facilities (class 1-4) is used as the Benchmark for the estimated C&D waste disposal Baseline

*The estimated percentage of C&D waste at Class 1-4 facilities is uncertain with a 10% plausible spread for each, ranging from 24-44% for Class 1 and 90-100% for Class 2-4, impacting the C&D waste disposed at levied facilities range to be between 59% and 74% of all waste disposed at levied facilities, with precision expected to improve as more data becomes available.

**Diversion at facilities is not representative of total waste diversion for the baseline year of 2023 as diversion can occur both directly from C&D sites or at resource recovery facilitates. Refer section 5.4 for more detail.

Figure 6: C&D Waste Disposal Baseline (within the selected baseline calendar year - 1st of January 2023 to the 31st of December 2023)

Applying the activity source data and assumptions to levied waste disposed gives the following result: *Waste generated by construction and demolition activities made up 69.4% of all material disposed of at Class 1-4 disposal facilities*. It is important to note that this number excludes material diverted at disposal facilities which is discussed in greater detail in Section 5.4 below.

Table 3: Total Disposal Numbers (within the selected baseline calendar year - 2023)

	Gross Tonnage Received (t)	Diverted at facility (t) (percentage in terms of gross tonnage received)	Net Tonnage Received (t)	Construction and Demolition Net Tonnage* (t) (percentage in terms of net tonnage received)
Class 1-4 Facilities (all levied)	9,010,000	1,442,000 (16%)	7,567,000	5,253,000 (69.4%)
Class 5 Facilities (unlevied)	19,965,000	144,000 (0.7%)	19,821,000	19,821,000 (100%)
Total	28,975,000 t	1,586,000 t	27,389,000 t	25,074,000 t (91.5%)

*** Excludes C&D waste diverted at disposal facility**

There is uncertainty associated with the percentage of material disposed at Class 1-4 facilities that is from C&D activity, taken to be 34% for Class 1 landfills and 100% for Class 2-4 landfills. Data is insufficient to determine the spread and distribution of uncertainty around these point estimates with precision; however, a spread of 10% for each is plausible based on data available (24-44% for Class 1 landfills, 90-100% for Class 2-4 landfills). This would mean the C&D waste disposed at levied facilities could be between 4.488M tonnes and 5.59M tonnes, or between 59% and 74% of all waste disposed at levied facilities (Class 1-4). This uncertainty will reduce as improved activity source data is generated from recent waste data regulations.

5.2.1 Breakdown of total C&D waste disposal at individual Classes 1-4 (levied)

Levied disposal facilities (Class 1-4) form the foundation of this initial baseline assessment. The confidence in C&D activity source assumptions at these sites is higher and more applicable, most notable in the case of Class 2-4 disposal facilities which, by definition, receive entirely C&D waste. Within the parameters of this assessment, the proportions of C&D waste disposed of at Class 1-4 facilities is assumed to be the following:

Table 4: Construction and demolition gross and net tonnage proportion at disposal facilities (within the selected baseline calendar year - 2023)

	Construction and Demolition Proportion of Total Waste	Gross Construction and Demolition Waste (t)	Proportion of all Levied C&D waste	Net Construction and Demolition Waste (t)
Class 1	34%	1,320,000	20.5%	1,193,000
Class 2	100%	399,000	6.2%	301,000
Class 3 & 4	100%	4,729,000	73.3%	3,760,000
Total		**6,448,000**	**100%**	**5,254,000**

The total C&D waste disposed of at these facilities is 5,253,000 tonnes, 20.9% of overall waste disposed in the baseline year at all Class 1-5 facilities and 69% of all waste disposal at levied disposal facilities. Most of this waste is disposed of at Class 3-4 facilities, with only 6.2% of C&D waste ending up in Class 2 facilities (C&D fill facilities). With the classification of material permitted in Class 3&4 facilities, this disparity in facility proportions is apparent when looking at the disposal data through a material compositional lens. Additionally, this proportion is approximately reflected in the number of each of these facilities at the time this report has been prepared (Class 1 = 40 (22%), Class 2 = 15 (8%), and Class 3&4 =129 (70%)).

A key unknown in discussing these numbers is whether the number of Class 2 facilities available influences the tonnages received at the different classes of facilities. It may be that Class 1 landfills in particular have to play a more significant role in the disposal of C&D materials due to a lack of accessible Class 2 disposal sites. This is discussed more below.

5.2.2 Material Composition of C&D Waste Disposal Streams to Class 1-4 Facilities (levied)

The vast majority of waste disposed to Class 1-4 levied facilities is soil waste; 'uncharacterised soil', 'virgin excavated natural material' (VENM), 'topsoil', and 'topsoil with grass'. The most common above-ground construction and demolition waste materials ('asphalt', 'concrete', 'timber', 'plasterboard' etc.) represent 23% of this waste in total. Compositional information presented in Table 5 for Class 2-4 landfills is taken from unpublished MfE data, based on individual site audits. There was significant variation in numbers between the sources for the novel rubble sub-categories; information on the ranges discussed in this study can be viewed in Appendix B. More information and comparisons of tonnages received and impacts on compositional breakdowns by focusing on waste streams associated primarily with horizontal and vertical infrastructure, and the effects of excluding soil from this comparison, can be reviewed in Appendix C.

Table 5: Net material composition of Class 1-4 disposal facilities (within the selected baseline calendar year - 2023)

Material	Class 1 (t)	Class 2 (t)	Class 3&4 (t)	Total (t)	% of Baseline
Paper/cardboard	22,678	16,513	-	39,191	0.75%
Plastics	29,816	45,391	11,288	86,495	1.65%
Putrescibles/Organics	7,138	9,350	26,313	42,801	0.81%
Ferrous metal	20,239	3,921	3,736	27,896	0.53%
Non-ferrous metal	1,175	6,635	3,736	11,546	0.22%
Glass	7,138	5,429	-	12,567	0.24%
Textiles	30,991	29,783	7,552	68,326	1.30%
Timber	381,648	98,321	11,288	491,257	9.35%
Rubber	5,963	603	-	6,566	0.13%
Rubble - Sorted rubble	-	603	-	603	0.01%
Rubble - Unsorted/Mixed Rubble	-	2,035	-	2,036	0.04%
Rubble - Masonry Blocks, Bricks and Pavers	-	-	8,823	8,823	0.17%
Rubble - Ceramics (Bricks and tiles)	-	-	556	556	0.01%
Rubble - Clay Pipes	-	-	5,724	5,724	0.11%
Rubble - Concrete	-	3,016	89,113	92,129	1.75%
Rubble - Asphalt	-	-	160,181	160,181	3.05%
Rubble - Peat	-	-	6,280	6,280	0.12%
Rubble - Topsoil	-	2,337	-	2,337	0.04%
Rubble - Topsoil (without grass)	-	-	622,680	622,680	11.86%
Rubble - Topsoil (with grass)	-	-	133,471	133,471	2.54%
Rubble - Plasterboard	65,596	14,703	-	80,299	1.53%
Rubble - VENM	45,357	5,806	441,194	492,357	9.38%
Rubble - Uncharacterised soil (may be contaminated)	90,623	51,725	2,227,036	2,369,384	45.12%
Rubble – Contaminated	484,197	905	0	485,102	9.24%
Potentially hazardous	-	3,016	0	3,016	0.06%
Total	**1,192,559**	**300,092**	**3,758,971**	**5,251,622**	**100.00%**

Per Table 5, Class 1 and 2 disposal facilities generally accept many of the same types of waste from C&D sources, but Class 1 landfills in general receive much higher tonnages. This does suggest that in some areas Class 1 landfills are fulfilling the role of Class 2 disposal facilities, accepting similar waste streams that cannot be feasibly or economically transported to and disposed of at the limited number of Class 2 facilities in the country.

The composition tables above and below are expressed in terms of tonnages, instead of volume. This is important to note as volume/tonnage ratios (i.e. densities) vary significantly across the material classifications discussed, particularly with regards to plastics. Using tonnages as the basis for this analysis is consistent with standard reporting and analysis practices in the waste sector, but can under-represent materials like plastics, which can occupy multiple times the space of metals or concrete in landfills for the same weight.

At a high level, materials associated with vertical infrastructure, horizontal infrastructure, and soil waste contribute around 24%, 5% and 71% respectively. These different materials groupings and proportions are discussed further below.

5.2.3 Breakdown of Vertical (Infrastructure Material) C&D Waste Disposal at Class 1-4 (levied) Facilities

When looking at the compositional data through the lens of common materials associated with above-ground vertical construction (see Table 6) vertical infrastructure C&D waste accounts for 879,340 tonnes of disposed waste at levied disposal facilities (Class 1-4) and demolition. This constitutes 17% of the waste disposed to Class 1-4 landfills.

Included in this analysis are tonnages of C&D waste received at all levied facilities (Class 1-4), excluding waste streams generally not associated with vertical infrastructure (i.e. houses, apartments, commercial buildings). These materials are prevalent in residential, industrial, and commercial structures. Excluding materials associated more closely with horizontal infrastructure—such as sorted and unsorted rubble, clay pipes, concrete, asphalt, various types of soil, including topsoil and contaminated soil—streamlines the focus on vertical infrastructure. The largest sources of this material by weight are timber, miscellaneous hazardous materials,

Table 6: Vertical building product waste for Class 1-4 disposal facilities (within the selected baseline calendar year - 2023)

Material	Class 1 (t)	Class 2 (t)	Class 3&4 (t)	Total (t)	% of Baseline
Paper/cardboard	22,678	16,513	-	39,191	0.73%
Plastics	29,816	45,391	11,288	86,495	1.66%
Putrescibles/Organics	7,138	9,350	26,313	42,800	0.82%
Ferrous metal	20,239	3,921	3,736	27,896	0.50%
Non-ferrous metal	1,175	6,635	3,736	11,546	0.23%
Glass	7,138	5,429	-	12,567	0.23%
Textiles	30,991	29,783	7,552	68,326	1.29%
Timber	381,648	98,322	11,288	491,258	8.79%
Rubber	5,963	603	-	6,566	0.11%
Rubble - Masonry Blocks, Bricks and Pavers	-	-	8,824	8,824	0.17%
Rubble - Ceramics (Bricks and tiles)	-	-	556	556	0.02%
Rubble - Plasterboard	65,596	14,703	-	80,299	1.43%
Potentially hazardous	-	3,016	-	3,016	0.06%
Total	**572,382**	**233,666**	**73,293**	**879,340**	**16.74%**

plastics, plasterboard and textiles. It is important to note that when analysing only the disposed quantities of these materials, the proportion of C&D material diverted at each Class of disposal facility was spread equally among all material categories. While this assumption was necessary to gain insights into both vertical and horizontal C&D material disposal, it is likely incorrect as diversion of material will vary across both facility class and material type.

Over 90% of vertical infrastructure waste outlined in Table 6 is reported to be disposed at Class 1 and 2 facilities, which is promising given that waste from above-ground assets should be disposed to C&D fills or landfills. The question of whether approximately 49,000 tonnes of organics, timber and plastics should be disposed at sites meant to manage inert materials is worth investigating, and the in-progress activity source data reporting improvements could help to identify the sources of these materials. Class 1 landfill tonnages far outstrip tonnages to Class 2 facilities, which again could be due to accessibility barriers. Further work is required to evaluate this.

More analysis is needed to confirm whether the estimates presented for Class 2-4 landfills are in line with ongoing trends as they are based on a small number of data surveys for facilities – data confidence in the interim should be treated as low.

Please refer to Appendix B for information on the compositional data ranges for rubble sub-category wastes for Class 2-4 landfills.

5.2.4 Breakdown of Horizontal (Infrastructure Material) C&D Waste Disposal at Class 1-4 (levied) Facilities

Materials associated with horizontal infrastructure C&D activities constitute just over 5% of the waste disposed to Class 1-4 disposal facilities. The largest components of this material are asphalt and concrete, with other classifications representing minor tonnage. Almost all this material is being disposed to Class 3&4 facilities, which is the intended disposal pathway for horizontal infrastructure waste materials.

Table 7: Horizontal building product waste for Class 1-4 disposal facilities (within the selected baseline calendar year - 2023)

Material	Class 1 (t)	Class 2 (t)	Class 3&4 (t)	Total (t)	% of Baseline
Rubble - Sorted rubble	-	603	-	603	0.02%
Rubble - Unsorted/Mixed Rubble	-	2,036	-	2,036	0.05%
Rubble - Clay Pipes	-	-	5,724	5,724	0.11%
Rubble - Concrete	-	3,016	89,113	92,129	1.80%
Rubble - Asphalt	-	-	160,181	160,181	3.13%
Total	**-**	**5,655**	**255,018**	**260,673**	**5.11%**

More analysis is needed to confirm if estimates presented for Class 2-4 landfills are in line with ongoing trends as they are based on a small number of data surveys for facilities – data confidence in the interim should be treated as low. As stated previously It is important to note that when analysing only the disposed quantities of these materials, the proportion of C&D material diverted at each Class of disposal facility was spread equally among all material categories. While this assumption was necessary to gain insights into both vertical and horizontal C&D material disposal, it is likely incorrect as diversion of material will vary across both Class of disposal facility and material type.

Refer to Appendix B for information on the compositional data ranges for rubble sub-category wastes for Class 2-4 landfills.

5.2.5 Class 1-4 Surplus Soil Disposal at Class 1-4 (Levied)

Soil and contaminated/unclassified rubble materials constitute over 78% of the waste disposed to Class 1-4 landfills. The largest source of this waste reported is uncharacterised/possibly contaminated soil, which suggests more work is needed to understand the most significant flows to landfills, especially when, if characterised, the material could be diverted to cleanfill sites instead. Additional analysis is needed to confirm whether the estimates presented for Class 2-4 landfills are in line with ongoing trends, as they are based on a small number of data surveys for facilities – data confidence in the interim should be treated as low.

Table 8: Soil waste for Class 1-4 Facilities (within the selected baseline calendar year - 2023)

Material	Class 1 (t)	Class 2 (t)	Class 3&4 (t)	Total (t)	% of Baseline
Rubble - Peat	-	-	6,280	6,280	0.12%
Rubble - Topsoil	-	2,337	-	2,337	0.05%
Rubble - Topsoil (without grass)	-	-	622,680	622,680	12.15%
Rubble - Topsoil (with grass)	-	-	133,471	133,471	2.61%
Rubble - VENM	45,357	5,806	441,194	492,357	9.51%
Rubble - Uncharacterised soil (may be contaminated)	90,623	51,725	2,227,036	2,369,384	46.07%
Rubble - Contaminated	484,197	905	-	485,102	9.24%
Total	**620,177**	**60,773**	**3,430,661**	**4,111,611**	**78.29%**

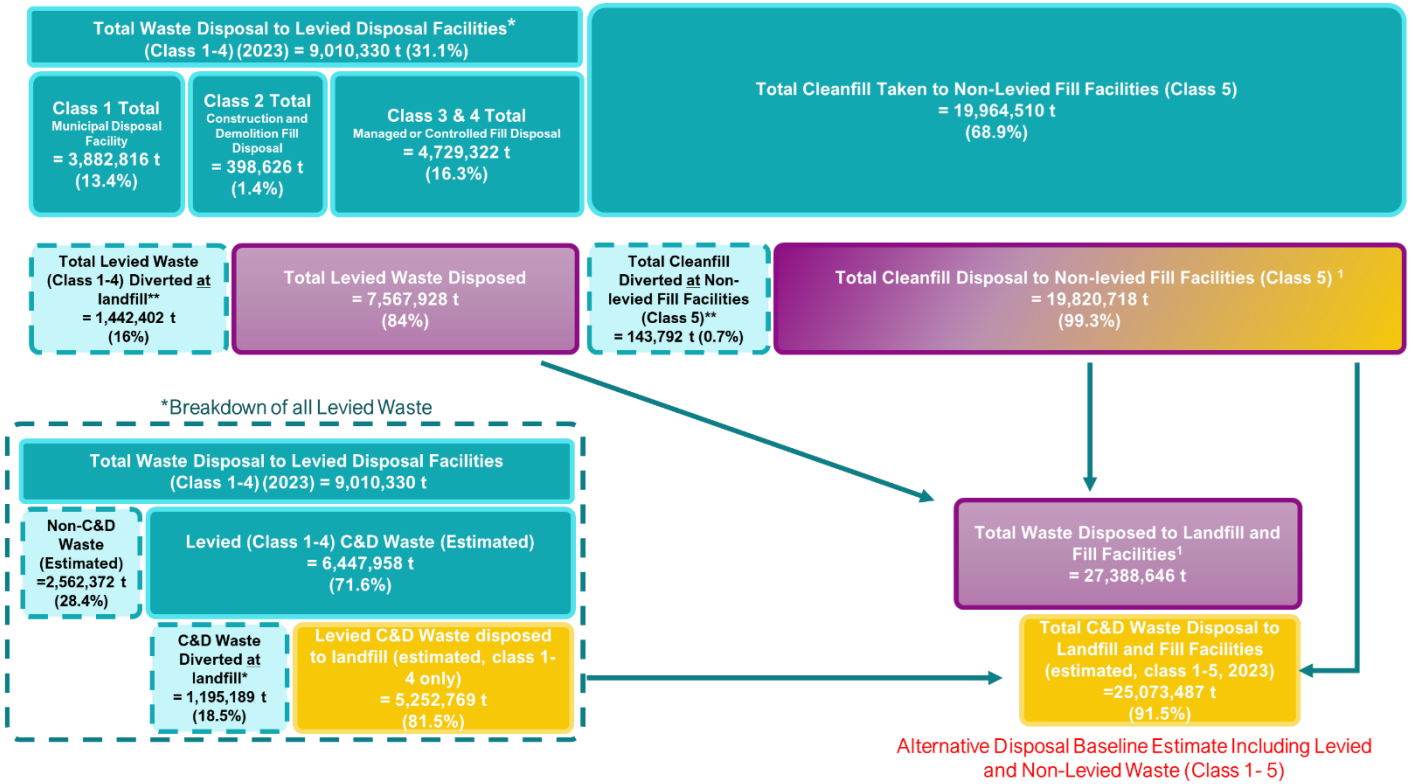
Table 8 shows that around 10% of total Class 1-4 disposed material is VENM, which is generally disposed to Class 5 disposal facilities. Another 10% is classified as contaminated rubble. Almost half of waste disposed to levied (Class 1-4) facilities is uncharacterised soil, which represents a significant opportunity for better understanding of soil wastes and potential diversion from disposal. Further work to understand the actual properties of this 2.4 million tonne/year waste stream will significantly improve our understanding of C&D waste disposed to Class 1-4 facilities, and hopefully in the future much of this material can be either classified as VENM or contaminated soil which will improve our understanding of the scale of soil contamination and help identify better treatment/diversion pathways.

Please refer to Appendix B for information on the compositional data ranges for rubble sub-category wastes for Class 2-4 landfills.

5.2.6 Breakdown of surplus soil disposed at Class 1-5 (Levied/Non-Levied) facilities

Non-levied waste sent to Class 5 landfills accounts for 19,965,000 tonnes of waste per year. This represents 69% of all waste received across all reporting disposal facilities. When non-levied waste is added to the compositional analysis presented, soil- and rubble-type wastes end up accounting for 87% of all disposed materials.

Assuming that Class 5 landfills receive waste entirely from C&D sources is a key uncertainty – other sources like mining are represented in Class 5 tonnages. However, there is little information to quantify the contribution of different sources to this significant waste disposal facility class. When we include disposed Class 5 waste to the disposed levied (Class 1-4) baseline, assuming Class 5 is classified as both waste and 100% derived from C&D, the baseline increases to 91.5% of all disposed C&D waste disposed at landfill, and the tonnages reported increase from 5,252,769 tonnes to 25,073,487 tonnes.



[1]Total waste disposal to levied disposal facilities (class 1-5) is used as the Benchmark for the estimated alternative C&D waste disposal Baseline

**Diversion at facilities is not representative of total waste diversion for the baseline year of 2023 as diversion can occur both directly from C&D sites or at resource recovery facilitates. Refer section 5.4 for more detail.

Figure 7: Alternative C&D Disposal Baseline Including Non-Levied Waste (Class 5) for baseline calender year (2023)

This additional 19,820,718 tonnes of additional cleanfill materials changes the material composition proportion drastically as well. Excluding the non-levied (Class 5) waste, previously the largest material proportion of C&D disposed waste were ‘Rubble – uncategorised soil’ (46.1.%), ‘Rubble- Topsoil without grass’ (12.1%), ‘Rubble VENM’ (9.5%), and ‘Timber’ (8.8%), by including Class 5 material in this composition VENM changes its relative proportion from 9.5% to 77% while all other materials are reduced by more than two thirds.

Without sufficient data on the activity source for materials disposed to Class 5 landfills, which consists of entirely VENM material, it is not recommended that this alternative baseline is used instead of the C&D baseline considering waste disposed to Class 1-4 levied facilities only. Consideration should be given to expanding the scope of the

baseline measure when better activity source data is available for Class 5 disposal facilities, and a better link of VENM tonnages reported back to vertical and horizontal infrastructure projects can be made.

5.3 C&D Waste Generation Analysis and Results

Due to the availability of activity type data and research/case studies to support an accurate assessment of WGFs across the key build types at the focus of this assessment, only the waste generated from the following sources was able to be evaluated:

Table 9: Summary of outputs of MFA assessment, resulting from data availability

Construction activities estimated	Alteration/ renovation activities estimated	Demolition activities estimated	Construction activities excluded due to data availability	Alteration/ renovation activities excluded due to data availability	Demolition activities excluded due to data availability
• Single-storey dwellings • 2-3 storey townhouse • Apartments • Public and commercial buildings	• None	• Single-storey dwellings • 2-3 storey townhouse	• Roads	• Single-storey dwellings • 2-3 storey townhouse • Apartments • Public and commercial buildings • Roads	• Apartments • Public and commercial buildings • Roads

Across the build types and activities investigated, the source-based MFA was able to account for 1,360,000 tonnes of C&D waste generated, with the largest material categories assessed being general ‘Rubble/concrete/cleanfill’, followed by ‘Other materials’, ‘Timber’, ‘Brick’, ‘Plasterboard’ and ‘Metals’ as can be seen in Table 10 below.

When comparing this number to vertical infrastructure common waste materials presented in Section 5.2.3 (1,360,000 tonnes vs 879,000 tonnes) it is expected that these numbers should be fairly similar due to the scope of waste generation in this study (all vertical infrastructure minus industrial buildings). However, this waste generated (1,360,000 tonnes) includes all diverted waste rather than waste received and disposed at landfill. The disposed generated waste estimated in this report (267,000 tonnes or 19.6% of total C&D waste generated) is much lower than the total waste generated due to potentially unrealistic diversion rates captured in this study (refer section 5.4.2 for more detail) which is accentuated by the comparison of total waste generated and disposed vertical infrastructure.

The prominent size of two generic categories (‘Rubble/concrete/cleanfill’ and ‘Other materials’) is a non-ideal outcome of the MFA process, however this method of categorising data became necessary after reviewing the available case studies for generating the WGFs – differences in the use of similar categories between different

studies, as well as differences in categorisation standards used to group materials, meant that generic groupings were the only way to avoid double-counting of materials when combining different sources.

In comparing the material compositional data for the waste generation and waste disposed, the difference in soil/rubble compositions is notable, with a much lower percentage seen in the generation analysis. This could be accounted for by multiple reasons, the first of which is the scope of generation captured in this study (all vertical build types) which lends itself to be less soil/rubble-centric. Secondly, many case studies and data sets utilised in this study had little to no reporting of soil waste generated during the construction, renovation and demolition stages.

For more information on MFA results for individual build types, please refer to Appendix D.

While the total levied C&D waste accounted for from a disposal perspective is 6.4 Mt, waste accounted for from a generation perspective was only estimated to be 1,360,000 tonnes. While these numbers were unlikely to match up due to the scope of this assessment, the disparity between these two numbers highlights gaps in data reporting which will need to be addressed in future C&D baseline estimates.

Table 10: C&D Waste Generation Data Estimate Summary (within the selected baseline calendar year - 2023)

Outputs	Description	Units	Single Storey Dwelling	2-3 Storey Town House	Apartments	Public & Commercial Buildings	Total	% of Total Waste Generated
			AVG	AVG	AVG	AVG	AVG	AVG
Total Waste Generated	Construction	t	107,500	43,400	11,100	165 700	327,800	24%
	Demolition	t	456,300	582,300	-	-	1,038,600	76%
Total waste generated split by material	Paper/cardboard	t	1,200	1,100	500	3,300	6,100	0.4%
	Plastics	t	700	500	100	1,200	2,500	0.2%
	Putrescible/Organics	t	0	0	0	0	0	0.0%
	Ferrous metal	t	10,700	8,000	400	5,100	24,200	1.8%
	Non-ferrous metal	t	1,000	500	0	0	1,500	0.1%
	Glass	t	0	0	0	0	0	0.0%
	Textiles	t	0	0	0	0	0	0.0%
	Timber	t	65,900	80,400	1,700	36,100	184,100	13.5%
	Soil	t	700	1,000	2,600	0	4,300	0.3%
	Brick	t	35,200	19,800	300	0	55,300	4.1%
	Plasterboard	t	7,100	3,400	1,200	18,900	30,600	2.2%

Outputs	Description	Units	Single Storey Dwelling	2-3 Storey Town House	Apartments	Public & Commercial Buildings	Total	% of Total Waste Generated
			AVG	AVG	AVG	AVG	AVG	AVG
	Rubble/concrete/cleanfill	t	332,800	324,100	4,800	56,400	718,100	52.7%
	Other materials	t	105,100	186,700	0	44,700	336,500	24.7%
	Total waste accounted for	t	560,400	625,500	11,600	165,700	1,363,200	100.0%
Diverted Material		t	465,100 (83%)	506,700 (81%)	5,800 (50%)	122,600 (74%)	1,100,200	80.4%

Table 10 shows the average quantities for each build type and material category. Additional weighted averages were calculated for this report based on data quality and average floor area of case studies, however these numbers were not significantly different enough from the overall average to warrant use, especially taking into consideration the additional assumptions needed to utilise these weighted averages. Refer Appendix D for these quantities.

5.4 C&D Waste Diversion Analysis and Results

Through the waste generation and diversion analysis, estimates of material diversion percentages at each end of the C&D waste lifecycle have been prepared.

For diversion associated with waste received at disposal facilities, diversion figures refer specifically to waste received at the facility that is not disposed to landfill, the material is instead reused (on or off-site) or reprocessed. These numbers occasionally include waste used for local cover, among other potential uses of material discussed in Section 4.2.5. These diversion figures do not include waste sent directly to resource recovery facilities nor waste recovered from transfer stations.

For the source-based waste generation data used in this study, diversion is estimated at the point of waste generation i.e. waste that is not sent directly to a disposal facility is considered “diverted”. This articulation of diversion differs from one used for disposal facilities in several important respects. Firstly, this diversion includes re-use or recycling of materials that are not first sent to disposal facilities. Second, this diversion does not account for materials sent to resource recovery facilities that are subsequently landfilled (e.g. due to contamination) or material sent to landfills that are subsequently recovered (e.g. used for cover). Not having visibility over the waste flows downstream of the source of origin is the key uncertainty in reviewing these numbers.

5.4.1 Disposal facility diversion data – based on reporting at facilities

Class 1-4 (levied) disposal facilities report on average between 10-25% diversion, which in total represents about 1,200,000 tonnes worth of diverted material annually. Diversion is more readily achieved at Class 2 landfills as well as Class 3&4 landfills than Class 1 landfills. This could be due to the differing types of material received (i.e. Class 1 putrescible wastes being harder to divert towards land cover etc.), but in total around 19% of material being sent to levied facilities is successfully diverted.

As discussed above and in Section 4, whether 19% of waste is actually being diverted from landfill rather than being used for onsite cover or incinerated, for example, is a challenge to determine – further work is needed in order to understand the actual waste outcomes from diversion.

It is important to note that the diversion split of C&D and non-C&D for Class 1 disposal facilities (34% C&D) has been assumed to be equivalent to the proportional split to total waste which is most likely not the case.

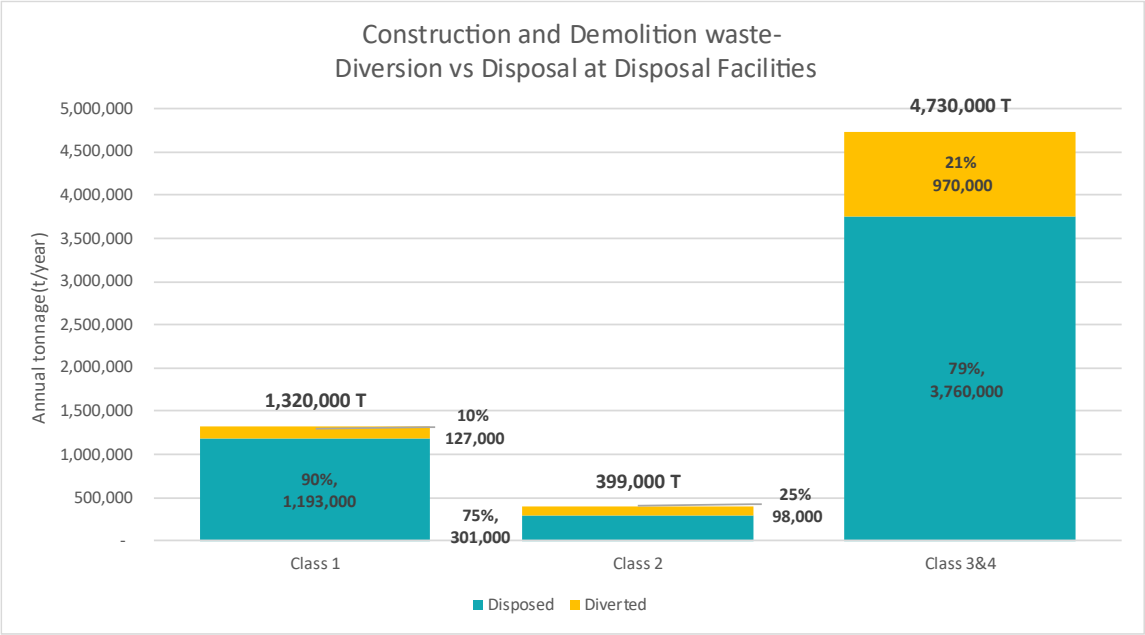


Figure 8: Breakdown of diversion percentages at Class 1-4 disposal facilities (within the selected baseline calendar year - 2023)

Under this assumption the split of Levied (Class 1-4) waste diversion is: 82.5% for C&D waste (1,195,000 tonnes) and 17.2% for Non-C&D waste (247,000 tonnes).

Referring to the compositional assessment in Section 5.2.2 there is potential for more diversion of waste considering only ‘timber’, ‘concrete’, ‘VENM’, ‘plasterboard’ and ‘organics’, but the most significant waste stream ‘uncharacterised soil’ needs to be understood further to determine an achievable diversion target for these facilities.

5.4.2 Generated waste diversion – based on MFA case study reporting

Diversion estimates from available waste generation data sources differ to the diversion percentages measured at landfill sites. Much of the difference is due to differences in measurement process.

Generation source diversion estimates may overstate their actual end-of-life diversion due to waste being ‘diverted’ to recovery facilities ultimately still being disposed to landfill. However, not all waste sent to landfill gets disposed to landfill either. The diversion numbers presented below should be considered with this in mind.

From the case studies evaluated in this MFA process, the following diversion rates are:

- Single story households:
  - Construction activity diversion – 75%
  - Demolition activity diversion – 84%
- 2-3 storey terraced units:
  - Construction activity diversion – 75%
  - Demolition activity diversion – 81%
- Apartments:
  - Construction activity diversion – 52-72%
- Commercial buildings:
  - Construction activity diversion – 74-100%

These numbers appear to be significant and suggest that more than three-quarters of all waste generated by C&D activities across all categories of vertical infrastructure is diverted towards re-use applications and material recovery facilities. We know that this is not the case because there are over 1,300,000 tonnes of waste generated just from the activity types we have been able to review in this study, and processing capacity of this scale in New Zealand, unfortunately, does not exist.

The likely cause of these high diversion numbers reported is that projects that record and report their waste generation and diversion have set targets for waste minimisation, perhaps connected to certification and/or accreditation. High-performing projects self-select into the case study pool, which inflates estimates of overall diversion achieved. Analysis of more projects, and analysis of representative projects (not just projects with diversion targets or projects seeking certification) is needed to improve estimates of actual diversion achieved across each build type.

5.5 Overall observations from bringing together generation, diversion and disposal data

The MFA modelling results highlight the significant impact of C&D activities on the waste disposal sector. The waste generation data suggests that waste from vertical infrastructure contributes large amounts of material that ends up in Class 1 and 2 landfills primarily, but also that there is potential for significant diversion of these materials in projects where C&D waste diversion is tracked and prioritised. However, the disposal data shows that the vast majority of C&D waste is difficult to connect back to discrete C&D activities that can be tracked with available data, and that more work is needed to fully understand this sector.

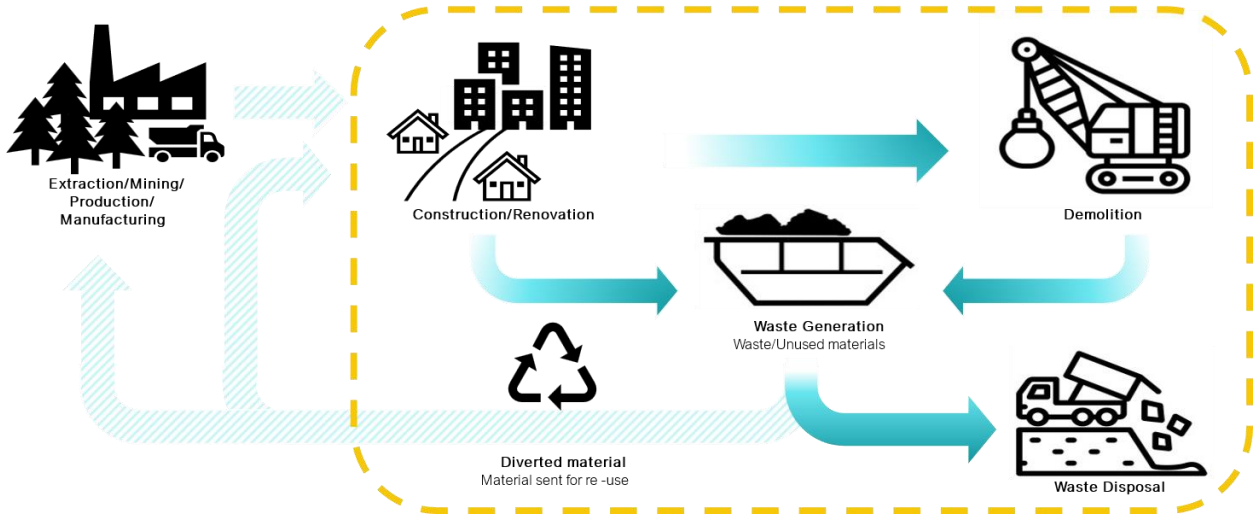
While this serves as an initial estimate of the C&D waste baseline, it represents a solid foundation for future enhancements. Further work is necessary to refine and incorporate more granular detail and accuracy, building on the robust groundwork already established. The key insights from the generation and diversion modelling results, some of which relate to the gaps and data barriers discussed earlier in this report, are summarised below:

- **Construction activity data is available across some types of vertical infrastructure** – existing consenting and developing construction reporting frameworks support access to data and use of data in understanding parts of the construction sector and its waste impacts. However, for the most part, data on site-specific waste outcomes is only available via voluntary reporting frameworks, which introduces the potential for preferential representation of high-performing projects.
- **Demolition activity is understood for only some types of vertical infrastructure** – data linking demolition activities and C&D waste generation is at early stages, and only exists for more common build types with reporting becoming more common, but contractor/developer-driven. Very little information on how demolition data is split across build types in the baseline year is accessible, creating challenges in accurately estimating demolition waste generated.
- **Renovation activity is not well understood** – apart from anecdotal evidence, renovation waste generation data is scarcely available in New Zealand. Much of this activity bypasses consenting processes, and has been much less of a focus for historic domestic waste generation case studies.
- **Diversion needs more effort to understand across the resource recovery sector** - diversion of materials at site data is largely unavailable with only sites that achieve or aim to achieve high diversion rates being recorded. Diversion recorded at disposal facilities misses the impact of upstream reuse and diversion to reprocessing. The resource recovery sector needs to be investigated in more detail from generation to final material end use.
- **Horizontal infrastructure is a significant unknown, and deserves further investigation** – as well as C&D waste from roads which this analysis was unable to evaluate, waste from other kinds of transport and utilities infrastructure projects like rail, power, gas, water etc. is expected to contribute significantly in filling the gap between the generation and disposal numbers presented in this report.
- **Data is out there, but not centrally available** – different datasets exist for waste generation and disposal activities, owned by a variety of government agencies that oversee different construction and infrastructure development portfolios, but these are not currently integrated with disposal facility data overseen by MfE. Private datasets across construction, renovation, demolition and resource recovery industries are developing, but not readily available at a regional or national level to help inform policy.
- **Specifications and requirements could be more specific** – across tracking and reporting frameworks and waste categorisation systems, data availability and usefulness is affected by interpretations of definitions and requirements. Efforts to understand the differences across concrete, plasterboard, tiles and cleanfill materials, and also in de-mystifying “diversion”, and the introduction of new reporting categories and requirements by MfE will help to improve this information over time.

6 Recommendations – Baseline Study and C&D Waste Management

A series of recommendations have been developed from baseline modelling, case study data review and engagement with C&D industry and experts throughout this project. These recommendations have been broken down into generation, diversion and disposal.

Key recommendations that are likely to provide ongoing regular data improvements back to MfE have been written in bold.



It should be noted that the Ministry is currently phasing in new C&D disposal facility operator reporting requirements, via the Waste Minimisation (Information Requirements) regulations (2021). A key change is the requirement for activity source reporting for waste to all disposal facilities and transfer stations. As mentioned in Section 5, this data will improve the accuracy of waste activity – including C&D waste – reporting within the next few years.

Additionally, at the time of this report's issue, the Ministry is reviewing the waste classifications and auditing protocols in the Solid Waste Analysis Protocol (SWAP), including updating protocols for Class 2-5 facilities. These changes are intended to improve the waste auditing system for better C&D waste stream data and evidence.

There are opportunities for future policy and/or regulation for C&D waste reduction, management, and data collection outcomes, with the Waste Minimisation Act (2008), the Building Act (2004) and the Resource Management Act (1991) of most relevance. This could lead to an established system for continuous C&D waste data reporting and tracking, and support the move away from point-in-time estimate reporting. This report should be used as a basis for future policy work to explore these opportunities.

6.1 Waste Generation

This analysis had limited success in tracking C&D waste associated with infrastructure and other soil-generating activities back to its sources. Overall observations and recommendations for future generation assessments are given below, followed by specific recommendations for construction, renovation, and demolition assessments.

A key observation is that engagement with the waste industry needs to be more diverse, as industry representatives who wanted to take part in this study were more likely to have higher-than-average diversion rates compared to industry standards. Anecdotally engagement showed there are large differences in waste outcomes at sites measuring waste generation/diversion performance vs sites that are not measuring performance. Most case studies were conducted in Auckland, which may skew the results as other regions lack access to diversion services.

Further efforts are required to increase the number and variety of waste generation case studies for assessing waste generation and diversion across various build types. This is particularly important for projects with and without waste minimisation and diversion targets. Recommended improvements to C&D waste disposal data reporting are:

Recommendation	Description	Responsible
Improve and diversify case studies.	Increase and diversify waste generation case studies by using different build types and engaging with industry that are not already minimising waste. Consider consulting waste sector experts and construction firms experienced in large-scale C&D projects to access more private data sets.	Industry groups/Ministry for the Environment
Consider additional datasets.	Future studies should explore using non-material or site-based datasets, like trade and transportation records for waste management, to enhance analysis accuracy and support efforts to fully measure material circularity. Collaborate with private organisations who manage bulk datasets, such as NZGBC and ISCA, to share data and inform future baseline assessments. This could include creating information sharing agreements between private and public sector organisations.	Industry groups/ construction and demolition specialists Ministry for the Environment
Explore the use of digital apps for reporting.	Digital apps for reporting of waste skip/truck content could be deployed with minimal investment.	Waste/ resource recovery operators, supported by central government funding where applicable
Implement material passports to promote reuse.	A material passport is a digital document that provides detailed information about the materials used in a building. It includes data on the material's origin, composition, and potential for recycling or reuse. This concept supports the circular economy by making it easier to track and manage materials throughout their lifecycle, reducing waste and promoting sustainability. Build As Material Banks (BAMB) construction models and other similar frameworks can enable the use of material passports or even achieve similar outcome to material passports for assets above a certain size/design complexity.	Central government (multiple agencies)

Recommendation	Description	Responsible
Embed material tracking and diversion standards into construction activities	**Adopt international practices to embed material tracking and diversion standards in construction activities. For example:** • **Issue building consents with reference to material and waste estimations at design phase.** • **Require architects and engineers to provide materials breakdowns at the consent stage, for building renovation and demolition, so that data is recorded throughout the property's lifetime.**	**Local government**
Implement mandatory site waste management plans consistently across New Zealand	**Implement mandatory site waste management plans consistently across New Zealand and amend requirements to include onsite waste generation records and supplementary data such as weights/volumes and photos of skip bin/truckloads of waste.**	**Central/ Local government**
Expand project data collection framework	**Expand the data collection framework used for this project for use by external agencies to develop comprehensive datasets and enable tracking of C&D waste data over time, and include additional government agencies with involvement in other vertical and horizontal infrastructure build projects.**	**Ministry for the Environment**

6.1.1 Construction Waste

Construction data was the most accessible from government agencies and private sector organisations involved in this project, as well as from the literature review conducted. Recommendations address data issues and insights from industry engagement workshops. Some recommendations also involve targeted external auditing and measurement opportunities, while others apply to system-level interventions that may be more challenging to implement but offer significantly improved outcomes.

Recommendation	Description	Responsible
Consider how future building methods will impact data	Changes to construction methods – such as prefabrication – will have an impact on waste sources, with less on-site waste and more from upstream manufacturing. Future assessments should include waste from these alternative methods to expand waste data baselines and better align generation and disposal estimates, aiding in measuring the circularity of New Zealand's construction sector.	Ministry for the Environment

Recommendation	Description	Responsible
Use estimates of building waste from large-scale projects and invest material analysis	Utilise estimates of building waste generated through large-scale projects and invest in further work to generate representative material breakdowns for typical built asset types to support consenting for demolition, and planning processes for managing C&D waste materials.	Industry groups / construction contractors
Improve the assessment of excavated materials from infrastructure projects	Assessment of excavated material on typical construction projects should be undertaken, comparing different building types to support consistent estimates of excavated soil.	Industry groups / construction contractors
Investigate waste generation throughout project lifecycle	C&D waste generation changes (both in terms of tonnages and composition) over the different stages of a construction, renovation or demolition project. For example, site preparations will produce the most soil and concrete waste, while physical asset construction or demolition will result in higher waste quantities for building materials. Further investigation and reporting of waste generation trends over the course of projects could be investigated via existing reporting and certification frameworks, to assist in predicting more accurate waste flows and diversion opportunities present over different phases of significant projects.	Industry groups / construction contractors

6.1.2 Demolition Waste

The analysis found that some demolition data was available for specific build types, but overall data was lacking (refer Section 5). With demolition representing up to 90% of total annual waste generated for some build types evaluated in this assessment, better understanding demolition of all build types is a priority for an updated generation baseline. Some of these proposed actions cover targeted external auditing and measurement opportunities; while others relate to system-level interventions which would be more difficult but could provide far improved outcomes. Key recommendations are below:

Recommendation	Description	Responsible
Leverage NZDAA or other professional bodies to engage with demolition contractors	Demolition contractors can contribute and improve modelling outcomes. Engagement with demolition contractors and industry leaders in New Zealand through NZDAA or more targeted engagement is an opportunity to capture high-quality material data.	NZDAA/ Ministry for the Environment

Recommendation	Description	Responsible
Consider ways of collecting demolition waste data through procurement mechanisms, future regulatory controls or reporting requirements	**Demolition activities have less regulatory oversight or permitting requirements than construction, especially below certain project sizes, so there is ample data not being collected under standard consenting and reporting frameworks that could contribute to generation modelling. Local or central government could consider ways of collecting demolition waste data through procurement mechanisms, or when considering any future regulatory controls or reporting requirements for demolition.**	**Local / Central government**

6.2 Waste Diversion

As mentioned in Section 5, the diversion baseline was the most difficult to quantify fully given the various opportunities for diversion across the lifecycle of a C&D project, and the different meanings of 'diversion' at different points in the material system (described in Section 4).

Key recommendations for collecting more representative diversion data are below:

Recommendation		Responsible
Evaluate access to diversion infrastructure across regions	Engagement with industry participants suggests there is a need to investigate regional trends and differences in waste generation, diversion and disposal practices. This will help to gain insights into where diversion from landfill is occurring most and where support/infrastructure is required to improve material diversion and access to resource recovery options across regions.	Ministry for the Environment
Establish a waste and resource recovery licensing scheme	**Access to resource recovery facility material flow data, including material tonnages received and recovery rates, needs to be established. This could be made available if the central and or territorial authorities impose regulation for a waste and resource recovery facilities (facility licencing scheme).**	**Ministry for the Environment**

6.3 Waste Disposal

The disposal data baseline in this report is the most comprehensive currently available for C&D waste in New Zealand. Sections 4 and 5 identify several data gaps and assumptions that impact the presented baseline. Key actions and recommendations to address these issues and enhance the disposal baseline in future studies are summarised below.

6.3.1 Data Reporting

The Online Waste Levy System (OWLS) and Solid Waste Analysis Protocol (SWAP) reporting is the most comprehensive source of C&D waste disposal data in New Zealand. However, there are still areas for improvement, and the following recommendations will help to better define both the understanding of tonnages and compositional breakdowns.

In addition to OWLS and SWAP data, engagement with territorial authorities, construction contractors, housing developers, researchers, consultants, C&D resource recovery and waste operators throughout the project helped shape the following recommendations.

Recommendation	Description	Responsible
Additional auditing of OWL and SWAP reporting to make sure data is high quality	**This analysis found possible differences in how measurements are reported and noted that rules for reporting waste diversion are not applied consistently at disposal sites. Nationwide auditing could make data more accurate.**	**Ministry for the Environment / Disposal facility operators**
Collect more tonnage data via weighbridges and improve methodology	Volume to weight ratio conversions and other variations in site-based disposal facility and transfer station tonnage reporting methodologies affect the accuracy of reported waste tonnages. Collecting more tonnage data via weighbridges, and support to make onsite methods used to calculate and report waste more consistent, is needed to improve data accuracy and transparency.	Ministry for the Environment / Disposal facility operators
Use improved reporting to evaluate different materials within overall waste tonnages	Analysis for this project has for the most part focused on overall tonnages as this was the best quality data. Future comparisons should assess different material waste streams for generation, diversion and disposal.	Ministry for the Environment
Utilise smart cameras and AI	Visual monitoring technology such as smart cameras/AI for data capture and monitoring has the potential to enhance detailed reporting of waste at key aggregation points.	Waste/ resource recovery operators, supported by central government funding where applicable

6.3.2 C&D waste disposal infrastructure

Final recommendations on the topic of C&D disposal infrastructure access and alternative disposal pathways (i.e. illegal dumping) are presented below.

Recommendation	Description	Responsible
Review access to Class 2 sites, and impacts on waste transportation requirements	Access to Class 2 facilities varies greatly across different regions, which affects the final disposal pathway for C&D materials. This likely leads to variance in C&D diversion and proportions of disposal between Class 1, Class 2 and Class 3 and 4 facilities. Opportunities for waste received at Class 1 landfills and 3&4 disposal facilities to be disposed at Class 2 fills should be investigated. Flows of C&D waste across regional boundaries is challenging to assess as the source of waste material data (beyond activity source classification data) is not currently recorded in OWLS data reporting therefore it is unclear where the waste has come from. If this challenge was resolved, additional thought could be needed into how material movement across regional boundaries is captured.	Ministry for the Environment
Investigate illegal dumping of C&D waste	Illegal dumping and disposal of C&D waste materials other than at Class 1-5 disposal facilities is not captured in this assessment, as there is such little data on this alternative disposal pathway for C&D materials. The scope and severity of these practices, particularly with regard to C&D materials, is unknown but should be considered an area where more evidence and understanding of the scale of the problem is required.	Ministry for the Environment

7 Conclusions

This study aimed to provide a revised assessment of Construction and Demolition (C&D) volumes generated, diverted and disposed to Class 1-5 disposal facilities in New Zealand, using new reported data from levied and non-levied facilities to update previous baseline estimates of the contribution of C&D waste to total waste disposed. Previous studies had estimated this contribution at around 50% of waste disposed to Class 1 landfills only, but had not considered other classes of disposal facilities that also received C&D waste among other waste streams. In this study, new reported data on composition of non-Class 1 facilities and diversion rates at landfill were used to develop the findings of previous studies and present a revised baseline estimate of C&D waste disposal.

The study also assessed whether this C&D disposal data could be linked back to common sources of C&D waste including construction, renovation and demolition activities across key infrastructure types. This was performed following a Material Flow Analysis (MFA) methodology, combining estimates of waste generation and diversion for different types of C&D activities with independent data on the number of C&D activities across different categories of both vertical and horizontal infrastructure.

Using new data reported by OWLS and SWAP data reporting processes, an updated baseline of waste disposal in New Zealand was produced, highlighting the large contribution of C&D wastes (particularly cleanfill/soil wastes) towards the total disposal numbers reported. A baseline of generation and diversion was not able to be presented, due to data availability restrictions, so this remains an unknown for future work programmes to address.

This assessment has highlighted that current C&D disposal tonnages are more significant than previously estimated - the contribution of C&D activities towards total tonnages processed in our waste sector is even higher than previous estimates, with C&D waste contributing 70% of all waste disposed to levied facilities. This means that C&D waste tracking and waste prevention/diversion measures are more critical than previously understood. Non-levied facilities (Class 5 cleanfill disposal facilities) were not included in the revised baseline for a number of factors, including lower data accuracy and lower confidence in waste activity sources. Across levied and non-levied facilities, soil wastes represented 87% of all waste disposed, with the vast majority of this being cleanfill. This is the first time a totalised estimate of soil waste to disposal facilities has been produced, and the magnitude of estimated soil disposal (from C&D and non-C&D sources) is a surprising outcome of this study.

This report has developed a number of opportunities for future works to explore in order to address the key gaps and unknowns discussed. Key opportunities are identified in the table below:

Recommendation	Description	Responsible
Additional auditing of OWL and SWAP reporting to make sure data is high quality	This analysis found possible differences in how measurements are reported and noted that rules for reporting waste diversion aren't applied consistently at disposal sites. Nationwide auditing could make data more accurate.	Ministry for the Environment / Disposal facility operators

Recommendation	Description	Responsible
Embed material tracking and diversion standards into construction activities	Adopt international practices to embed material tracking and diversion standards in construction activities. For example: • Issue building consents with reference to material and waste estimations at design phase. • Require architects and engineers to provide materials breakdowns at the consent stage, for building renovation and demolition, so that data is recorded throughout the property's lifetime.	Local government
Expand project data collection framework	Expand the data collection framework used for this project for use by external agencies to develop comprehensive datasets and enable tracking of C&D waste data over time, and include additional government agencies with involvement in other vertical and horizontal infrastructure build projects.	Ministry for the Environment
Implement mandatory site waste management plans consistently across New Zealand	Implement mandatory site waste management plans consistently across New Zealand and amend requirements to include onsite waste generation records and supplementary data such as weights/volumes and photos of skip bin/truckloads of waste.	Local government
Consider ways of collecting demolition waste data through procurement mechanisms, future regulatory controls or reporting requirements	Demolition activities have less regulatory oversight or permitting requirements than construction, especially below certain project sizes, so there is lots of data not being collected under standard consenting and reporting frameworks that could contribute to generation modelling. Local or central government could consider ways of collecting demolition waste data through procurement mechanisms, or when considering any future regulatory controls or reporting requirements for demolition.	Local/ Central government
Establish a waste and resource recovery licensing scheme	Access to resource recovery facility material flow data, including material tonnages received and recovery rates, needs to be established. This could be made available if the central and or local governments impose regulation for a waste and resource recovery facilities (facility licencing scheme).	Ministry for the Environment

Future assessments of our national C&D waste baseline aided by the results of improvements currently underway to data reporting requirements and investigation of C&D activity source data, and implementation of the actions and opportunities presented in this report, will continue to improve the transparency of the C&D waste system. It is recommended that this baseline is revisited within two to three years, when more data will be available via existing data improvement programmes to ratify and confirm the results of this report based on newly available data. Increasing the accuracy and transparency of the C&D waste baseline over time will highlight opportunities for future action and data improvement, and by proxy lead to better waste reduction and promote beneficial reuse and recycling outcomes.

A

Appendix A – Data Source Quality Assessment

	0	1	2	3
Recency- How recent is the dataset	data from 10+ years ago	5-10 years	between 2-5 years	within the last 2 years
Sector Representation- How well does the data represent the sector?	Estimated single data point	Single data points	Small data sample collated	Multiple data points, analyzed to produce data
Locality - How relevant is the data in a NZ nationwide	International	Australia, Canada, UK, USA	Region specific	National
Overall Reliability - Assessment of overall quality of dataset	Generic data with multiple assumptions	Questionable Source/ not necessarily accurate/Interpolation needed	Reliably sourced and relevant data not necessarily accurate	Reliable, relevant and accurately weighted data

Table 11: Data summary for build-type C&D waste generation analysis, including activity type and waste generation data

Build type	Activity type	Annual activity data available	Waste generation factor data sources	No. of projects represented	Material Split Data sources	Diversion Data sources	Overall data availability assessment
Single Story House	Construction	Yes	3	195	2 Sources	1 Source	Multiple case studies with alignment between activity and generation data
	Demolition	Yes	2	194	1 Source	1 Source	Multiple case studies, but uncertain material split/diversion data
	Renovation	Yes	0	0	0 Sources	0 Sources	No applicable WGF available.
2-3 story Townhouse	Construction	Yes	3	189	2 Sources	1 Source	Multiple case studies with alignment between activity type and generation data
	Demolition	Yes	1	14	1 Source	1 Source	Single sources for most variables; low case study count
	Renovation	Yes	0	0	0 Sources	0 Sources	No applicable WGF available.
Apartments	Construction	Yes	4 (three international)	27	4 Sources	2 Sources	Multiple case studies with alignment between activity type and generation data
	Demolition	No	1	2	1 Source	1 Source	Lack of activity data, and limited sources for composition and diversion achieved.
	Renovation	No	0	0	0 Sources	0 Sources	No applicable WGF available, and no activity type data available.
Commercial	Construction	Yes	6 (one international)	90	5 Sources	1 Source	Multiple case studies with alignment between activity type and generation data
	Demolition	No	0	0	0 Source	0 Source	No applicable WGF available, and no activity type data available.
	Renovation	No	0	0	0 Sources	0 Sources	No applicable WGF available, and no activity type data available.
Roads	Construction	Yes	1	4	1 Sources	1 Source	Good activity type data. Case studies available, but enormous disparities in WGFs reported.
	Demolition	No	0	0	0 Sources	0 Sources	No applicable WGF available, and no activity type data available.
	Renovation	Yes	0	0	0 Sources	0 Sources	Good activity type data. No applicable WGF available.

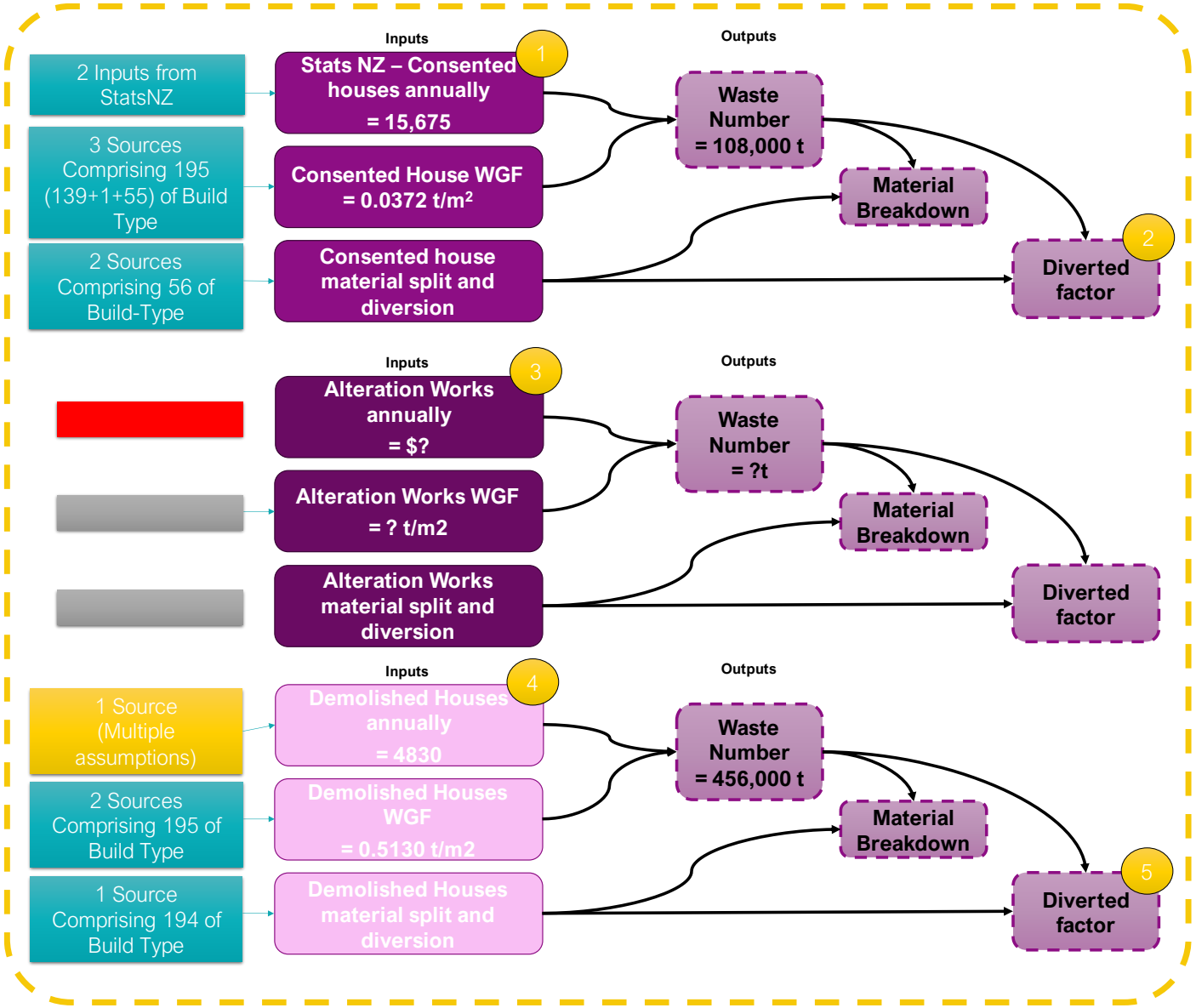
B

Appendix B – Summary of Class 2-4 Disposal Facility Composition Data - Unpublished

Unpublished MfE Data on Class 2-4 composition data – summary							
	Landfill class	**Class 2**			**Class 3&4**		
	No. of sources	Three surveys; 5,600 t			Five surveys; 3,800 t		
		Min	Average	Max	Min	Average	Max
Rubble	Sorted rubble	0.0%	0.2%	0.6%	0.0%	0.0%	0.0%
Rubble	Unsorted/mixed rubble	0.0%	0.7%	1.5%	0.0%	0.0%	0.0%
Rubble	Masonry blocks, bricks and pavers	0.0%	0.0%	0.0%	0.0%	0.2%	1.1%
Rubble	Ceramics (bricks and tiles)	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Rubble	Clay pipes	0.0%	0.0%	0.0%	0.0%	0.2%	0.6%
Rubble	Concrete	0.0%	1.0%	3.0%	1.1%	2.4%	4.1%
Rubble	Asphalt	0.0%	0.0%	0.0%	3.0%	4.3%	5.8%
Rubble	Peat	0.0%	0.0%	0.0%	0.0%	0.2%	0.8%
Rubble	Topsoil	0.0%	0.8%	1.4%	0.0%	0.0%	0.0%
Rubble	Topsoil (without grass)	0.0%	0.0%	0.0%	0.1%	16.6%	42.9%
Rubble	Topsoil (with grass)	0.0%	0.0%	0.0%	0.1%	3.6%	7.1%
Rubble	Plasterboard	3.8%	4.9%	6.4%	0.0%	0.0%	0.0%
Rubble	VENM	0.0%	1.9%	3.7%	0.0%	11.7%	21.2%
Rubble	Uncharacterised soil (may be contaminated)	0.4%	13.1%	33.6%	30.0%	59.2%	73.4%
Rubble	Contaminated soil	0.0%	0.3%	0.6%	0.0%	0.0%	0.0%

C

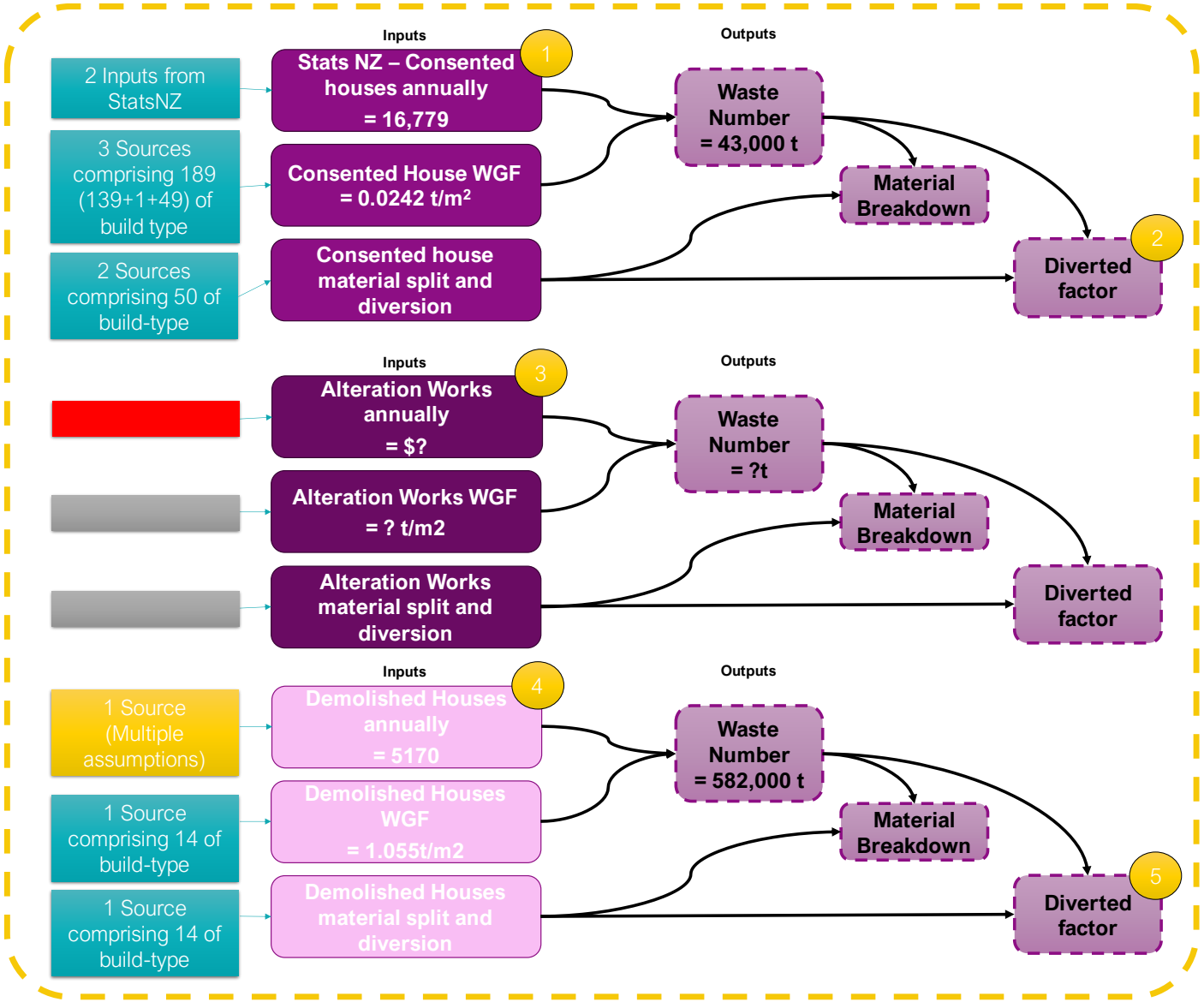
Appendix C – Generation Baseline Material Flow Analysis Results



Single Storey Housing Developments – Waste generation MFA results.

Key Assumptions and notes in Yellow:

1. Consented houses need to be aggregated with Code of compliance inspection data to get realistic numbers
2. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste
3. A value for all consented and non-consented alterations and additions has been obtained in $ value for all dwellings however split is unknown
4. Dwelling Demolition number assumed to be 10,000. Split between townhouse and single story is proportional to consent
5. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste



2-3 Story Developments – Waste generation MFA results

Key Assumptions and notes in Yellow:

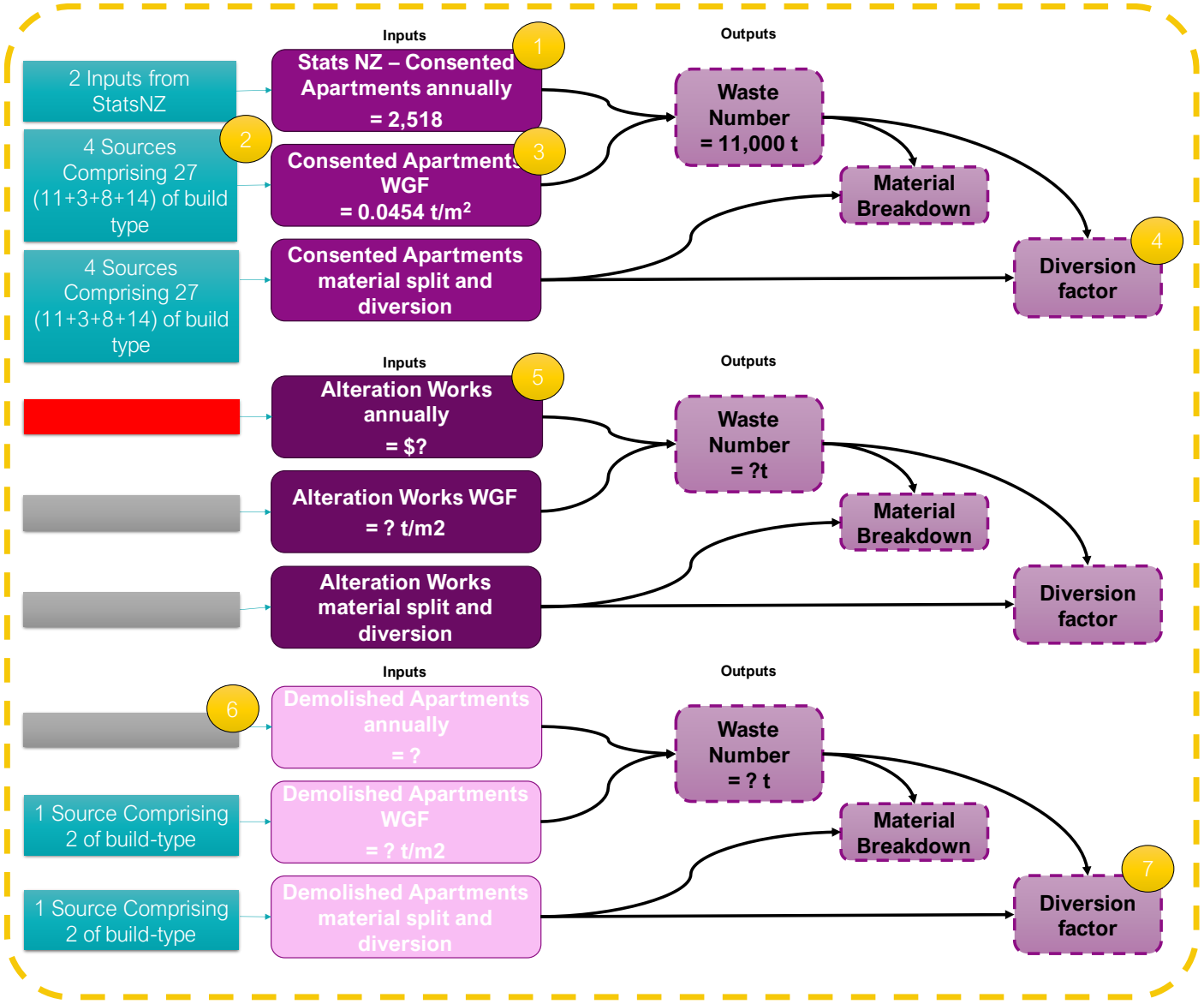
1. Consented houses need to be aggregated with Code of compliance inspection data to get realistic numbers

2. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste

3. A value for all consented and non-consented alterations and additions has been obtained in $ value for all dwellings however split is unknown

4. Dwelling Demolition number assumed to be 10,000. Split between townhouse and single story is proportional to consent.

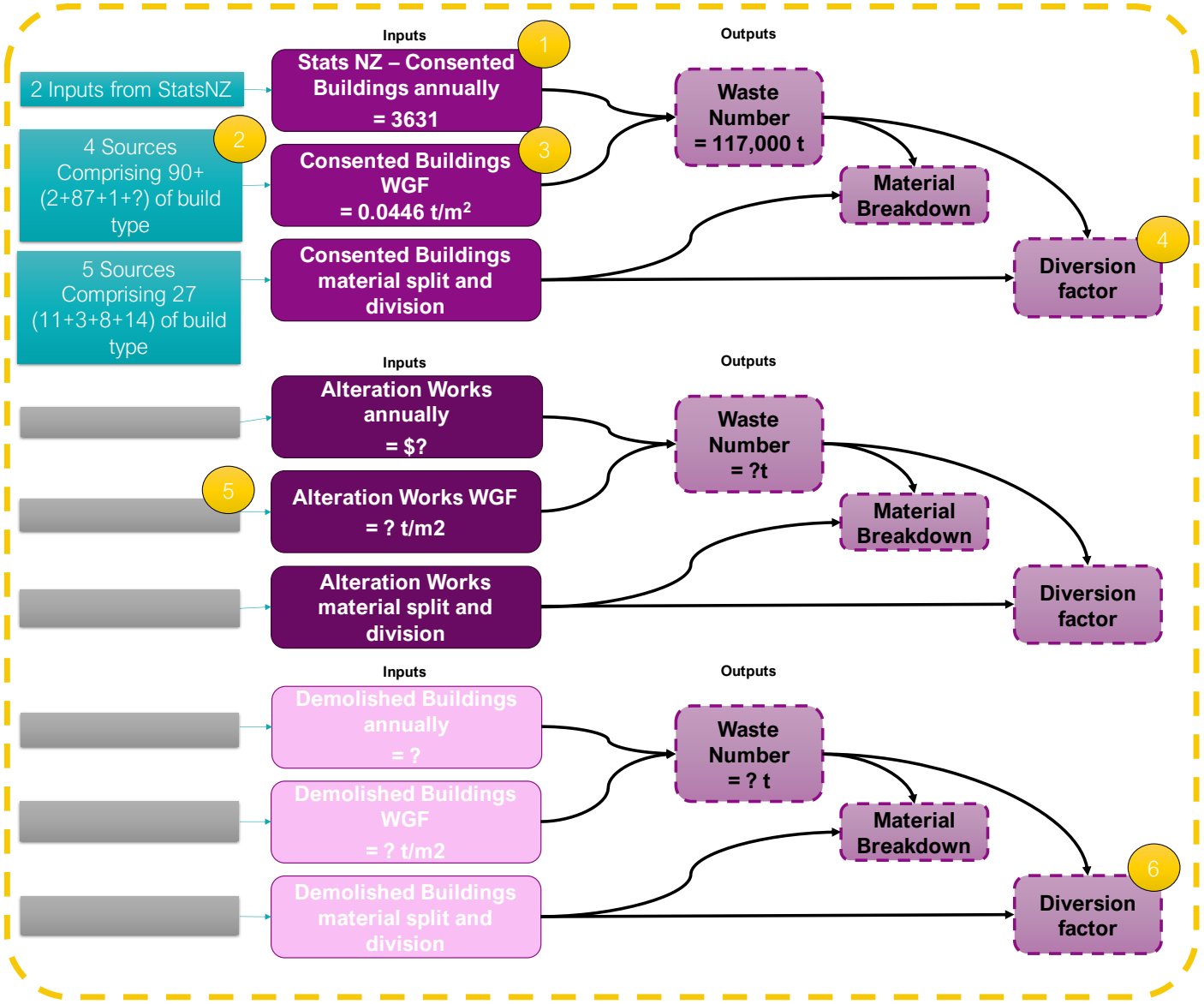
5. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste



Apartment Developments – Waste generation MFA results

Key Assumptions and notes in Yellow:

1. Consented houses need to be aggregated with Code of compliance inspection data to get realistic numbers
2. 3 of the 4 sources are international reports, this has been considered in the Data Weighting. Assumed these studies are applicable to NZ
3. WGF is per unit rather than per complex
4. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste
5. A value for all consented and non-consented alterations and additions has been obtained in $ value for all dwellings however split is unknown
6. Assuming this number is reasonably low with most demolitions being single/2-3 story townhouses
7. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a

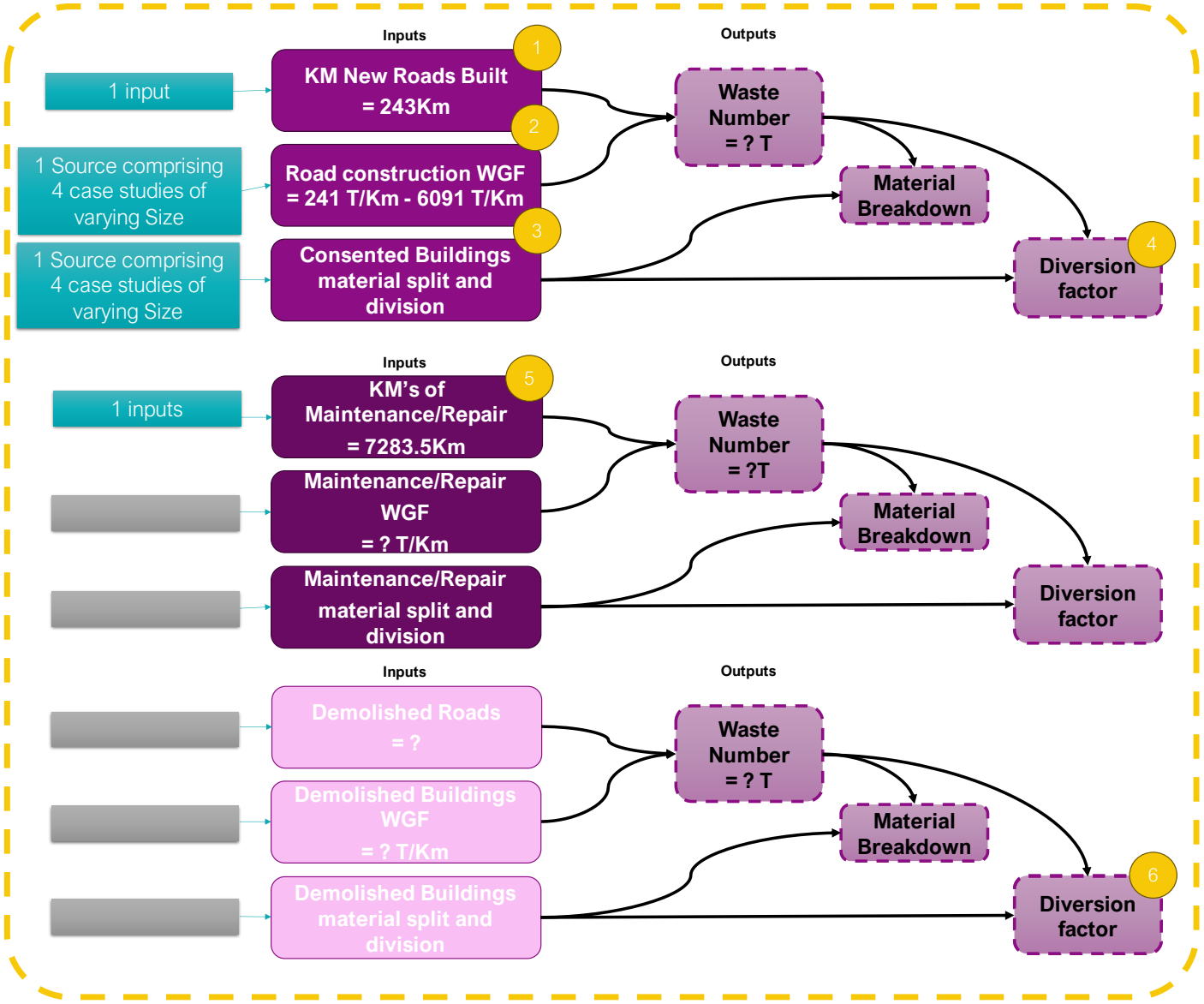


Commercial Building Developments – Waste generation MFA results

Key Assumptions and notes in Yellow:

1. Consented Buildings need to be aggregated with Code of compliance inspection data to get realistic numbers
2. 1 of the 4 sources are international reports, this has been considered in the Data Weighting. Assumed these studies are applicable to NZ
3. WGF is Applicable to all sub-build types included in this
4. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste
5. Some data regarding Internal fit-out of commercial buildings has been obtained and can produce a WGF however is not in terms of $
6. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste

Commercial Building Developments – Waste generation MFA results



Roading Developments – Waste generation MFA results

Key Assumptions and notes in Yellow:

13. Comprised of both Local and State highway roads.
14. Bridges not able to be included due to lack of case studies/WGF sources
15. Data is wide-ranging and only for SHW Projects
16. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste
17. Comprised of both Local and State highway roads. Includes Pavement rehabilitation, Resurfacing, Road reconstruction, and Seal extension
18. There is most likely a bias in this number based on the fact that studies done on waste coming from building sites could lead to a reduction in waste

Roading Developments – Waste generation MFA results

Key Assumptions and notes in Yellow:

19. Comprised of both Local and State highway

D

Appendix D – Summary of generation source compositional data by build type

Table 12ry of generation source MFA results; using best material classification available (generic rubble/concrete/cleanfill)

Outputs	Description	Units	Single Storey Dwelling			2-3 Storey Town House			Apartments			Public & Commercial Building		
			Weighted AVG (data quality)	AVG	Weighted AVG (floor area)	Weighted AVG (data quality)	AVG	Weighted AVG (floor area)	Weighted AVG (data quality)	AVG	Weighted AVG (floor area)	Weighted AVG (data quality)	AVG	Weighted AVG (floor area)
Total Waste Generated	Construction	t	106,245	107,517	81,428	42,494	43,373	69,020	11,567	11,166	11,646	150,948	165,713	390,096
	Demolition	t	456,331	456,331	456,331	582,279	582,279	582,279						
Total waste split by material	Paper/card	t	1,231	1,245	767	550	1,083	799	189	515	137	1,194	3,276	0
	Plastics	t	693	702	17	567	545	51	109	112	143	1,300	1,190	6,734
	Putrecibles/Organics	t	0	0	0	0	0	0	0	0	0	0	0	0
	Ferrous metal	t	10,687	10,722	11,608	8,137	7,965	9,641	302	407	107	3,693	5,111	14,985
	Non-ferrous metal	t	857	968	750	403	483	385	0	0	0	0	0	0
	Glass	t	31	31	31	6	36	0	0	0	0	0	0	0
	Textiles	t	0	0	0	0	0	0	0	0	0	0	0	0
	Timber	t	65,691	65,895	64,676	79,989	80,388	76,184	1,349	1,684	694	31,655	36,147	82,123
	Soil	t	709	709	709	1,017	1,017	1,017	601	2,608	2,433	0	0	0
	Brick	t	35,205	35,205	35,205	19,838	19,838	19,838	39	335	156	0	0	0
	Plasterboard	t	6,973	7,057	1,594	3,600	3,417	4,037	1,000	1,212	275	11,909	18,931	26,014
	Rubble/concrete/cleanfill	t	332,080	332,841	307,770	323,447	324,140	339,540	5,027	4,824	5,193	31,561	56,358	47,149
	Other materials	t	104,939	105,103	111,151	186,887	186,650	199,516	3,007	0	2,502	69,436	44,743	214,553
	Total waste accounted for	t	559,096	560,478	534,278	624,441	625,562	651,008	11,623	11,697	11,640	150,748	165,756	391,558