Residential Construction Waste Analysis

Prepared for BC Housing by Light House

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Introduction

In Canada, construction and demolition (C&D) waste is one of the largest contributors to municipal solid waste. Statistics Canada estimates that about 4 million tonnes of C&D waste were generated in Canada in 2010, and this number could be higher depending on how C&D waste is tracked[1]. The waste leads to significant costs to governments, businesses and the environment. Canadian municipalities spent more than $3.2 billion on waste management in 2012[2] with the added negative impact on human health and wellness due to environmental contamination and greenhouse gas emissions. In addition to the cost of managing the waste, there is the avoidable cost of the excess and unrecovered materials to the project owners as well.

According to a study commissioned for Environment Canada, only 16% of CRD waste was reused or recycled (653,000 tonnes), the remaining 84% was disposed (3,353,000 tonnes), mainly in landfills (see Table 1). [3]

Table 1: Sources of CRD waste

Building stage	Residential	Non-residential	Total CRD waste
Construction	15% (366,600 tonnes)	5% (78,100 tonnes)	444,700 tonnes (11%)
Renovation	57% (1,393,100 tonnes)	32% (500,100 tonnes)	1,893,200 tonnes (47%)
Demolition	28% (684,300 tonnes)	63% (984,600 tonnes)	1,668,900 tonnes (42%)
Total amount of CRD waste	**2,443,900 tonnes (61%)**	**1,562,800 tonnes (39%)**	**~4 million tonnes (100%)**

Residential construction, renovation and demolition contributes just over 60% to total CRD waste generation, making the management of waste in this sector extremely important.

The activity related to residential new construction is the cause of approximately 75% of new construction waste. According to BC Housing's British Columbia's Monthly New Homes Registry Report[4], 70% of the new registered homes are multi-unit residential buildings (MURBs) over the last seven years. This report analyses the waste generated by the construction of MURBs.

[1] Statistics Canada, 2013
[2] Statistics Canada, 2014
[3] Guy Perry and Associates and Kelleher Environmental, 2015
[4] BC Housing, 2021

Chart 1: Share of Registered New Homes by Building Type, BC, 2014-2020

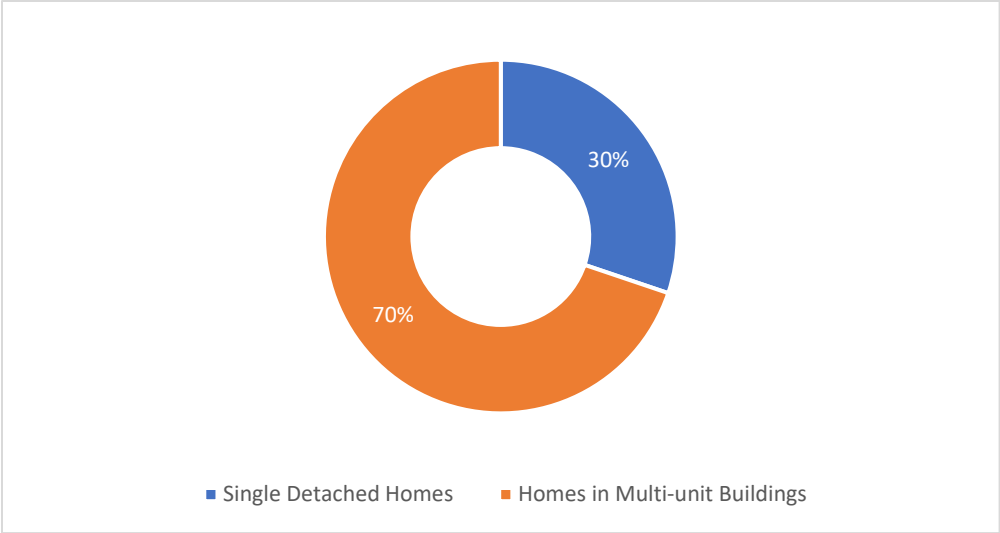
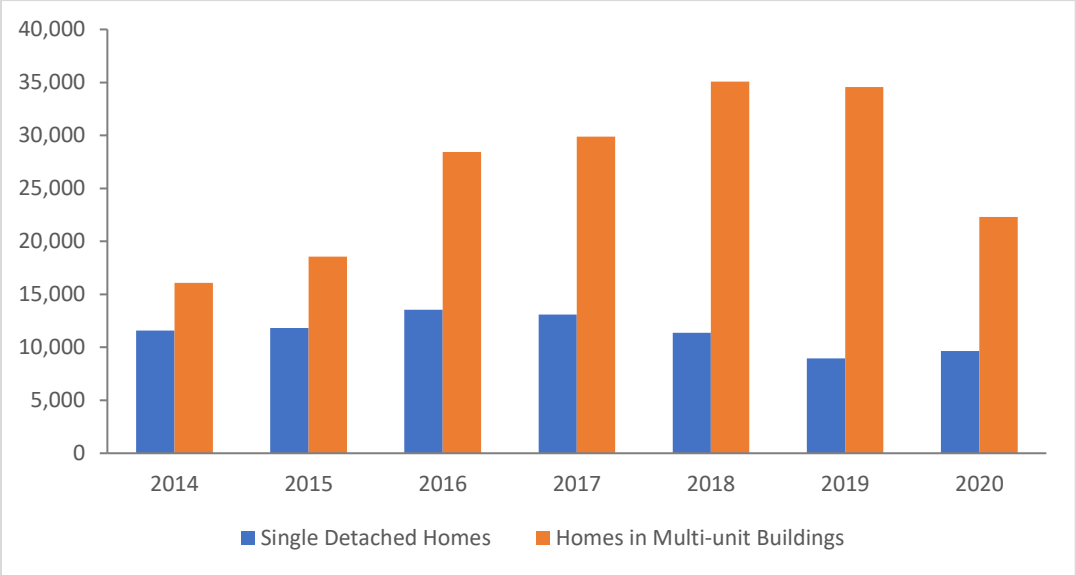


Chart 2: Registered New Homes by Building Type, BC, 2014-2020



Analysis

1. National Residential Construction Waste Analysis

The sampling dataset is based on 106 multi-unit residential buildings (MURBs) totalling 1.96M m^2 built from 2007 to 2019. The following table shows the types of residential buildings across Canada. 'Low-rise' buildings are defined as three stories or less, 'mid-rise' is four to nine stories, and 'high-rise' is ten stories or more.

Table 2: Number of Three Types of Residential Buildings from Dataset

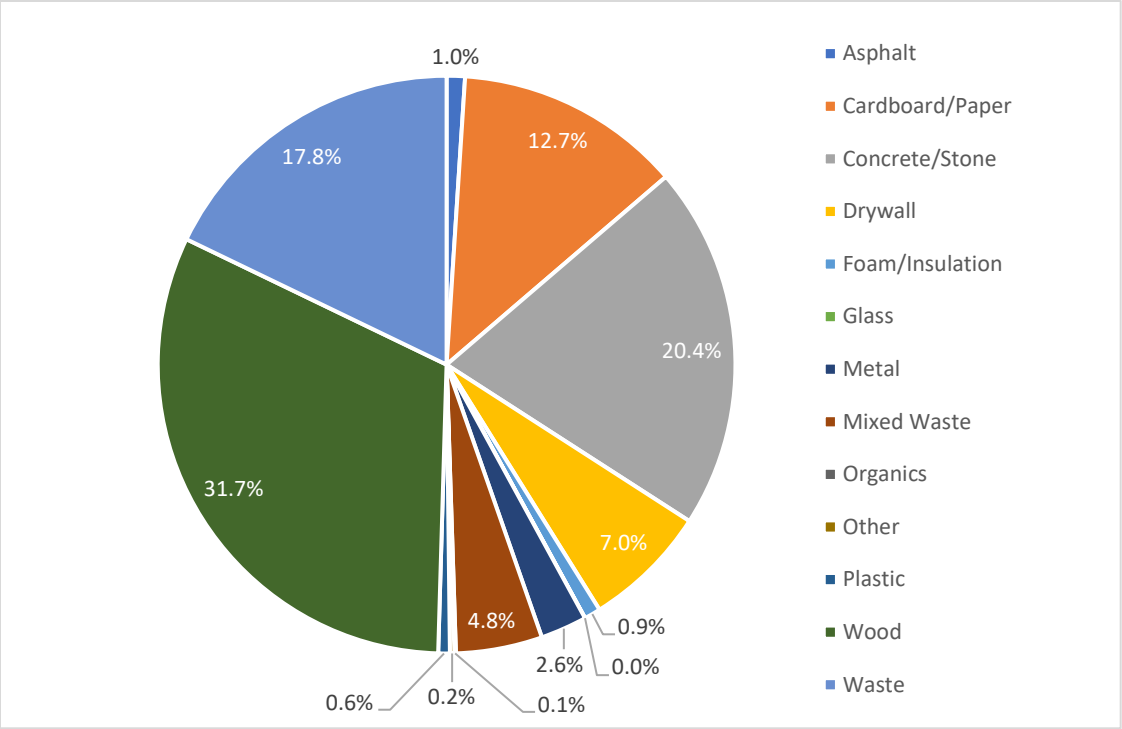
Province	Low-rise multi-unit residential	Mid-rise multi-unit residential	High-rise multi-unit residential	Total
AB	0	1	2	**3**
BC	4	21	16	**41**
MB	1	0	0	**1**
NS	0	2	0	**2**
ON	2	17	28	**47**
QC	0	7	5	**12**
Total	**7**	**48**	**51**	**106**

These 106 LEED certified residential projects all targeted the *Construction Waste Management* non-mandatory credit which requires the tracking of all construction and demolition waste on the project, and awards points for diversion rates of 50% or greater. As a result, the sampled projects have an average diversion rate of just over 85% as compared to the 16% nationwide average. The tracking allows us to determine what types of materials are going to waste on these construction projects, as per Table 3 below.

Table 3: Construction Waste by Material per m^2 of Gross Floor Area, National

Material	Weight Generated per GFA (kg/m2)	Percentage Total by Weight	Volume Generated per GFA (m3/m2)	Percentage Total by Volume
Asphalt	1.6	1.7%	0.004	1.0%
Cardboard/Paper	2.7	2.9%	0.046	12.7%
Concrete/Stone	37.4	39.8%	0.073	20.4%
Drywall	7.6	8.0%	0.025	7.0%
Foam/Insulation	0.1	0.1%	0.003	0.9%
Glass	0	0%	0	0%
Metal	5.6	6.0%	0.009	2.6%
Mixed Waste	3.6	3.9%	0.017	4.8%
Organics	0	0%	0	0.1%
Other	0.2	0.2%	0.001	0.2%
Plastic	1.2	1.2%	0.002	0.6%
Wood	20.5	21.8%	0.114	31.7%
Waste	13.5	14.3%	0.064	17.8%
Totals	**94.0**	**100%**	**0.359**	**100%**

Chart 3: % Volume Generated per GFA (m^3/m^2), National



These figures capture some demolition of existing structures on site, where included in the project scope. Concrete waste is the highest portion by weight among all materials at 37.4%, followed by wood (20.5%) and waste (13.5%). By converting the materials from weight into volume[5], wood becomes the most significant contributor (31.7%), then concrete (20.4%) and waste (17.9%). The recycling rates on these projects show us that source separation on site into single waste streams has a higher recycling rate than commingled (mixed waste) that is sorted off-site with overall diversion rates that are much lower.

It is worth noting that, although foam/insulation has a low waste generation rate, there are only a few facilities that accept this material. There are toxins in foam insulation, such as spray polyurethane foam (SPF) which is otherwise promoted as a "green" product. In addition to the toxicity, SPF makes it more difficult to separate other building materials that it adheres to, lowering the overall diversion rates for demolition projects. The other common insulation materials such as fibreglass are nearly impossible to recycle[6]

In order to account for the materials hidden in the *Mixed Waste* and *Waste* categories, we can combine the LEED project data with Metro Vancouver's 2018 *Construction & Demolition Waste Composition Study* (TRI Environmental Consulting, 2019). If we assume that these two categories are consistent with the construction waste generated in Metro Vancouver, then both categories can be converted into the materials they are composed of, based on the 2018 study. The following table shows the results of the 2018 Metro Vancouver study converted to material categories to match the LEED data.

[5] Appendix A
[6] Recycle Nation, 2014

Table 5: Metro Vancouver C&D Waste Composition by Material[7]

Material	% by Weight
Asphalt	4.9%
Cardboard/Paper	1.6%
Concrete/Stone	1.4%
Glass	1.8%
Metal	4.2%
Organics	0.5%
Other	11.9%
Plastic	11.5%
Wood	60.8%
Waste (household garbage)	1.5%

Table 6: Metro Vancouver Residential Projects – Mixed Waste and Waste Converted to Materials

Material	Weight (kg)	% by Weight	Volume (m3)	% by Volume
Asphalt	856,360	1.6%	1,970	1.0%
Cardboard/Paper	1,212,390	2.3%	20,210	10.2%
Concrete/Stone	19,019,180	35.5%	37,280	18.7%
Drywall	4,209,830	7.9%	14,030	7.1%
Glass	266,740	0.5%	210	0.1%
Metal	4,027,640	7.5%	6,710	3.4%
Organics	79,860	0.1%	540	0.3%
Other	1,765,630	3.3%	8,500	4.3%
Plastic	1,716,480	3.2%	3,440	1.7%
Wood	11,348,250	21.2%	63,050	31.7%
Waste	9,009,750	16.8%	42,900	21.6%

[7] TRI Environmental Consulting, 2019

Chart 4: % of Materials by Weight, Metro Vancouver Residential Projects (waste converted)

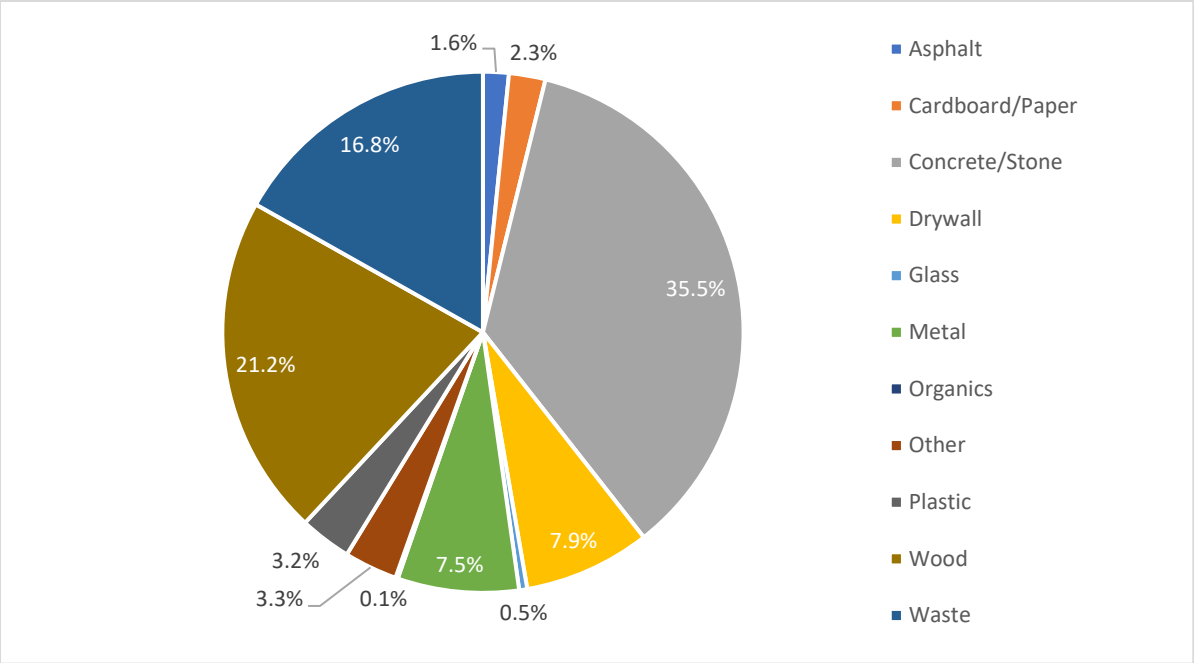
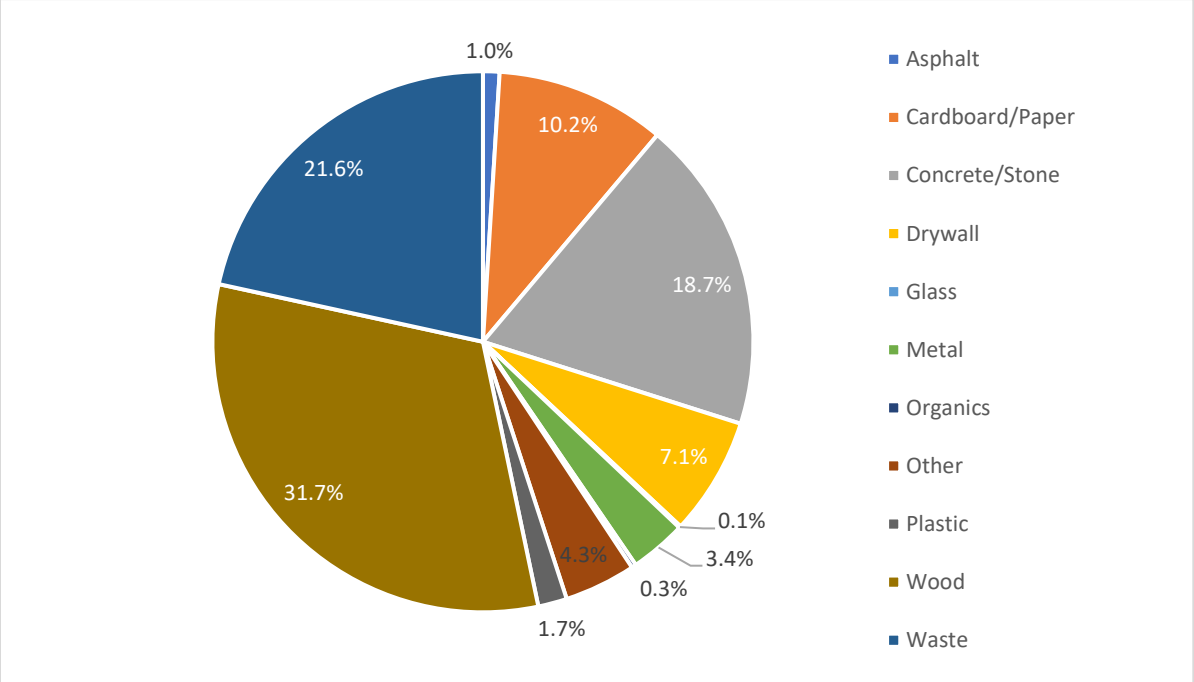


Chart 5: % of Materials by Volume, Metro Vancouver Residential Projects (waste converted)



By converting the unknown wastes into materials, we see a clearer picture of the materials that are going to waste on residential construction sites.

Conclusions & Tools

Thanks to local governments' waste reduction and diversion regulations, the amount of C&D materials diverted from landfills has increased by 30% in 10 years[8]. The following are examples of the C&D reduction efforts of municipalities in BC.

The City of Vancouver has set a goal to become a city of zero waste by 2040. In 2014, Vancouver passed The Green Demolition By-law, requiring the diversion of 70% to 90% of some residential demolition materials from landfills. In 2016, Vancouver managed to divert 86% of demolition from landfills[9].

In 2011, the City of Port Moody passed a by-law to reduce C&D materials sent to landfills. It requires developing a residual materials management plan and a cash deposit when applying for a new construction or demolition permit. In 2013, the City obtained a diversion rate of 84% of these materials from landfills[10].

In 2006, the Regional District of Nanaimo (RDN) set a target of diverting 75% of the region's waste from landfills by 2010. RDN introduced a landfill ban on the disposal of clean wood waste in 2007. In 2008, as a result of the ban, landfill disposal of wood waste was reduced by 87%[11].

With additional information and tools, the industry can continue to achieve higher diversion rates as we work towards our ultimate goal of CRD waste avoidance. The LEED project waste information indicates that municipal and regional governments can ask for much higher rates of diversion from builders than is currently being required.

1. BC Construction Waste Receiving & Salvage Facilities

Accompanying this report is a list of salvagers, service providers, recycling facilities and construction waste haulers. This list extends the work done by Metro Vancouver in their publication *Construction & Demolition Waste Reduction and Recycling Toolkit*[12] and the Capital Regional District (CRD), as well as the efforts of the Coast Waste Management Association (CWMA), and expands the list to cover Squamish-Lillooet Regional District (SLRD), the Okanagan, as well as online platforms.

2. Mid and High-Rise Residential Construction Waste Calculator

To plan for waste management it's helpful to know the volume of different materials that can be anticipated for a new construction project. A calculator has been provided that estimates the waste for mid and high-rise residential construction, based on the averages of the waste materials generated by the 106 sample projects.

[8] Canadian Council of Ministers of the Environment, 2019
[9] City of Vancouver, 2021
[10] CR&D Case Study 7
[11] CR&D Case Study 4
[12] Metro Vancouver Regional District, 2020

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Appendix A

Weight to Volume Conversion Table

Material	m^3/kg	kg/m^3	Source	Notes/Description
Asphalt	0.0022995	434.9	EPA	Estimate 95% asphalt roofing, 5% asphalt paving
Cardboard/Paper	0.0166667	60.0	CaGBC LEED 2009 reference guide, page 390	Cardboard
Concrete/Stone	0.0019600	510.2	EPA	
Drywall	0.0033333	300.0	CaGBC LEED 2009 reference guide, page 390	Gypsum Wallboard
Foam/Insulation	0.0333333	30.0	https://www.atermit.com/upload/Expanded%20Polystyrene%20(EPS)%20Foam%20Insulation%20(density%2030%20kgm).pdf	verified as approximately average by this site
Glass	0.0007804	1,281.5	California Integrated Waste Management Board	
Metal	0.0016667	600.0	CaGBC LEED 2009 reference guide, page 390	Steel
Commingled	0.0047619	210.0	CaGBC LEED 2009 reference guide, page 390	Mixed Waste
Organics	0.0067422	148.3	EPA	Mixed Yard Waste - Uncompacted
Other	0.0048159	207.6	USGBC 2009 reference guide, page 360	Construction and Demolition Mixed Waste
Plastic	0.0020015	499.6	TRI 2019	Chlorine Plastic
Waste	0.0047619	210.0	CaGBC LEED 2009 reference guide, page 390	Mixed Waste
Wood	0.0055556	180.0	CaGBC LEED 2009 reference guide, page 390	

Priority of sources: 1) CaGBC/USGBC; 2) EPA; 3) Industry/academic source