DELPHI GROUP

In Partnership with

DILLON CONSULTING

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Economic & Environmental Assessment of Waste Diversion in Canada's Construction & Demolition Sector Study

Executive Summary

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KBL Waste Management

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Glossary

Aggregates: A key ingredient in concrete along with water and cement. Aggregates are granular materials such as sand, gravel, or crushed stone. Concrete can also be crushed at the end of its useful life to make aggregate for new concrete.

Alternative Daily Cover (ADC): Cover material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.

Biomass: A plant-based material used as fuel to produce heat or electricity. Examples are wood and wood residues, energy crops, agricultural residues, and waste from industry, farms and households. Also known as biofuel.

Building Deconstruction / Deconstruction: Describes the selective dismantling or removal of materials from buildings prior to (or instead of) conventional demolition. It is an approach to building removal that can convert this waste stream into highest-value resources in a manner that retains their original functionality as much as possible for reuse in future buildings.[1]

Construction and Demolition (C&D) Waste / Commingled C&D Waste / Mixed C&D Waste: Includes waste and recyclables generated from construction and from the renovation, demolition, or deconstruction of pre-existing structures. It does not include land clearing debris, such as soil, vegetation, and rocks, nor does it include hazardous and/or heavy industrial waste.[2]

Clean Fill: This refers to uncontaminated construction waste materials, such as natural soil, rock, concrete, or asphalt that can be reused in other construction projects.

Clean Wood Waste: A type of wood waste that does not contain contaminants such as paint, stain, chemicals, preservatives, additives, or glue. The wood may be pierced with nails or other metal fasteners like screws or staples.

Contaminated Wood: Wood waste (which includes chemically treated wood) that is processed and may contain glue, paint, stain and other preservatives and additives. It includes plywood, chipboard, OSB as well as chemically treated wood. It is not typically recycled, recovered or used for energy production.

Design for Disassembly (DfD): A principle that informs decisions and material choices, changing how materials are joined together and how they are layered in a way that is accessible, reversible, and robust.

[1] Canadian Council of Ministers of the Environment, 2008. Guide for Identifying, Evaluating, and Selecting Policies for Influencing Construction, Renovation, and Demolition Waste Management. Available at: https://www.ccme.ca/en/res/C&Dguidance-secured.pdf

[2] LEED, 2009. LEED Canada Reference Guide for Green Building Design and Construction 2009.

Demolition: Deliberately destroying a building or portion of a building, often in order to build something else in its place.[3]

Demolition Waste: Refers to wastes and material debris that are derived from the process of demolishing existing structures.[4]

Disposal: Refers to the collection, processing and deposition of waste materials, typically in a landfill, without the reuse or recycling of those materials.

Diversion: Any action or practice that breaks down used materials to displace raw materials. This includes recycling, composting, remanufacturing, material reuse and waste-to-energy for some regions. Please refer to the 'waste-to-energy' and 'reuse' definitions for more information.

Drywall: A board made of several plies of fiberboard, paper, or felt bonded to a hardened gypsum plaster core and used especially as wallboard.

Elimination: This term also refers to landfilling.

Gypsum: A soft white or gray mineral consisting of hydrated calcium sulfate. It occurs chiefly in sedimentary deposits and is used to make drywall.

Hog Fuel: A wood residue and waste product that is processed through a chipper or mill and produces coarse chips and clumps normally used for fuel.

Landfill Ban: Generally imposed by a municipal solid waste bylaw, this prohibits certain materials from entering the landfill.

Landfill Tipping Face: Also known as the working face (or working front), where waste collection vehicles unload their contents.

Scrap Metal: Discarded metal consisting of recyclable materials collected for reprocessing, including copper, aluminium, brass, steel, stainless steel, lead, and zinc.

Recycling: The collection, reprocessing, marketing, and use of materials that were diverted or recovered from the solid waste stream.[5]

Reuse of Materials: The reemployment of materials in the same or a related capacity as their original application, thus extending the lifetime of materials that would otherwise be discarded. Reuse includes the recovery and reemployment of materials recovered from existing building or construction sites. Also known as salvage.[6]

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[3] Construction Material Salvage and Recycling Market Assessment October 2021 Prepared for the City of Victoria, by Light House Sustainability Society

[4] Metro Vancouver, 2021. DLC Waste Management Toolkit: A Guide for the Building Construction Industry. [online] Greater Vancouver Regional District. Available at: https://www.vrca.ca/wp

[5] Construction Material Salvage and Recycling Market Assessment October 2021 Prepared for the City of Victoria, by Light House Sustainability Society

[6] USGBC. 2021. Glossary: U.S. Green Building Council. Available at: https://www.usgbc.org/glossary#reuse

Solid Waste: Refers to recyclables, organic materials (such as food waste, leaves and yard waste) and garbage generated by residential sources (households) and industrial, commercial, and institutional sources, which the construction, renovation and demolition sector. Also referred to as MSW – Municipal Solid Waste. Excludes soils, liquids, and any hazardous wastes.

Salvaged Material: A construction component recovered from existing buildings or construction sites and reused. Common salvaged materials include structural beams and posts, flooring, doors, cabinetry, brick, and decorative items.[7]

Source Separation: When recyclables such as clean wood, cardboard, and scrap metal, are separated on site and either put into separate bins, a dual (or multi) compartment bin, or stored in piles on the site.[8]

Steel: Steel is the most common type of metal material used in building structures in the residential and commercial industry in the form of steel girders, support beams, trusses, piling, rebar, etc. Based on the interviews conducted with C&D stakeholders nationwide, 'scrap metal' or 'metal' is being used interchangeably with 'steel.' Therefore, this study uses scrap metal in lieu of steel throughout the report. Steel is tracked as part of the Metals or specifically the Ferrous Metal stream.

Tipping Fees: A fee paid to dispose waste in a landfill that is based on the weight of waste per tonne. This fee can be passed down to waste generator from landfill through fees or taxes.

Waste-to-Energy / Incineration / Use (d) as fuel / energy/Energy valorization: The processing of waste into other fuels that can be used in industrial processes, such as cement kilns. Also known as energy from waste (EFW) or waste to energy (WtE), it is a process that recovers energy from waste materials. EFW/WtE may include direct combustion, the collections of emissions and by-products from waste such as biogas.[9]

[7] USGBC. 2021. Salvaged material, Glossary: U.S. Green Building Council. Available at: https://www.usgbc.org/glossary#salvaged-material
[8] Metro Vancouver, 2021. DLC Waste Management Toolkit: A Guide for the Building Construction Industry. [Online] Greater Vancouver Regional District. Available at: https://www.vrca.ca/wpcontent/uploads/DemolitConstructWasteToolkit.pdf
[9] Canadian Council of Ministers of the Environment, 2008. Guide for Identifying, Evaluating, and Selecting Policies for Influencing Construction, Renovation, and Demolition Waste Management

Acronyms

AB: Alberta

ADC: Alternative Daily Cover

BC: British Columbia

BTU: British thermal unit

CCME: Canadian Council of Ministers of the Environment

C&D: Construction and Demolition

CRD: Construction, Renovation, Demolition

CSA: Canadian Standards Association

DfD: Design for Disassembly

EFW: Energy from Waste

HFH: Habitat for Humanity

GVA: Gross Value Added

ICI: Industrial, Commercial, and Institutional

LEED: Leadership in Energy and Environmental Design certification

MB: Manitoba

MDF: Medium Density Fibreboard

MSW: Municipal Solid Waste

MRF: Materials Recovery Facility, Multi Re-use Facility

NB: New Brunswick

NL: Newfoundland and Labrador

NS: Nova Scotia

NU: Nunavut

NWT: Northwest Territories

ON: Ontario

OSB: Oriented Strand Board

PEI: Prince Edward Island

QC: Quebec

RCA: Recycled Concrete Aggregate

RAP: Reclaimed Asphalt Pavement

RDF: Refuse-derived Fuel

ROI: Return on Investment

Res: Residential

SK: Saskatchewan

WtE/WTE: Waste to Energy

YK: Yukon Territory

Executive Summary

Waste reduction strategies in the construction and demolition (C&D) sector will be a crucial aspect of moving Canada towards a more circular economy by helping to realize the economic and GHG reduction potential of reducing and diverting C&D waste back into the economy through higher value uses.

To better understand the current and potential state of Canada's C&D waste streams, this national study builds on a C&D study completed in 2022 for the Province of British Columbia prepared by The Delphi Group and Dillon Consulting. This national study focuses on four materials, the same that were the focus of the BC study, to provide a preliminary snapshot of the disposal and diversion flow from C&D waste, and the trends that can be observed at national, provincial, territorial, and municipal levels.

While C&D waste materials are composed of multiple materials and composites, this study is focused on the four below, which were selected based on their volume in landfill, potential for improved resource efficiency and material circularity, and high embodied carbon content:

1. Wood (Clean and Contaminated)
2. Drywall (Gypsum)
3. Metal (Steel)
4. Concrete

These materials are profiled individually and in the following seven regions across Canada:

1. Atlantic Provinces (NS, NB, NL, PEI)
2. Quebec
3. Ontario
4. Prairies (MB, SK)
5. Alberta
6. British Columbia[10]
7. Territories (NWT, YK, NU)

[10] To the extent possible, this report integrates findings from the C&D study completed in 2022 for the Province of British Columbia.

Setting the Context

Construction and demolition waste represents a significant portion of waste that goes to landfill. This is a global issue – the construction industry uses roughly 30% of the total raw materials extracted globally and generates about 30% of the world's waste.

Today, nationally, more C&D waste is being disposed rather than diverted from landfill. Significant investments in built infrastructure will be needed to accommodate population shifts and growth, both in urban and rural regions across Canada. As new construction, renovation and demolition generates an increase in C&D waste streams, advancing circular economy practices and strategies in the construction sector will be crucial in capturing the value of these significant waste streams including creating new opportunities to divert waste to higher value uses, reducing disposal in landfills, generating revenue, and creating jobs.

A study conducted by Light House focused their analysis on national construction waste across both residential and ICI sectors in light of growth in construction and renovation activity, The study found that in 2018, the annual waste generation for new construction and major renovation was in the range of 1.41 to 4.77 million tonnes.[11] Note that this figure does not include demolition, and focused only on LEED certified projects which require C&D data to be tracked and reported as part of the certification. Given that LEED projects are seeking to minimize environmental impacts, the waste generation for non-LEED projects is likely to be much greater.

Over the next 10 years, Canada's residential and ICI sector is expected to see growth that will cause an increase in C&D waste. Investment in commercial building construction is expected to increase by 28% by 2027[12], while investment in industrial construction will see slightly smaller growth, at 13% by 2027 from 2021 levels. Meanwhile, in the residential sector, growth will be seen across all housing unit types, notably in multi-unit family housing. In addition to new construction, renovation and maintenance investment is expected to continue to rise through to 2027. By 2027, annual renovation investment will be only 6% below annual investments in new-home construction.[13] This will be driven in large part by three factors:

1. Turnover of older homes located in densely populated, mature urban markets.
2. Aging of the existing housing stock.
3. Retrofitting of homes to allow ageing in place.

Three scenarios exist in Canada, for the processing and disposal of C&D Waste:

- **Scenario 1** – C&D facility with separation available (mechanical and manual) that recovers useful C&D materials for resale and recycling
- **Scenario 2** – C&D facility with no separation available
- **Scenario 3** – No C&D facility. C&D waste goes into a municipal solid waste landfill

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[11] http://www.nzwc.ca/Documents/WatchingOurWaste-Analysis.pdf

[12] https://www.buildforce.ca/system/files/forecast_summary_reports/2022%20National%20Summary%20Constr%20Maint%20Looking%20Forward.pdf

[13] https://www.buildforce.ca/system/files/forecast_summary_reports/2022%20National%20Summary%20Constr%20Maint%20Looking%20Forward.pdf

Federal, Provincial and Municipal Policies Driving C&D Waste Diversion

Various policies and initiatives, at all levels of government, are in place and being developed to support C&D waste diversion. The overarching goals of these measures include:

- Capturing value ($) of C&D "waste" through reuse, repurposing and resale, which could improve the business case for deep retrofits
- Creating jobs as materials are salvaged rather than thrown out
- Reducing biodiversity and supply chain pressures by complementing the supply of raw materials from primary resource extraction and processing
- Enabling new opportunities to turn "waste" into higher value uses (using resources more efficiently), in alignment with the circular economy hierarchy for waste management
- Reducing embodied carbon in new materials by increasing their recycled material content
- Reducing the need for new landfills or landfill expansions, waste exports

To reduce environmental impact and transition to low-carbon, climate-resilient operations, the Canadian government launched the Greening Government Strategy in 2017, a pan-Canadian strategy that aims for a net-zero and climate resilient federal property. The Greening Government Strategy is a set of government-approved commitments that apply to all core government departments and agencies, and specific targets include reducing the embodied carbon of the structural materials of major construction projects by30% starting in 2025, diverting at least 90% of C&D waste from landfills by 2030, and considerations around life cycle cost-benefit analysis to inform building decisions.

Canada is also in the process of developing the Canada Green Buildings Strategy, a broad initiative to mobilize national climate action on the built environment, transform markets, and reduce costs in line with the goal of a net-zero emissions and climate-resilient buildings sector by 2050.[14]

Provincial and territorial (PT) governments across Canada are developing policies that apply circular economy principles and encourage the reuse and recycling of C&D waste. Provinces such as BC are enacting extended producer responsibility (EPR) through their recycling regulations, outlining the requirements for EPR.[15] While there are no EPRs in place at this time specific to C&D waste, EPRs do represent an important policy lever at the provincial and territorial level that could eventually be leveraged for the purpose of C&D waste management. By incorporating products with reclaimed and recycled content in building materials, companies are diverting waste from landfills and avoiding tipping fees.

Several representatives from provinces noted they are following the CCME *Canada -wide Action Plan on EPR,* which includes C&D materials.[16] As discussed later in this report, provinces and

[14] See: https://www.rncanengagenrcan.ca/en/collections/canada-green-buildings-strategy
[15] See: https://www2.gov.bc.ca/gov/content/environment/waste-management/recycling/extended-producer-responsibility/extended-producer-responsibility-reports-plans
[16] See link for full list of what is include in CCME *Canada -wide Action Plan on EPR* *https://scics.ca/en/product-produit/backgrounder-a-canada-wide-action-plan-for-extended-producer-responsibility/*

territories are already implementing many measures to support C&D waste management, such as:

- **Innovative financing mechanisms** to help municipalities establish the infrastructure, processes, and plans needed for improved waste management. For example, within the Quebec Residual Materials Management Policy, a framework was developed to provide regional municipalities with financial support for the development of residual materials management plans through landfill royalties applied to Construction, Renovation and Demolition (C&D) materials.
- **The development of studies, guidelines, and other tools and initiatives** that help to identify and prioritize action on C&D waste management. In Manitoba, for example, the provincial government is looking to establish a task force to address C&D waste and develop recommendations on options for a C&D waste management program.
- **Setting aspirational C&D waste diversion targets**. For example, the Quebec *Residual Materials Management Policy*'s Action Plan for 2019-2024 presents a target of recycling and valorizing 70% of all C&D residuals by 2023.
- The Government of Northwest Territories **identified C&D waste as a targeted material stream to divert from landfills** according to its 2019 Waste Resource Management Strategy and Implementation Plan and identified diversion targets as part of the 10-year roadmap.

Canadian municipalities have a strong influence on C&D waste reuse and recycling as many C&D waste processing plants are located in or near major cities. Local governments are driving diversion practices through bylaws, landfill bans, high tipping fees, and construction permits.[17] Leading municipalities such as Vancouver, Victoria, Toronto, and Montreal have included considerations around demolition material salvage and C&D waste in their economic strategies as a tool to increase revenue and create jobs in C&D waste management and diversion.

In addition to efforts at all levels of government, many other commercial and non-profit organizations are involved in enabling C&D waste diversion.

[17] For example, the Halifax Regional Municipality's bylaw sets a 75% diversion target for C&D waste and requires that it be managed in the same jurisdiction in which it has been generated. This encourages the jurisdiction itself to focus on diversion methods and prevents C&D waste from being transported to jurisdictions that are still in the process of developing their own C&D waste strategies.

Best Practices in C&D Waste Diversion

Many innovative and effective policy levers exist, at all levels of government. Through these policy levers, several objectives are achieved.

Prevent C&D waste disposal in landfills

- Bylaws - mandatory C&D diversion targets; require a Waste Management Plan be part of building and demolition permit applications; demolition waste reduction; deconstruction and salvage
- Landfill bans & elevated tipping fees; contractual diversion requirements (e.g. for comingled waste)
- Provide regional municipalities with financial support for the development of waste management plans

Support designing and building with lower carbon materials (low-carbon intensity or recycled content)

- Voluntary green building certification (e.g., LEED)

Encourage material recovery

- Provincial grants - to support activities by companies like Unbuilders for deconstruction
- Tax credits (federal and provincial)

Establish secondary markets for materials

- Establishing processing capacity to divert materials to be recycled or processed (e.g., wood or gypsum into alt fuels)
- Government-NGO partnerships (e.g., for used building material storage & resale facilities)

Best Practice Case Study – Quebec

Québec Residual Materials[1] Management Policy (a component of QC's Environmental Quality Act) introduces measures for the creation of a zero-waste society. It is accompanied by regular, 5-year Action Plans.

How it works:

- Action Plan 2011-2015 introduced landfill royalties (fees) to C&D waste and provided a framework to redistribute revenue to municipalities to support better waste management.
- Action Plan 2019-2024 presents a **target of recycling and valorizing 70% of all C&D residuals by 2023**.

Results:

- **85% of revenue from landfill royalties is redistributed to municipalities** based on their population and their performance in waste management.
- To date, each **municipality has received an average grant of $2.58 for every dollar spent on residential waste** management.
- The royalty regime is currently under review to encourage increased waste diversion to C&D recovery facilities. The government also intends to earmark some revenue to make recycling in C&D sector more efficient (e.g., development of technologies for reusing recovered materials, setting up and optimizing CRD recycling centers, and developing markets).

The following section highlights further best practices collected through the research.

Bylaws

- The Halifax Regional Municipality in Nova Scotia has a municipal bylaw to separate and sort all C&D waste in order to achieve a target of 75% diversion from landfill.

Fees

- In capitals such as Whitehorse and Yellowknife, landfill operators have established a higher landfill fee for mixed C&D waste vs. sorted waste such as metal or wood.

Creating Market Resale Opportunities

- The existence of Habitat for Humanity Restores, in several communities, were noted as a key driver and enabler for diversion and resale of recovered C&D materials.
- Noted in Nova Scotia was the establishment of some small contractors who seek out architectural finishings from older structures and historical buildings for re-use in renovations or new builds.
- In Newfoundland, due to the rural geographic makeup of small coastal rural communities and their very small populations, C&D material such as lumber, roofing, fixtures etc. are often re-used for cottage, cabin, private fishing stages and shed builds. Online sharing sites and social media site pages are popular and commonly used.
- The Home Again organization in NL accepts gently used furniture in partnership with the Robin Hood Bay landfill site in St. John's. Reusable items from renovations or housing are collected in sea shipping containers at the site and go to local families in need. This is not C&D building waste, but does include renovation waste.

Best Practice Bylaw Case Study – Port Moody, BC

What it is: Instituted a bylaw to divert construction and demolition materials from landfill.

How it works:

- Requires a Waste Management Plan as part of both building and demolition permit applications;
- Requires 70% of all recyclable materials created on site to be recycled by project completion;
- Application forms include a material checklist to help identify recyclable materials and a website link is provided which lists licensed recycling facility locations for applicants.

Results:

- An 85% diversion rate was achieved by 2013 for demolition projects;
- A 76% diversion rate was achieved for construction and renovation projects; and
- A total 84% diversion rate was achieved for all construction, renovation and demolition waste.

Financial Support and Incentives

- Within the Quebec Residual Materials Management Policy,[18]a framework was developed to provide regional municipalities with financial support for the development of residual materials management plans through landfill royalties applied to Construction, Renovation and Demolition (CRD) materials. Approximately 85% of revenue from landfill royalties ($23.07/MT in 2019, 24,32$/MT in 2022) is redistributed to municipalities based on their population and their performance in waste management. To date, each municipality has received an average grant of $2.58 for every dollar spent on residential waste management.

Based on the research and analysis conducted as part of this study, most cited and observed barriers to C&D waste diversion across the country are: a lack of landfill bans; a lack of flow controls; and low tipping fees

Collectively, these factors cause waste to follow the lowest cost pathway for disposal instead of recycling or reuse.

Best Practice Case Study – Unbuilders, Vancouver, BC

Unbuilders is a Vancouver-based deconstruction and material salvage company.

How it works:

- Trains carpenters & other skilled trade workers to disassemble homes.
- Provides a free estimate and a "salvage audit" to determine the value of each building's materials
- Deconstructs the building and provides on-site material separation;
- Building components are dismantled, lumber is de-nailed and processed for transport for reuse and remanufacturing.

Cost: Unbuilders offers tax credits that make deconstruction more affordable than traditional demolition. Unbuilders also sells a selection of reclaimed wood.

Unbuilders deconstruction = $14,595

Typical demolition = $26,500

Results:

- Yields less than 5% waste on average (and holds the City of Vancouver's record of a 99% salvage rate for a single-family home);
- Diverts 50 tonnes of waste and salvages 10 tonnes of lumber per project
- Unbuilders' process generates 6 jobs to every 1 demolition job (potential to create 75,000 jobs nationally)

[18] https://www.environnement.gouv.qc.ca/matieres/pgmr/

National C&D Outlook

The following table provides a high-level overview of the C&D waste totals by region.

Table 1: Total C&D Material Tonnages Disposed and Diverted

Canada (Regional Comparison)	Disposed							Diverted						
	ATL	QC	ON	PR	AB	TERR	BC	ATL	QC	ON	PR	AB	TERR	BC
Total C&D Materials (Total Reported from Current Study)														
Tonnage (Region) *Total in Thousands*	209	1,384	944	115	172	19	875	258	744	294	7	133	3	1,487
Tonnage (Country) *Total in Thousands*	**3,721**							**2,927**						

Overall, the following key takeaways emerged from the national outlook and regional comparison by material category:

- Today, nationally, more C&D waste is being disposed rather than diverted from landfill.
- Nationally, wood is the material that is most disposed of, however the source is largely unknown which could be improved by supporting more detailed waste data tracking.
- The percentage of C&D materials that are most disposed of across the provinces are wood and drywall. The study has shown that these materials can be diverted or reused if the right policies and infrastructure are in place.
- But efforts are underway, at all levels of government, to address C&D waste diversion.
- The leaders in diversion of C&D waste are BC, Quebec, Ontario and the Atlantic provinces.
- Diversion policies and practices exist across the country and are having an impact. For example, municipal waste reduction and diversion efforts have increased C&D materials diversion from landfills by 30% in 10 years.

Material Profile Key Takeaway Summaries

The following tables summarize key takeaways, factors influencing reuse, and best practices for diversion. More details on each material, and specifics on the diversion and reuse pathways can be found starting on page 50.

Table 2: Summary of Wood Material Profile

Key Takeaways	• Disposed wood tonnage is significantly higher for the ICI sector versus the residential sector. • Of the 4 materials, wood represented a significant proportion (54%) of disposed material in landfills. • Wood from the C&D waste sector is either clean or contaminated. This distinction can impact preferred options, and processing approaches, for reuse of the materials. • The higher value reuse of wood includes reused or resold clean wood, as well as particleboard and soundproofing panels. Next, medium value resale products for wood include chips for landscaping or pellets for fuel and livestock bedding, wood fines can be used in MDF board manufacturing. and the lowest value reuse product is landfill cover.
Factors Influencing Reuse, Repurposing and Recycling	• C&D waste facilities with tipping fees specific to waste streams, particularly wood, are lacking in both urban and rural centres across the country. • Where bans exist on clean wood in landfills (for example Metro Vancouver and Nanaimo in BC), there is much greater diversion of clean wood back into high value reuse streams. • A greater number of reuse stores, such as eco-centres or ReStore by Habitat for Humanity, also increased the likelihood of clean wood being diverted away from landfill. • While tipping fee rates were similar between regions, regions with low tipping fees for wood generally saw more wood disposed of rather than diverted.
Best Practices	• There are various wood recyclers such producing particle boards and panels from recycled fibres. • Treated wood such as electricity poles are in some cases transformed into new construction products such as planks. • A significant amount of wood is chipped and used as biomass for fuel (Hydro-Quebec, greenhouses). • Clean wood can be mulched as a landscaping product or wood fines can be used as MDF board manufacturing and waste wood can be chipped as hog fuel.

Table 3: Summary of Drywall Material Profile

Key Takeaways	• For diverted drywall, the highest value reuse is recycled wallboard. • If the gypsum can be recovered from the drywall, the majority of it can be recycled into the following applications: the manufacturing of new drywall; application to soils and crops as a bulking agent to improve soil drainage and plant growth (this is most prevalent in Nova Scotia); and an ingredient in cement production (this represents the lowest use value). • Where drywall is being accepted for recycling, some manufacturers are able to blend up to 30% of recycled drywall back into their process to create new drywall.
Factors Influencing Reuse, Repurposing and Recycling	• Given the challenges around collecting and processing used drywall, there is more drywall disposed than diverted in Canada. This is due to lack of recycling facilities outside of AB, ON and BC, and whether or not the facilities are easily accessible for those disposing of the material. • Facilities to process clean drywall waste into high value reuses (new wallboard) exist in 3 provinces – AB, ON and BC (owned and operated by New West Gypsum). Volumes of clean drywall waste processed at these facilities are limited to waste collected in close proximity to the processing plant. • Drywall tipping fees were generally found to be cheaper in rural communities in AB, QC, and the Territories regions. • Gypsum/Drywall tipping fees were similar between regions, with the exception of BC where rates were higher compared to the other regions.
Best Practices	• When it comes to recycling used drywall, a key factor to manage is distance to markets. If the recycler/processor is located on the same property as the manufacturer, a synergy is created decreasing transport costs. This is the case with New West Gypsum which operates in BC, AB, and ON. • Agricultural application of recycled gypsum was noted in Nova Scotia. Gypsum is a mineral containing calcium and sulfate which cannot support bacteria growth thus beneficial in decreasing dairy cow udder mastitis and exposure to environmental mastitis pathogens. Gypsum additives are pre-mixed with bedding materials or top dressed. • Further research would be beneficial to better understand the preferred pathways for drywall across regional governments, and how drywall is processed or disposed if specialized facilities are not available or if transport costs are too high to deliver drywall to the proper facilities.

Table 4: Summary of Concrete Material Profile

Key Takeaways	• Nationwide, more concrete is diverted than disposed given its weight and volume, which would result in costly tipping fees, and given its usefulness as a recycled aggregate. • Of the concrete that is tracked and diverted from known origins, the ICI sector diverts the most concrete. • There are many reasons to recycle concrete; lower costs of diversion compared to landfilling, conservation of air space within the landfill, extending the life of the landfill, and providing a LEED option for both reuse options for the construction industry.
Factors Influencing Reuse, Repurposing and Recycling	• Recycled concrete is widely used in the industry and is a relatively easy material to divert in comparison to other C&D materials given that it can generally be processed for recycling on site and demand for recycled concrete is quite high. • The cleaner the concrete is (not mixed with dirt or metal rebar), the higher likelihood it will be turned into aggregate and diverted from landfill.
Best Practices	• C&D bylaws requiring the recycling of concrete is another key driver that reinforces the reasons listed above and represents a key best practice. The Halifax Regional Municipality is an example of where concrete is recycled because of the local C&D bylaw.

Table 5: Summary of Scrap Metal Material Profile

Key Takeaways	• Scrap metals are the most accessible and easy C&D material to divert nationwide due to their resale value. For non-ferrous scrap metals from buildings, such as copper wiring, pipes, and rebar, the reselling price is relatively higher than other materials, further driving diversion of these materials from landfill. • Nationally, 2.9 million tonnes of scrap metal was diverted in 2019. • Of the scrap metal from C&D waste that is diverted, 22% is from the residential sector, 16% from ICI sector. • Overall trends found that many urban cities accept scrap metal free of charge. • The general practice for C&D waste would capture the metal using a magnet sorting machine which separates ferrous nails and other ferrous items from the mixed waste at private waste management facilities and local or regional landfills. This suggests that the value is not only high, but sufficient to warrant standard, consistent practices for retrieval across facilities/regions.

Factors Influencing Reuse, Repurposing and Recycling	• There are active and long-established recycling markets and cash value paid for scrap metals throughout the country,and is the highest value diversion pathway for scrap metal. • The financial incentive of recovering metal, and the available systems, supply chains, infrastructure, and secondary markets are key factors for diversion. Many of these factors can be expected to shape opportunities for the other 3 materials. • Distance to market is the main factor where scrap metal is not being diverted from landfill and recycled. • C&D scrap metal is often not specifically distinguished from other sources as the commodity is sold by weight and not differentiated by its source, which can impact tracking and reporting of this material.
Best Practices	• Metal tipping fees were similar between regions, except for Ontario where all investigated landfill facilities (urban and rural) accepted metal free of charge: the scrap metal is directed towards designated and large collection bins. • When sufficient infrastructure and established markets are in place, we observe very little scrap metal going to landfill. For instance, Ontario benefits from an active and long-established market and cash value paid for scrap metals throughout the province. There are many private scrap metal companies and local steel mills in Hamilton, Cambridge and Whitby among others, causing little metal going to landfills. • In terms of what scrap metal is recycled into specifically, that is an information gap that would require further investigation with metal recycling companies.

Economic Analysis Results

The following are the high-level takeaways of the analysis conducted using StatCan data to show the economic impacts of diverting waste from the selected material categories. The economic and employment impacts for the various diversion pathways were estimated by multiplying the total tonnage of materials currently being diverted (i.e., all scrap products currently being diverted including C&D scrap) by the approximate value of those materials for each diversion pathway.

Considerations for maximizing the economic, employment, environmental, and community benefits however will vary by region based on a number of important factors, including:

- The quality and quantity of the available C&D materials (e.g., clean versus contaminated wood, contaminated drywall, concrete with embedded deleterious materials);
- Access to relevant infrastructure, markets, and material processors / recyclers and manufacturers;
- Access to key industries in each region (e.g., agriculture, forestry, mass timber manufacturers, etc.); and
- Policies that can act as drivers for change (e.g., landfill bans and cost competitive tipping fees)

Please note that the total value of the materials diverted for each diversion pathway was multiplied by the 'best fit' economic multiplier for provinces and territories to estimate the gross value added (GVA), employment, product taxes, and the avoided disposal costs (based on landfill tipping fees).

Overall, the materials with the greatest opportunity in direct user impacts is summarized in the table below:

Table 6: Summary of Economic and Employment Impacts by Material Category Nationally (based on StatCan)

Scrap Products	Net Scrap ($)	Direct user impacts	
		Gross Value Added ($)	Jobs
Waste and scrap of wood and wood by-products	**602,447,000**	212,075,000	1,804
Waste and scrap of paper and paperboard	**230,034,000**	75,995,000	364
Ready-mixed concrete	**3,233,000**	1,183,000	9
Concrete products	**1,823,000**	667,000	5
Waste and scrap of iron and steel	**2,042,405,000**	476,198,000	2,874
Waste and scrap of non-ferrous metals	**2,841,981,000**	611,640,000	10,325
Construction, renovation & demolition diverted products	**52,100,000**	27,769,000	202

The study then established potential economic impact scenarios for waste diversion based on three different diversion rates and points in time:

1. Business as usual (BAU) diversion rate (44% in 2020) – national outlook,
2. Fifty percent (50%) diversion rate by 2026, and
3. Ninety percent (90%) diversion rate by 2030.

Key Findings

- It is important to note that StatCan does not have reported data on the construction, renovation and demolition category for Newfoundland and Labrador, Prince Edward Island and Saskatchewan. Analysis is, however, conducted on the Atlantic provinces, Prairies, and Territories based on the diverted tonnages identified for these 3 regions.
- The results of the scenario modelling for 2030 suggest that the economic benefits from the 90% diversion by 2030 scenario are significantly higher than the BAU scenario and the 50% scenario for the C&D category.
- The Atlantic provinces, specifically New Brunswick and Nova Scotia (StatCan) have a higher rate of GDP and jobs in the BAU scenario (2020) when compared to the 50% diversion by 2026 scenario. This is due to a higher diversion rate already being achieved by those provinces in the BAU scenario (2020). We identified that, based on the diversion data provided by the team, the Atlantic provinces currently have a 55.2% diversion rate for scrap products.

The figures and tables below provide some detail on these key findings. Please note that the tables include results from analysis undertaken using data from StatCan as well as results from analysis undertaken using data that was gathered directly for this study. Both are being shown to illustrate the difference in what is being reported by StatCan vs. what this study was able to uncover through both primary and secondary research.

Figure 1 below summarizes the GDP and employment impact results based on the data reported in this study.

Figure 1: Job and GDP results based on data reported in this study

Table 7: Summary of Economic Scenario Analysis – BAU Canada 44% Diversion in 2020 – StatCan vs Reported

Category	Sources of materials prepared for recycling	Diverted tonnes (2020)	Gross Output ($)	Direct user impacts	
				GDP ($)	Jobs
Construction & demolition[19]	**All sources of diverted materials (StatCan)**	750,525	52,099,569	**27,769,070**	**202**
	All sources of diverted materials (Reported)	2,927,000	203,185,023	**108,297,617**	**788**

Table 8: Summary of Economic Scenario Analysis – Canada 50% Diversion in 2026 – StatCan vs Reported

Category	Sources of materials prepared for recycling	Diverted tonnes (2026)	Gross Output ($)	Direct user impacts	
				GDP ($)	Jobs
Construction & demolition	**All sources of diverted materials (StatCan)**	978,972	67,957,816	36,221,516	264
	All sources of diverted materials (Reported)	3,817,930	265,031,182	141,261,620	1,028

[19] Shortened to construction and demolition from construction, renovation and demolition for consistency.

Table 9: Summary of Economic Scenario Analysis – Canada 90% Diversion in 2030 – StatCan vs Reported

Category	Sources of materials prepared for recycling	Diverted tonnes (2030)	Gross Output ($)	Direct user impacts	
				GDP ($)	Jobs
Construction & Demolition	All sources of diverted materials (StatCan)	3,172,394	220,219,662	117,377,080	854
	All sources of diverted materials (Reported)	12,372,136	858,842,743	457,763,182	3,332

Figure 2 below highlights the 2020 revenue and employment impacts from diversion by material.

Figure 2: Job and GVA results based on StatCan and reported data in this study. (2020 figures)

Avoided GHG Emissions Analysis

When C&D materials are diverted from landfill they can be recycled into content for new C&D materials. Compared to a baseline scenario of landfilling C&D waste, diversion of C&D materials from landfills and recycling them avoids GHG emissions in two ways:

1. **Direct:** By avoiding landfill methane emissions caused by waste materials decaying in landfill.
2. **Indirect:** By avoiding emissions associated with raw material extraction and processing (since the recycled materials become a substitute for, the virgin materials)

The GHG emissions associated with the production of construction materials that are made with recycled content is presented below. These GHG emissions are lower than those associated with the production of construction materials made with virgin content that they are replacing, therefore resulting in avoided GHG emissions. From a consumption perspective, materials with recycled content have lower GHG emissions intensities, resulting in a lower GHG footprint for products and activities that use recycled materials.

Table 10: Waste recycling emissions (national)[20]

C&D Waste Material	Recycled into…	Production emissions for materials with recycled content (tonnes CO2e / tonne)[21]	Primary replaced (virgin stock) material production emissions[22] (tonnes CO2e / tonne)
Concrete	Aggregate	0.003	**0.132**
Gypsum	Gypsum	0.032[23]	**0.12**
Wood	Wood	0.112	**0.313**
Steel	Steel	1.571	**4.018**

Avoided emissions from using recycled C&D materials are calculated using the following equation with results presented in the table below (all parameters are in tonnes CO2e/tonne material).

Avoided emissions = - (landfill emissions) + (Production emissions for materials with recycled content) – (primary replaced material production emissions).

[20] UK Government GHG Conversion Factors for Company Reporting.
[21] The materials are made from recycled content where the previous product was the same as the new product. The figures presented account for 'cradle-to-gate' emissions. Therefore, the recycled material values (which, in some cases, could be negative values) do not include avoided emissions from not using primary materials.
[22] The primary replaced material is the material that C&D waste is recycled into. The figures presented are 'cradle-to-gate' emissions (i.e., emissions associated with the extraction, primary processing, manufacturing, and transportation of virgin materials to the consumer). For wood, the emissions factor accounts only for non-biogenic emissions from decay of wood in landfill. Biogenic emissions are not included in the number provided, following GHG accounting best practices.
[23] Plasterboard

Table 11: Avoided emissions from C&D waste recycling (national)

C&D Waste Material	Avoided emissions calculation (based on formula above)	Avoided emissions (tonnes CO2e/tonne material)
Concrete	-0+0.003-0.132	**-0.129**
Gypsum	-0+0.032-0.12	**-0.088**
Wood	-0.828+0.112-0.313	**-1.028**
Steel	-0+1.572-4.018	**-2.447**

The figures below summarize the avoided emissions for each material group.

Wood

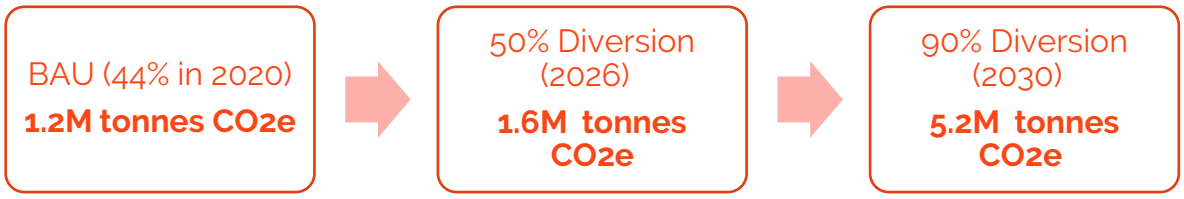

Figure 4: Avoided emissions for diverted wood based on 3 scenarios

Concrete

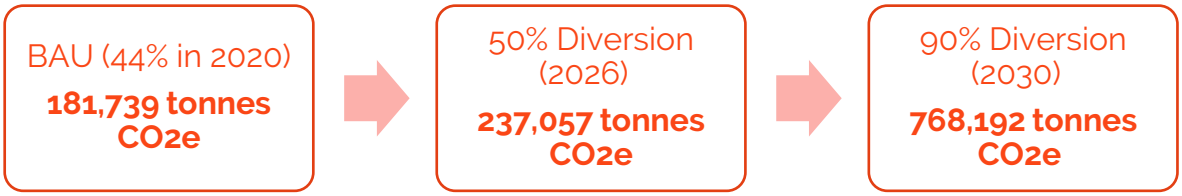

Figure 5: Avoided emissions for diverted concrete based on 3 scenarios

Metal

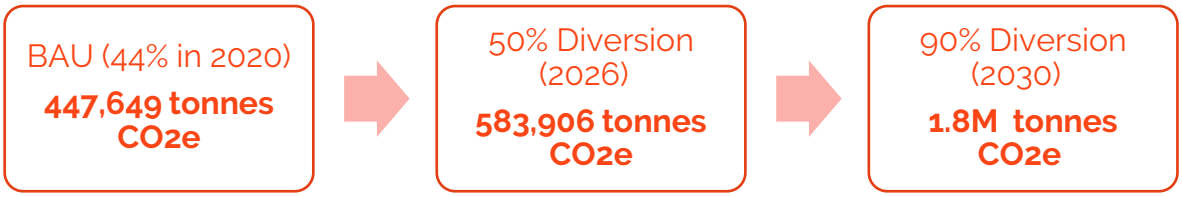

Figure 6: Avoided emissions for diverted metal based on 3 scenarios

Gypsum

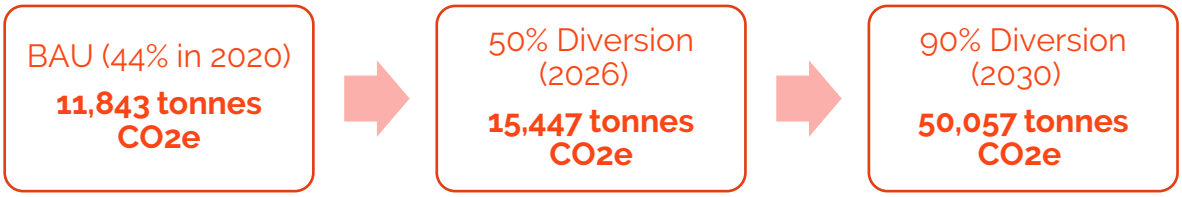

Figure 7: Avoided emissions for diverted gypsum based on 3 scenarios

Figure 8 below highlights the estimated 2020 avoided emissions from diversion by material.

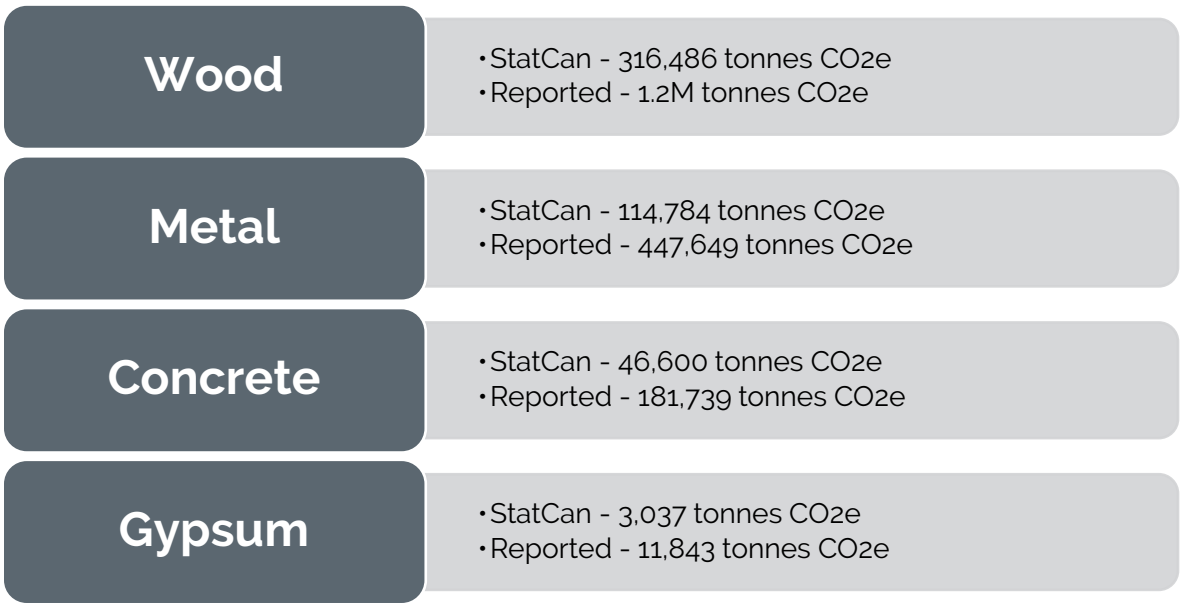

Figure 8: Estimated current (2020) avoided GHG emissions from diversion by material

Summary of Recommendations and Areas for Future Work

This study serves a key first step in providing a preliminary snapshot of disposal and diversion trends within Canada's C&D waste streams. There are several areas for future work and study that have been identified throughout the research and engagement process that was conducted to gather disposal and diversion data from key stakeholders across the provinces.

The following recommendations were developed to address the challenges and barriers that were most commonly seen across all provinces and thus considered the most important to achieve better diversion rates for C&D materials across Canada.

1. To maximize the benefits of increased recycling of C&D materials in Canada, **it is essential to have strong waste management and reduction policies and guidelines in place**. Some regions in British Columbia and Quebec have already demonstrated the impact of policies and bylaws that support industry partners (such as contractors, demolition companies, waste management firms, recycling facilities, etc.) in prioritizing diversion over disposal.

2. **Create reuse and recycling opportunities by establishing competitive landfill fees for disposal** and implementing landfill bans on dumping C&D materials.

3. **Implement municipal bylaws and regulations that mandate C&D waste end-use requirements** for C&D permits. This can support the reduction of C&D waste and the promotion of material reuse.

4. **Improve data collection and transparency in C&D waste management, mandatory licensing and annual reporting for private waste operators**. For example, Metro Vancouver's *Solid Waste Regulatory Program* requires licensing for all privately operated waste facilities, including those handling C&D materials, and leads to consistent tracking of disposal and diversion data numbers, providing valuable information for planning, performance tracing, and future policy development.

5. **Establish markets for diverted C&D materials to advance sustainable practices in the construction sector**. This necessitates a sustained investment in reuse and recycling infrastructure to support C&D industry compliance with regulations, policies, and bylaws.

6. **Provide proper storage solutions for salvaged C&D materials** to further promote and **expand the practice of deconstruction in local communities**. The growth of deconstruction has been limited by the lack of adequate storage facilities, also known as deconstruction hubs, to accumulate sufficient quantities of materials to sustain viable operations.

Looking Ahead

To enable the recommendations listed above, the following actions are recommended to maintain momentum on C&D waste diversion across the provinces and territories and to address information gaps:

- Continued engagement between federal, provincial, territorial and municipal governments to advance circularity of C&D materials, particularly to identify priority materials for further research e.g., asphalt, shingles and vinyl were identified during conversations with provinces and territories, however they were not included in the selected materials for this study.
- Further research to better understand optimal (highest value) reuses for C&D materials across Canada, recognizing regional variation (due to transport costs, processing infrastructure, etc).
- Characterize existing practices for collection and processing (e.g., how C&D materials are processed or disposed, if specialized facilities are not available to recover and reuse materials in new materials), key factors influencing collection and processing options (e.g., if transport costs are too high to deliver materials to facilities that can process them into new materials), and how existing practices may be adjusted to enable higher value uses.
- Seek to better understand preferred pathways for drywall in various regions, how drywall is processed or disposed if specialized facilities are not available or if transport costs are too high to deliver drywall the proper facilities.