METABOLIC

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SUMMIT72 QUANTITATIVE STRATEGY EXPERTS

Material Flows in the CRD Sector in Guelph-Wellington

A Material Flow Analysis

Index

Executive Summary

The City of Guelph and the Wellington County are using the momentum around the current circular initiatives in place to scale up their efforts and transform the construction, renovation and demolition (CRD) sectors through the Zero Waste Economic Transformation Lab (ZWETL) an initiative initiated by the Guelph's Circular Opportunity Innovation Launchpad (COIL) and supported by The Co-operators Group Limited (Co-operators).

This report describes a modeling exercise conducted to estimate construction, renovation, and demolition waste in the study geographic area. The estimate, primarily based on a model using building and demolition permits in the area, is supported by claim waste data and building site waste estimates.

A heavy construction geography

This estimate showed that the Guelph-Wellington area is heavily weighted towards construction versus demolition. In 2021, it is estimated that 321 kilotonnes of building materials will enter the built environment, while a small 15 kilotonnes will leave. Of the materials used to compose the local buildings, concrete was primarily used with a share of over 75% of all materials used, followed by wood and bricks. Construction, renovation and demolition waste is also principally composed of these three materials, although the shares of concrete, wood, and brick would be more uniformly distributed (respectively 37%, 18%, and 16%).

In terms of incoming and outgoing material flows, construction activities are predominant in the region compared to renovation, addition or demolition. The housing crisis accounts for the large share of construction of several types of residential buildings. We highlighted that converting basements to apartments would be the least impactful type of housing compared to the most impactful, high rise apartments.

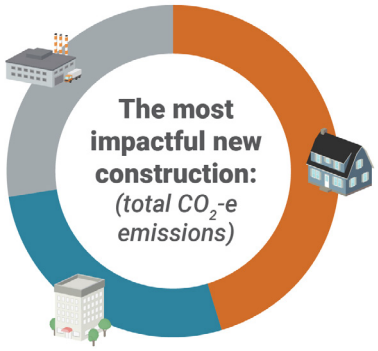
Availability of data

The current analysis had to rely on many assumptions due to the unavailability of building materials consumption and waste data. It provides an estimation of materials used for new construction and waste generated by demolition, but doesn't provide information on sourcing of consumed materials nor processing methods of waste generated. Unavailability of procurement and CRD waste collection/processing data prevents the identification of hotspots or more targeted opportunities in the current supply chain or processes. Moving towards a circular and sustainable construction and demolition sector requires transparency regarding waste processing so that circular opportunities for reuse of waste streams can be identified.

Towards a circular built environment

Using this analysis as a starting point, the Guelph-Wellington region can work towards a circular state with the creation of a detailed strategy and roadmap. It is essential to prioritize tangible and achievable cross-sectoral actions to move the sector towards a more sustainable and circular state. It is clear from this assessment that better data would be needed to better understand exactly what is happening throughout the life cycle of building materials and that space should be used more efficiently to reduce material needs.

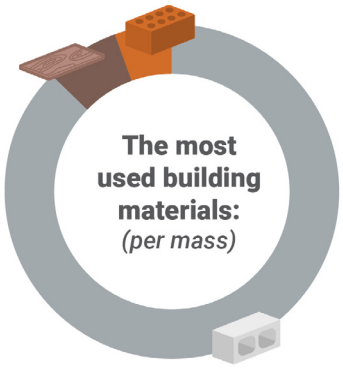
Building Types



- **Detached houses** *(20 ktonnes)*
- **High rise apartments** *(12 ktonnes)*
- **Industrial** *(12 ktonnes)*

While the construction of high rise apartments has a higher impact per m^2, there is a greater impact overall from detached houses as they are the predominant type of housing being demolished and constructed.

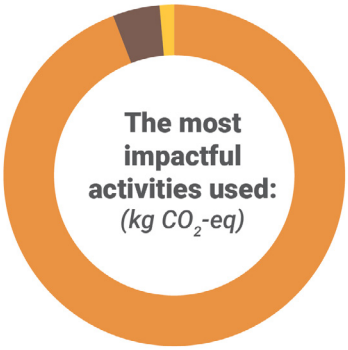
Building Materials



- **Concrete** *(244 ktonnes)*
- **Wood** *(20 ktonnes)*
- **Bricks** *(15 ktonnes)*

In all performed activities, concrete is the most predominant flow of materials. However, compared to other materials, the fraction of concrete flow is smaller in outflows than inflows.

All Activities



- **Construction** *(70,044 tonnes)*
- **Addition** *(3,315 tonnes)*
- **Renovation** *(903 tonnes)*

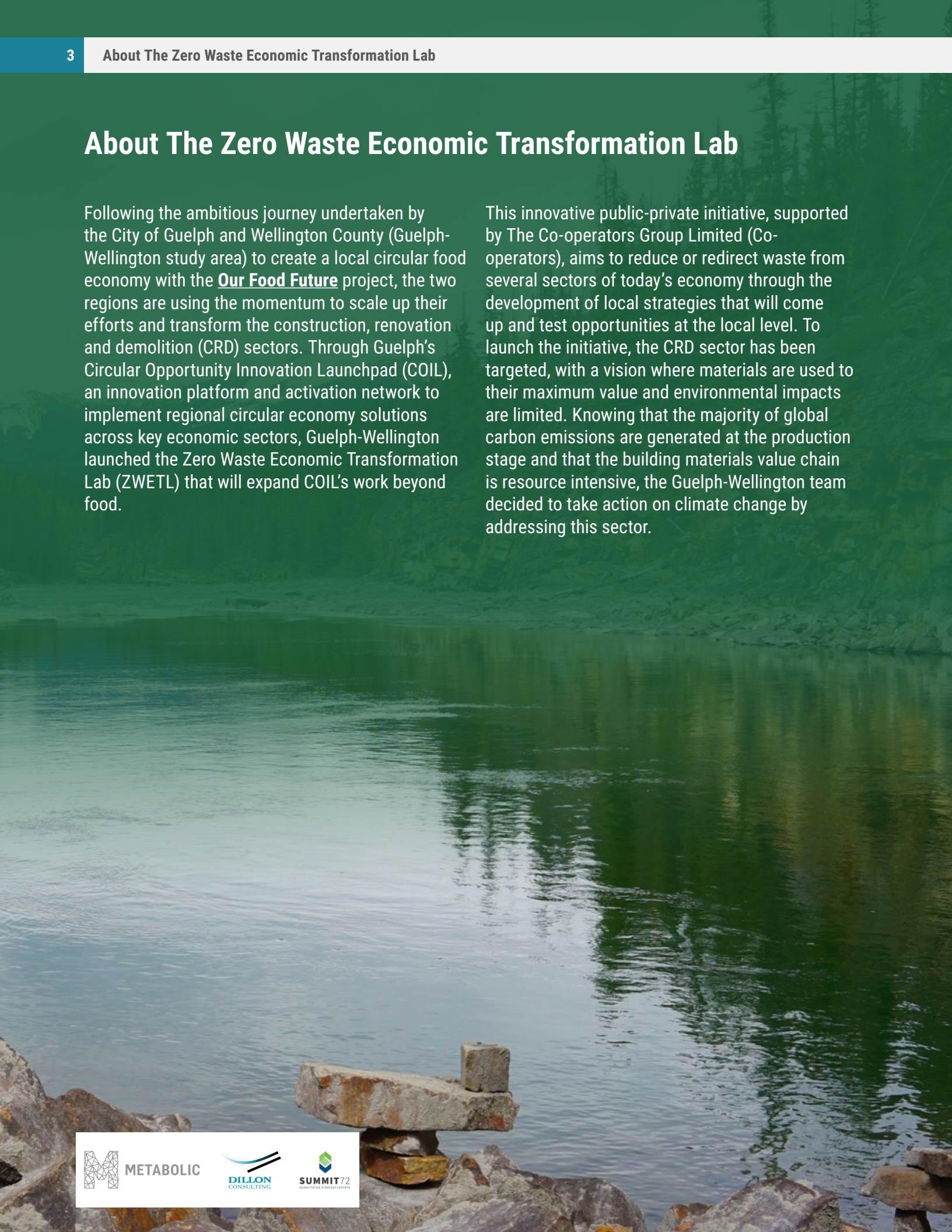
Within inflows, which have the highest impacts when compared to outflows, construction activities account for the highest consumption of materials, and attributes the highest GWP impacts.

Material Flows in the CRD Section in Guelph-Wellington

About The Zero Waste Economic Transformation Lab

Following the ambitious journey undertaken by the City of Guelph and Wellington County (Guelph-Wellington study area) to create a local circular food economy with the **Our Food Future** project, the two regions are using the momentum to scale up their efforts and transform the construction, renovation and demolition (CRD) sectors. Through Guelph's Circular Opportunity Innovation Launchpad (COIL), an innovation platform and activation network to implement regional circular economy solutions across key economic sectors, Guelph-Wellington launched the Zero Waste Economic Transformation Lab (ZWETL) that will expand COIL's work beyond food.

This innovative public-private initiative, supported by The Co-operators Group Limited (Co-operators), aims to reduce or redirect waste from several sectors of today's economy through the development of local strategies that will come up and test opportunities at the local level. To launch the initiative, the CRD sector has been targeted, with a vision where materials are used to their maximum value and environmental impacts are limited. Knowing that the majority of global carbon emissions are generated at the production stage and that the building materials value chain is resource intensive, the Guelph-Wellington team decided to take action on climate change by addressing this sector.



The Guelph-Wellington Area

The study area (Figure 1) includes the City of Guelph and seven member municipalities within Wellington County. Covering just over 85 km^2 and with a population of 143 740, the City of Guelph, an urban area, has a higher building density than the surrounding rural county, which is about 30 times larger and has a population of 241 000, almost twice that of the City of Guelph.

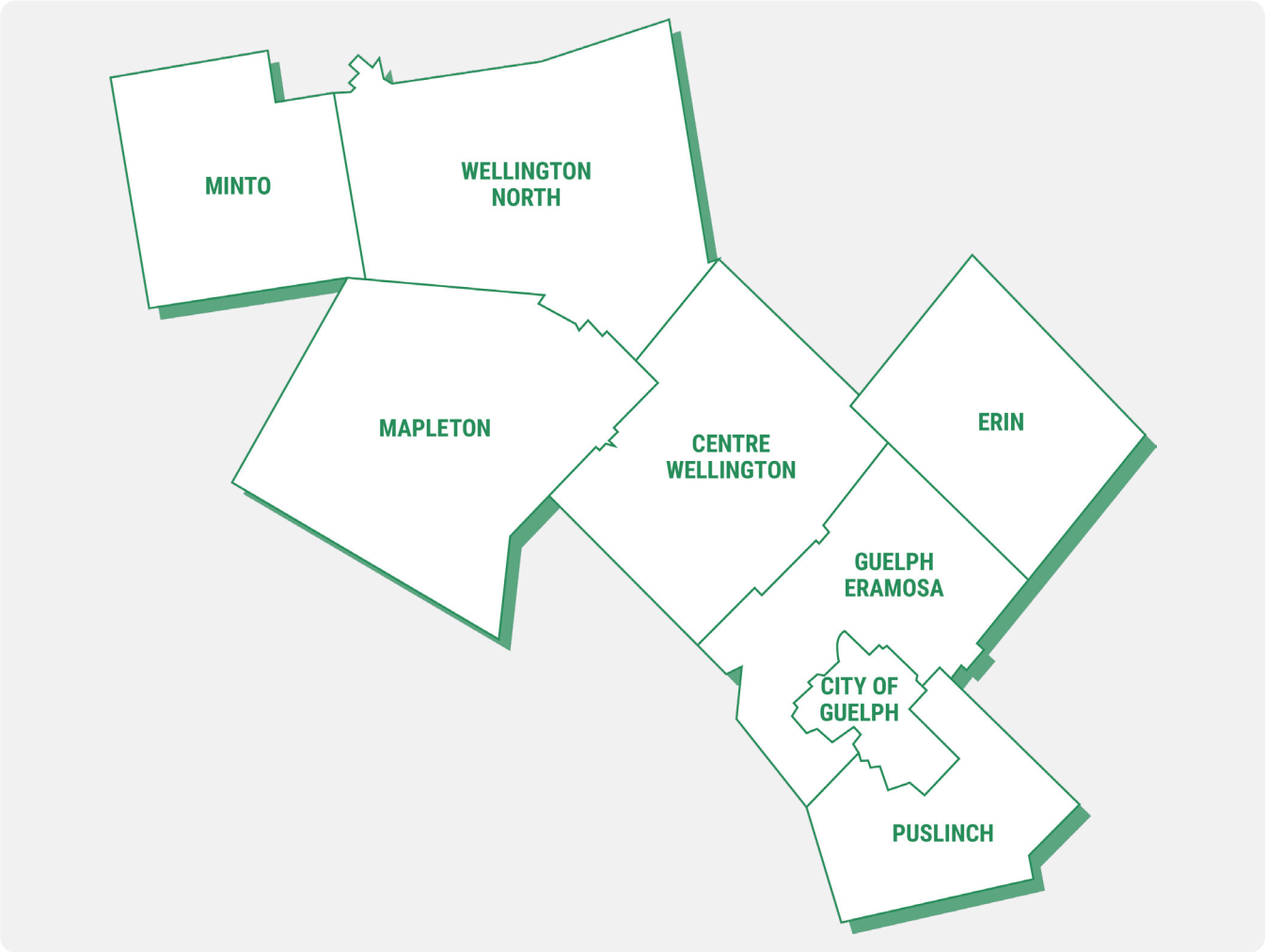


Figure 1. Geography covered in the study

Guelph-Wellingtons's Construction and Demolition Materials Flows

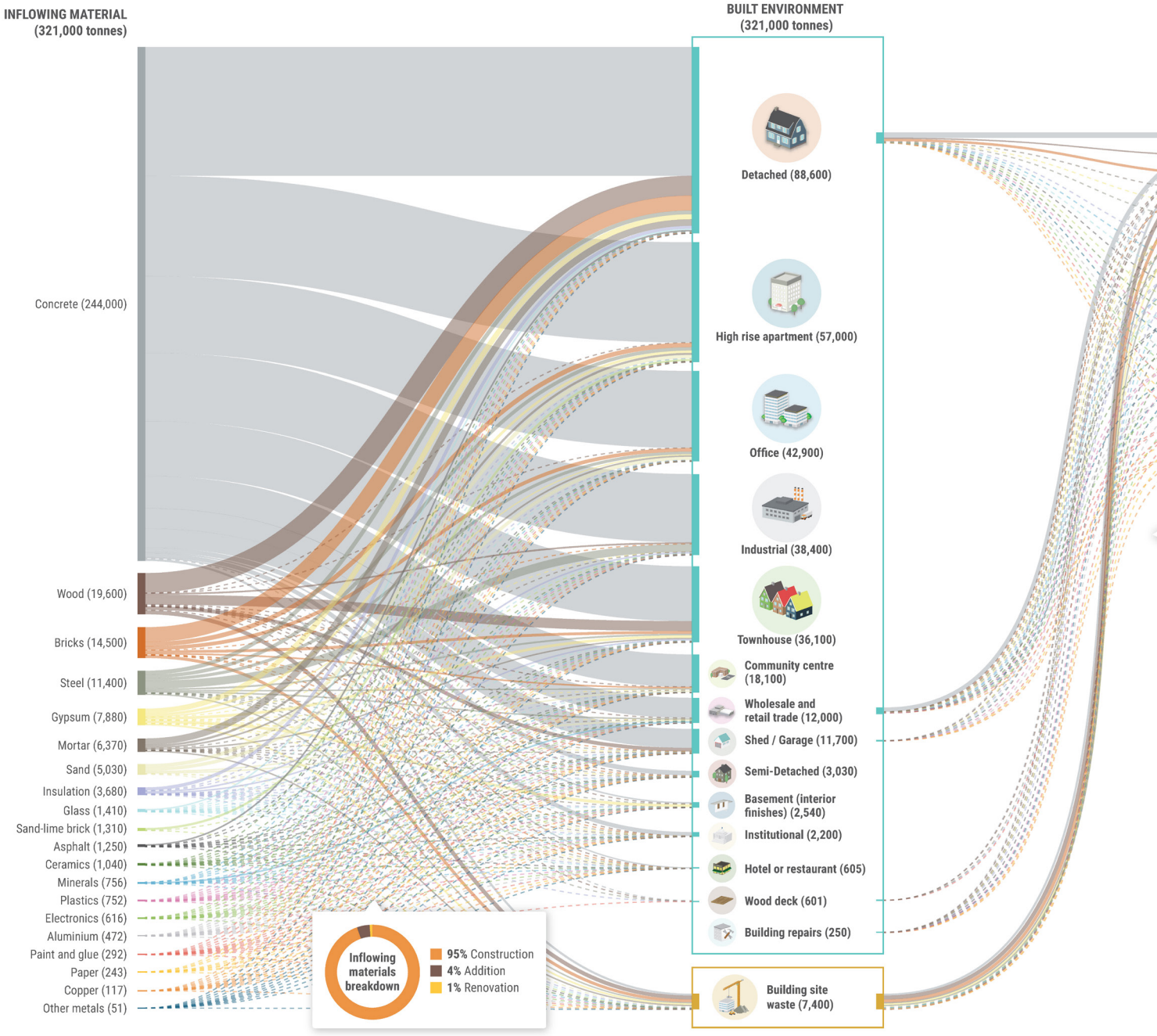


Figure 2. Sankey diagram of the Guelph-Wellington region CRD materials.

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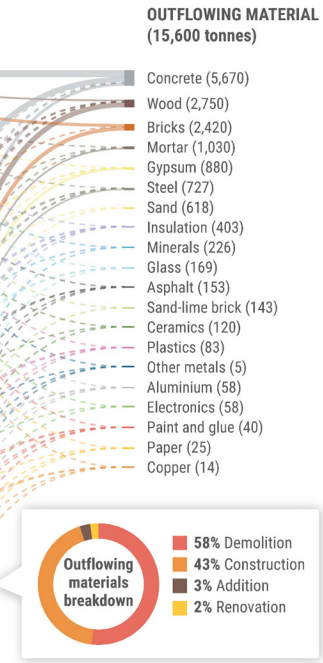

To better understand resource flows within the region's construction, renovation and renovation (CRD) sector, Guelph-Wellington commissioned Dillon Consulting Limited, (Dillon), Metabolic and Summit72 to conduct a Material Flow Analysis (MFA), which will increase the insight into regional flows and allow for more informed decisions to develop a realistic and bold roadmap for the region. This baseline assessment of CRD material flows provides a foundation for key stakeholders in the Guelph-Wellington study area to identify high-impact opportunities around key material flows in the CRD sector that can help transition the sector to a circular state.

The MFA illustrates material flows, which were modeled from three main sources. The majority of the consumption and waste flows were modeled from Metabolic's Urban Mining Model (UMM) based on construction and demolition permits issued in the region in 2021. Complementary to this model, we incorporated the standard building site waste fraction estimated at 10-15% by mass of new building materials – insights provided by a local expert working on building sites. Data from Cooperators was incorporated into our model as it covers material waste from damage repairs. This additional data source was important in part because some renovations are completed without a building permit (see Appendix I for the complete methodology).

Figure 2 is an MFA Sankey diagram for CRD materials within Guelph-Wellington. A MFA is read from left to right and in this case, the start of the flow (i.e., inflowing material) are the raw materials that are used as inputs for the built environment (e.g., from new construction and renovation projects). The middle of the MFA shows the types of buildings the raw materials were used for (i.e., Built Environment). The right end of the MFA illustrates the materials coming out of the built environment (i.e., outflowing material) as a result of demolition, renovation and/or construction waste generating activities.

As can be seen in the Sankey diagram, there is an imbalance in the mass of incoming and outgoing material flows in the built environment in Guelph-Wellington. This is largely due to the much greater amount of building versus demolition activity. Most of the inflowing material goes to residential buildings, such as detached homes, high rise apartments and townhouses. There is also a big share of inflowing material going to office and industrial buildings such as warehouses.

The mapped outflowing material is coming from the demolition of various building types and from waste generated during construction of new buildings. The following sections offer a more in-depth look at the MFA.

What About the Waste?

Waste disposal channels remain largely unknown in the study area due to the lack of adequate control of CRD waste generation, diversion and disposal and associated data. The majority of this type of waste is handled by private sector service providers with municipal governments handling a smaller proportion of CRD waste through their waste management facilities. Based on local observations and what is assumed to be common practice in Canada, it can be assumed that a large majority of the CRD waste generated finds its way into landfills.

The City of Guelph operates a drop-off depot at their integrated waste management facility (Waste Resource Innovation Centre, WRIC). The depot processes a small fraction of the CRD waste generated throughout the study area (see Appendix II) which is typically delivered from residents doing small construction projects and small contractors. In fact, in 2021, the WRIC received nearly 1,590 tonnes, hence about a tenth of the estimated waste generated in the study. From the small fraction collected, the majority was asphalt shingles that were recycled at the Try Recycling location in London, Ontario. Once recycled, the recycled asphalt product can be part of an asphalt mix and used in a number of applications (i.e., as a mixed material that can be added in certain applications).

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Guelph-Wellington Incoming Flows

The majority of activity generating incoming material flows in the Guelph-Wellington area is new construction (Figure 3). In 2021, the total number of building permits pertaining to incoming material flows in Guelph-Wellington are primarily new construction (87% by floor area) with a total built area of almost 415,634 m^2. Renovation or expansion/addition of the existing buildings, respectively 7 & 6% of floor area, both alternatives to building new structures, are the other two most common activities with areas of about 31,000 m^2 and 24,000 m^2.

In Figure 3, we can see the relation between the total floor area, the total mass of materials and the total global warming potential (GWP) of nine building types (see appendix I) being built or altered in the Guelph-Wellington region. Although the area built is dominated by detached homes, townhouses, high rise apartments, and industrial buildings, the total mass of incoming materials and associated emissions follows a slightly different trend where detached homes, high rise apartments, office and industrial buildings have the largest mass and impacts. From the MFA and the permit area distribution (Figure 2 & 4), we can highlight that residential building types are predominantly built in the region.

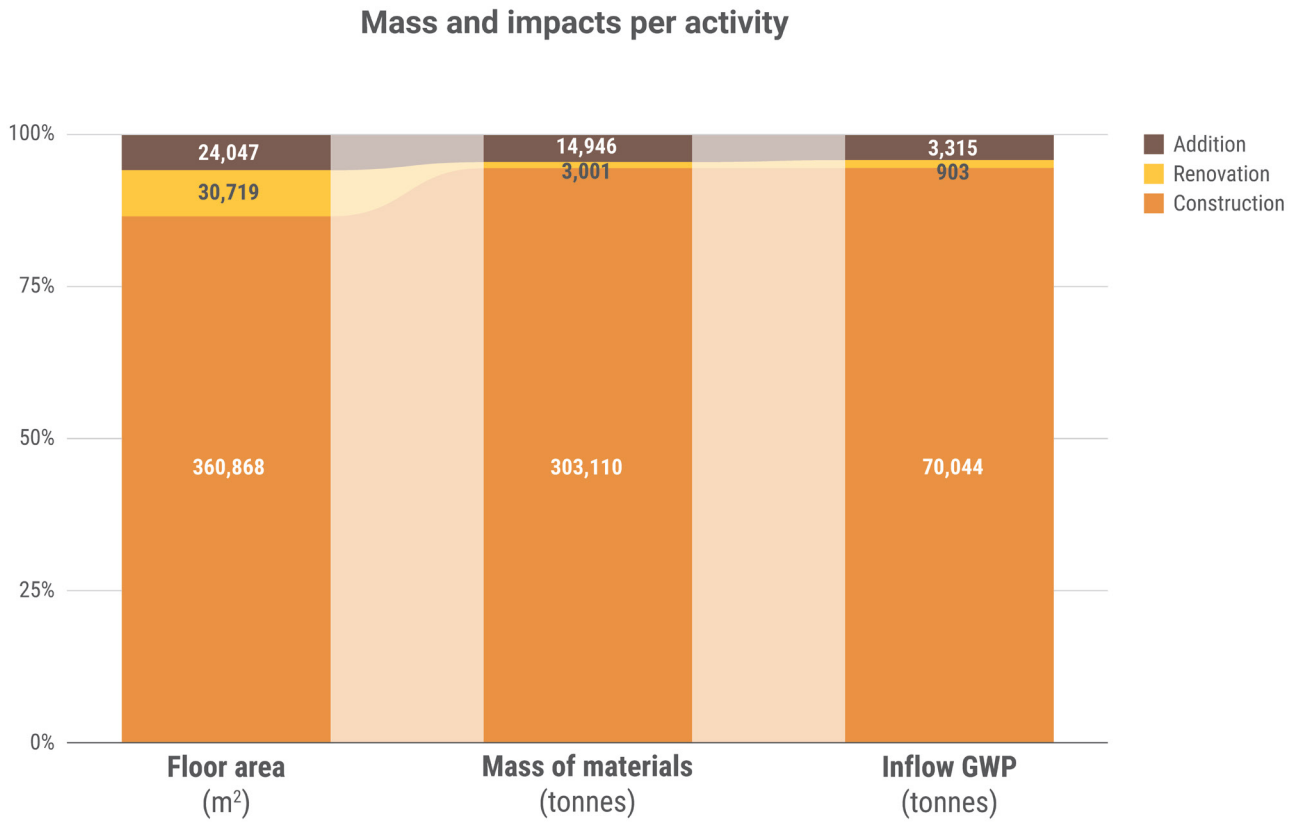


Figure 3. Building activity breakdown

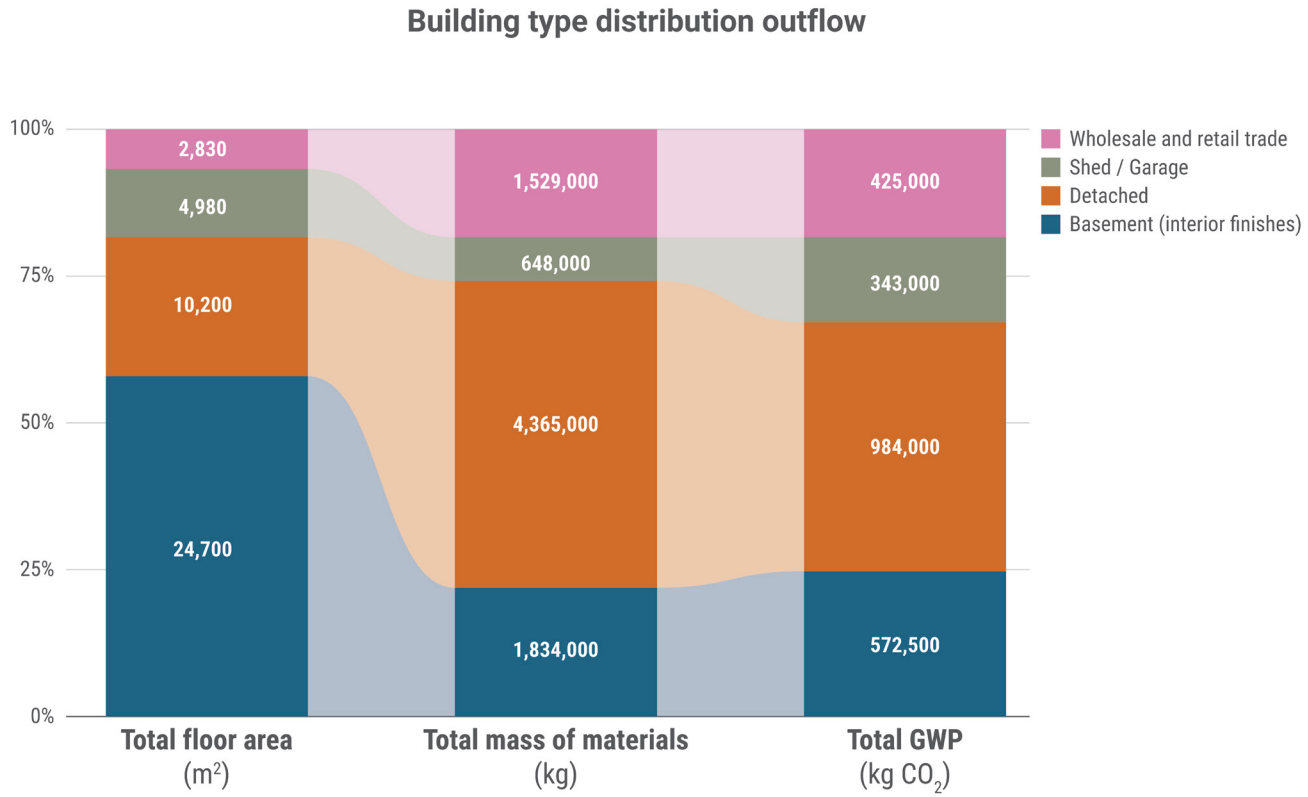


Figure 4. Building type distribution inflow

Single-family detached homes, townhouses, and high rise apartment buildings have the largest area allocated from building permits among the 9 building profiles studied, which is also reflected in the distribution of building materials used by mass (Figure 4). The attention and share of built area for residential buildings could be perceived as a direct response to the current housing crisis and is driven by local space availability.

Approximately 321 kilotonnes of building materials went into the built environment in 2021 from which the majority of materials used in terms of mass were concrete (76%), followed by wood (6%) and bricks (5%) (Figure 5). Not surprisingly, concrete is by far the most used material by mass. Despite not being only made of concrete, the most frequently building type built, detached homes, still uses a considerable amount of concrete for the ground floor slab and/or basements. Moreover, the large input of concrete in the built environment can be attributed to the construction of high rise apartment buildings and other non-residential buildings, such as office or industrial buildings that use a lot of concrete. The extensive amount of wood – about a third of the amount of concrete used by volume – utilized can be attributed to the structure of multiple building types such as detached homes or townhouses.

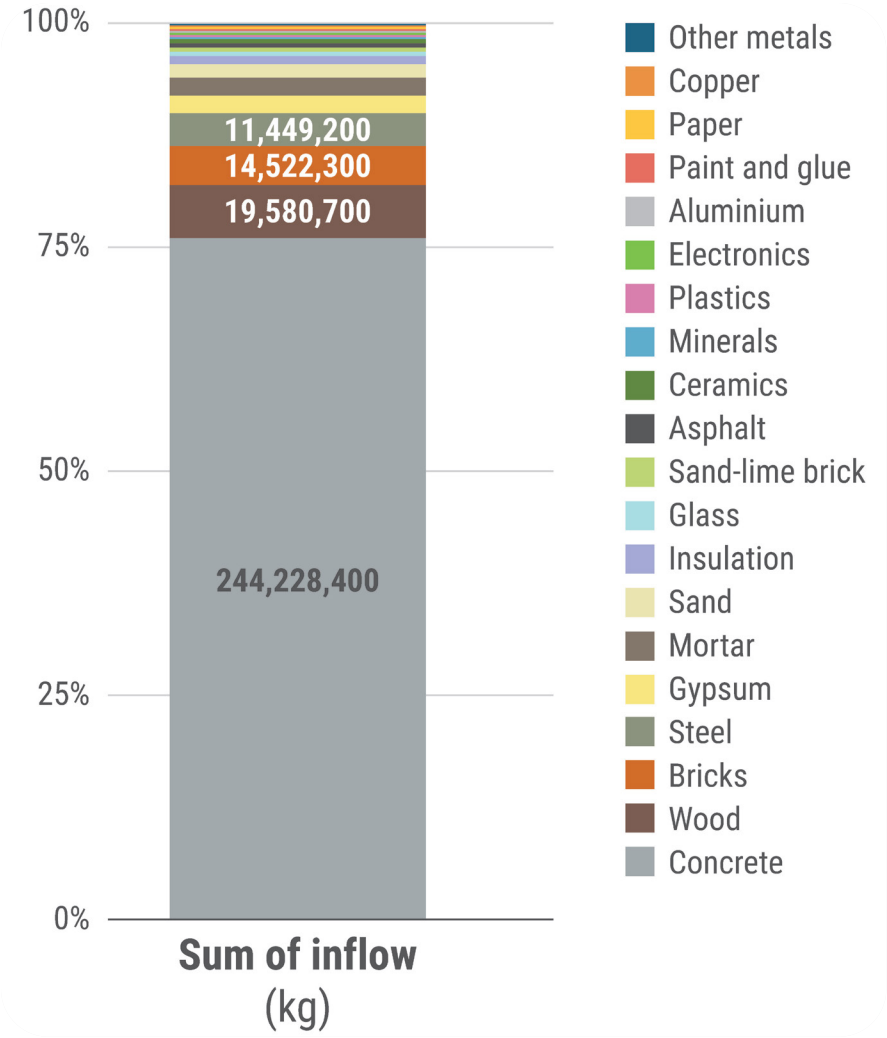


Figure 5. Inflowing materials

Density of materials

Concrete
2,400 kg/m³

Timber and wood building products
550 kg/m³

[Comparative life-cycle assessment of a mass timber building and concrete alternative]

Guelph-Wellington Outgoing Flows

The demolition permits in the Guelph-Wellington area that contribute to the generation of C&D waste have a total area of 11,038 m^2. In addition to the outflowing materials from building demolition (49%), a large quantity of waste is generated during building activities. Based on interviews with local building site managers, it was assumed that approximately 10-15% of building materials (excluding concrete) end up as waste due to off-cuts and over ordering. A small fraction of further CRD waste comes from renovation activities, although data on these activities was incomplete and might be underestimated (Figure 6).

The demolition permits in the Guelph-Wellington area that contribute to the generation of C&D waste have a value of $1,152,600 with a total area of 11,038 m^2. In addition to the outflowing materials from building demolition (48%), a larger quantity of waste is generated during construction activities. Based on interviews with local building site managers, we have assumed that 10-15% of construction materials end up as waste due to off-cuts and over ordering. A small fraction of further C&D waste comes from renovation activities, although data on these activities was incomplete and might be underestimated since some activities may take place without a permit.

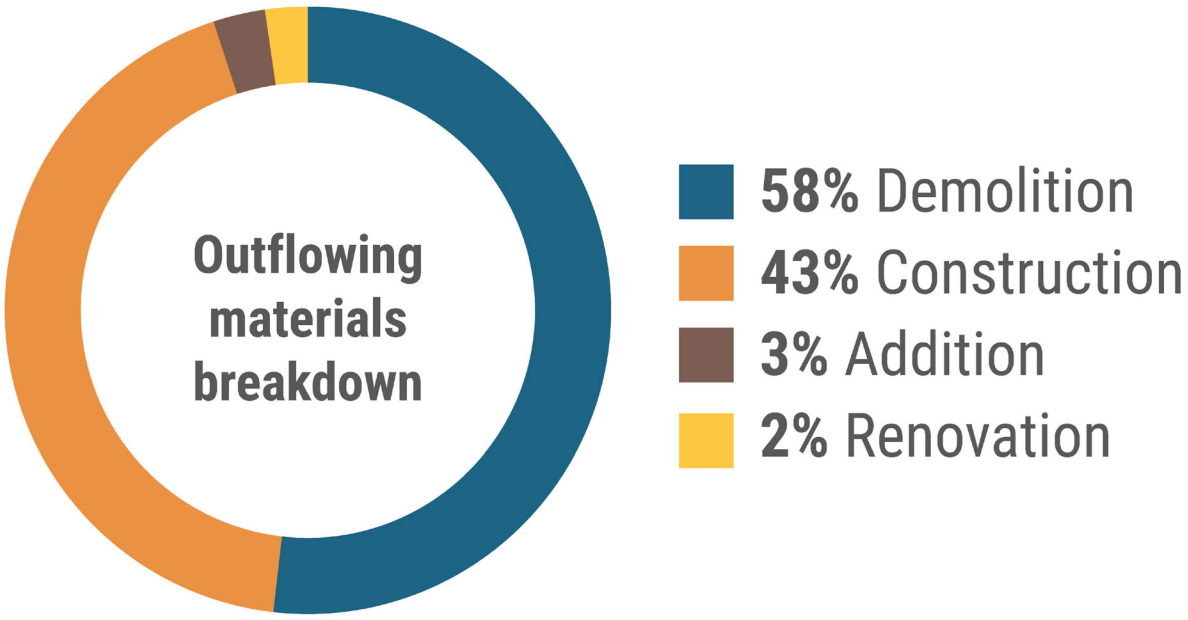


Figure 6. Breakdown of activities generating waste

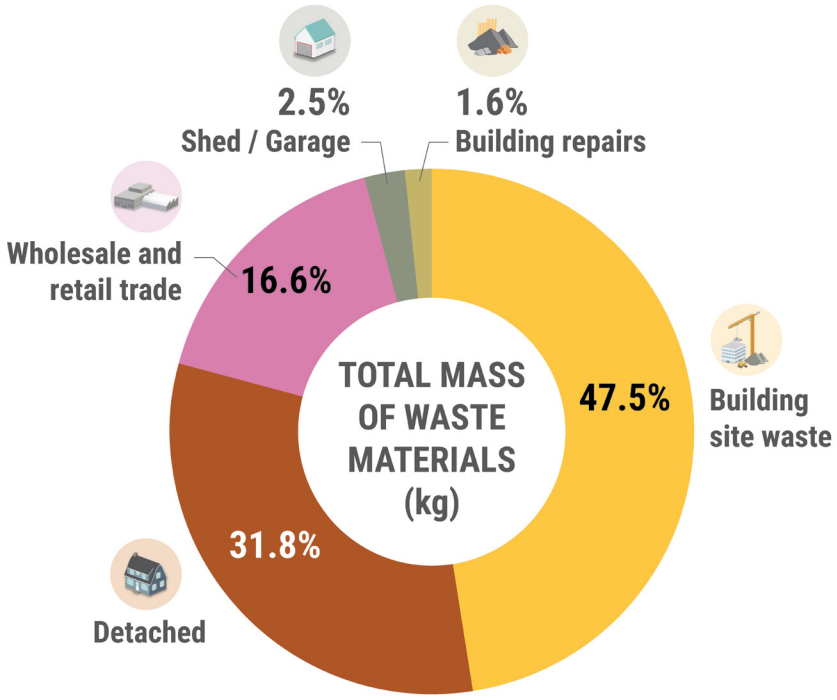


Figure 7. Mass distribution of the waste materials

In Figure 7, we can see the sources of construction and demolition waste in the region. Most of the waste is generated on building sites, the demolition and alteration of three building types also contributes to the waste generation in the Guelph-Wellington region.

The large share of building waste can be explained by the excessive amount of materials frequently ordered on building sites – a common practice in the sector – but also by the comparison with minimal demolition activities.

Demolition waste would come from the demolition of detached homes, wholesale and retail buildings, and sheds and garages. A smaller fraction of waste comes from building repairs after damage, the data for which was provided by Co-operators.

1 kt CO_2e is equivalent to the emissions of a full return flight between Vancouver and Amsterdam.

Figure 8. Embodied impact outflowing material

Embodied impact outflowing material

Wasted materials cannot have their embodied impacts assessed in the same way as new materials can. The embodied impacts of the building materials are calculated when producing new materials for introduction to the built environment.

To give an idea of the size of the embodied impacts of outgoing material we can calculate what the embodied impact would be if these materials were to be produced new (Figure 8). This gives an indication of how much impact could be saved by high-value reuse of building products through deconstruction instead of demolition practices.

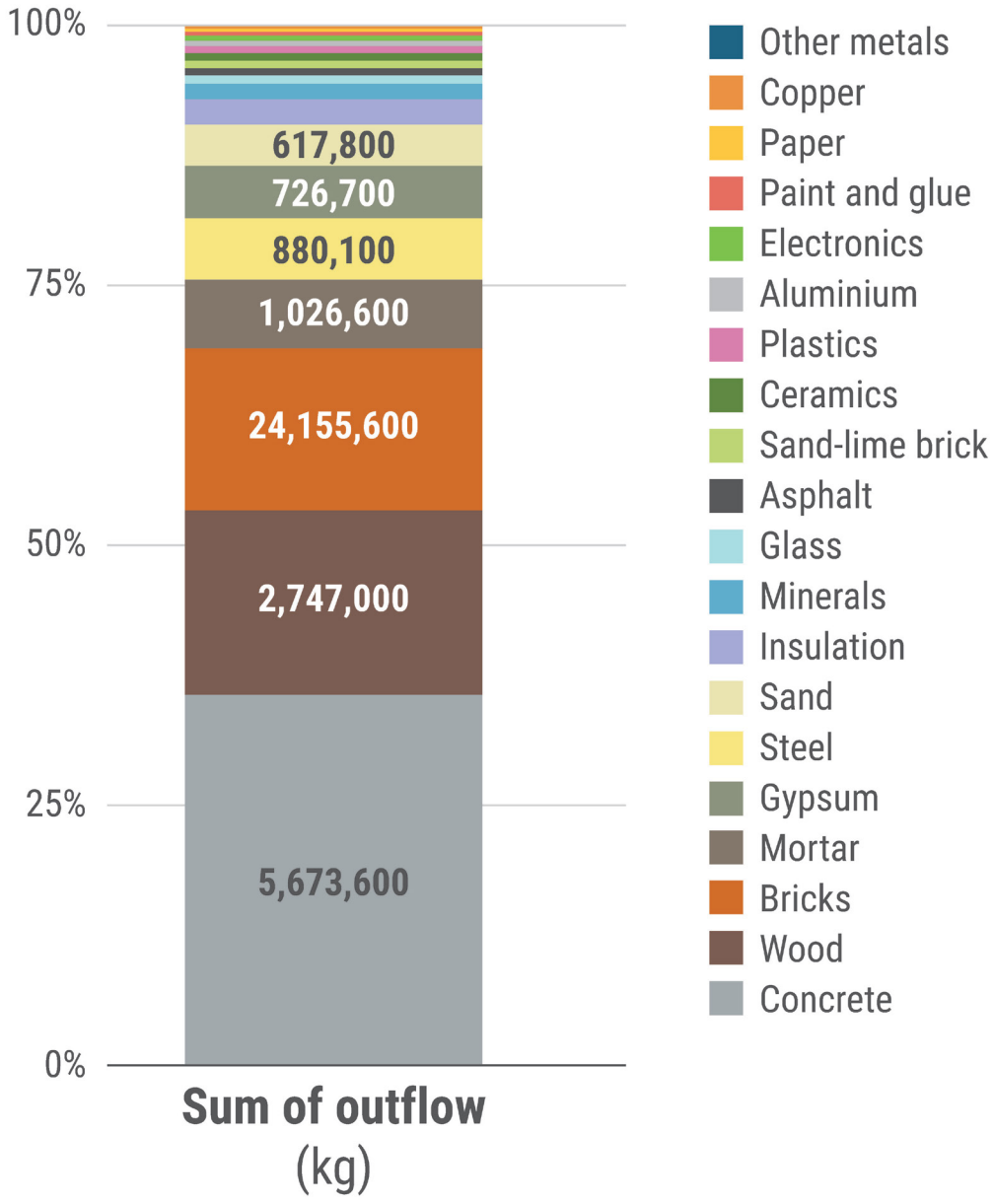
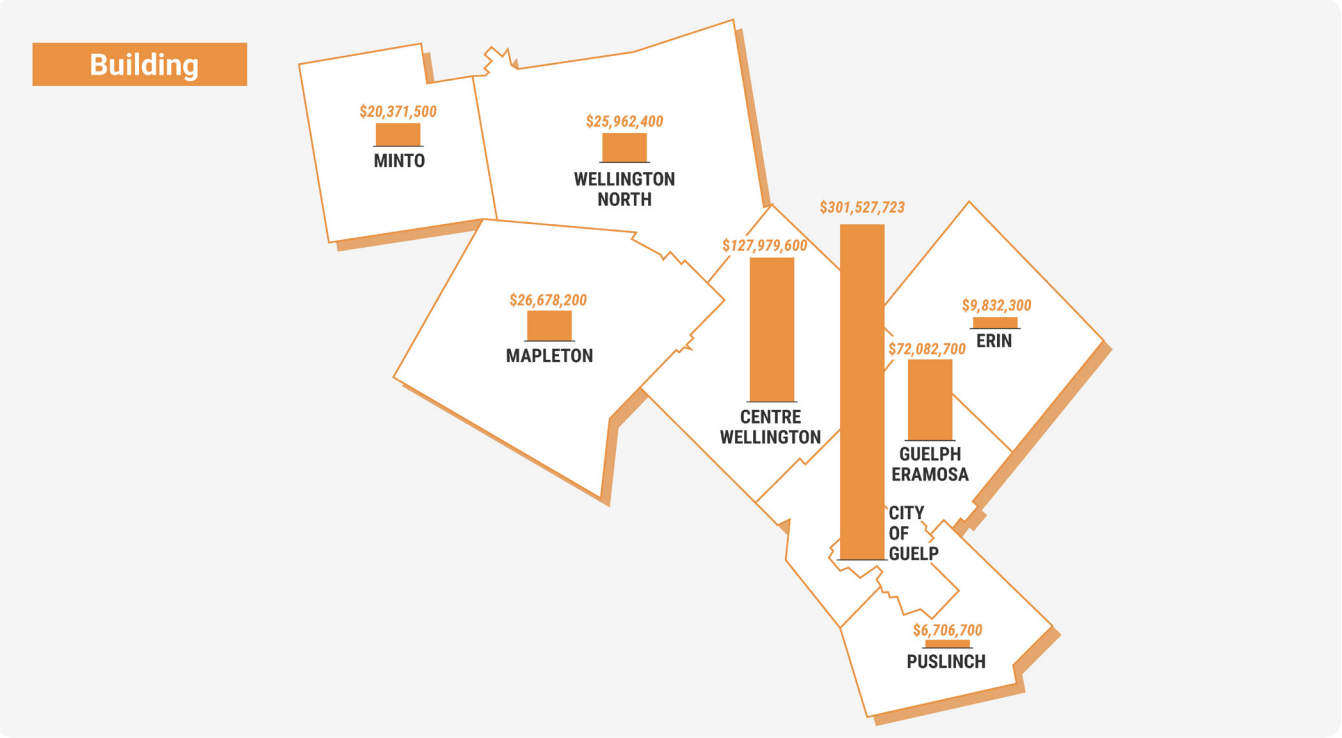


Figure 9. Outflowing materials

15.6 kilotonnes of outflowing materials came out of the built environment in 2021. As seen in Figure 9, most of the materials output in terms of mass consisted of concrete (37%), wood (18%), bricks (16%), and mortar (7%).

Spatial Analysis

The study area can be divided into Wellington County and the City of Guelph, two widely different typologies, the first being a rural region and the second an urban one. The next section looks at differences in CRD activities between the two municipalities. Below, in Figure 10, we can see the monetary value of construction and demolition activities distributed over Wellington County's member municipalities and the City. From the breakdown, we see that the City of Guelph had much more building activity, while Wellington saw more demolition activity in 2021.



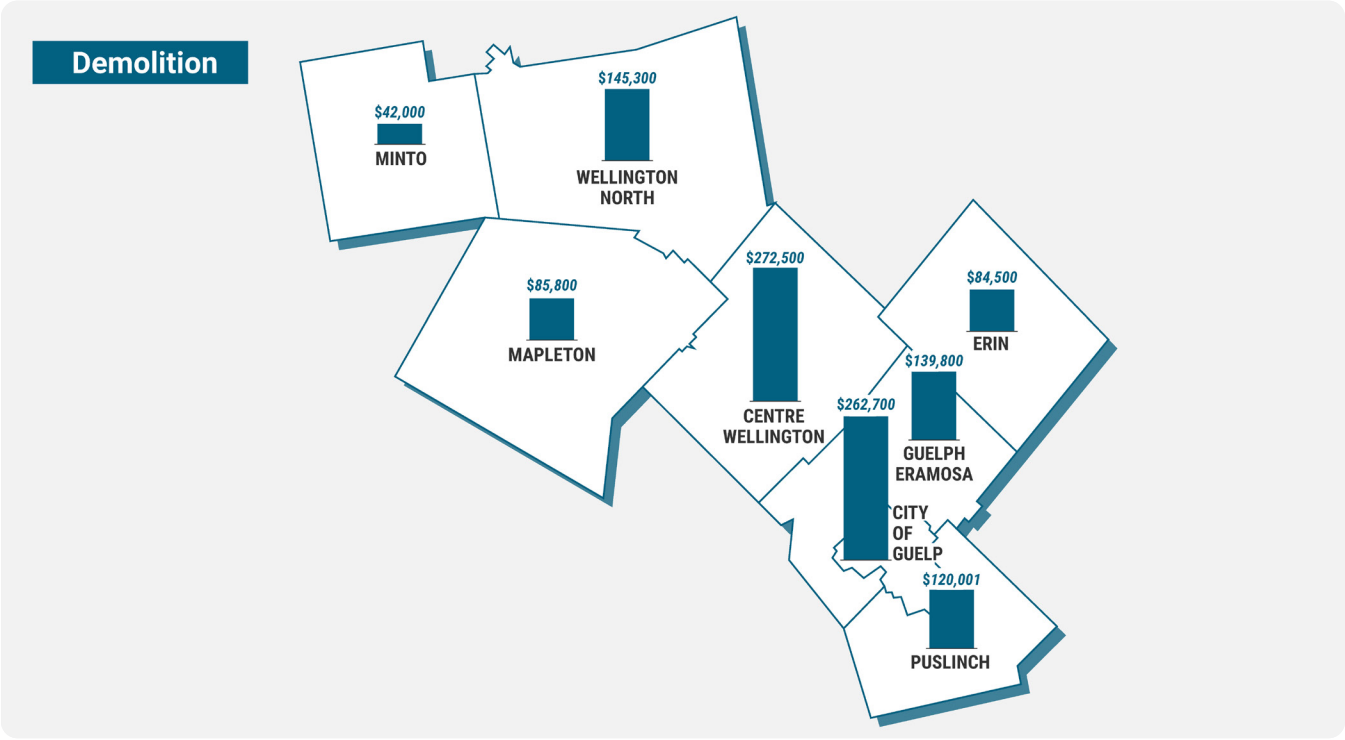


Figure 10. Monetary value of the building and demolition permits in the Guelph-Wellington region

Monetary value and area of permits

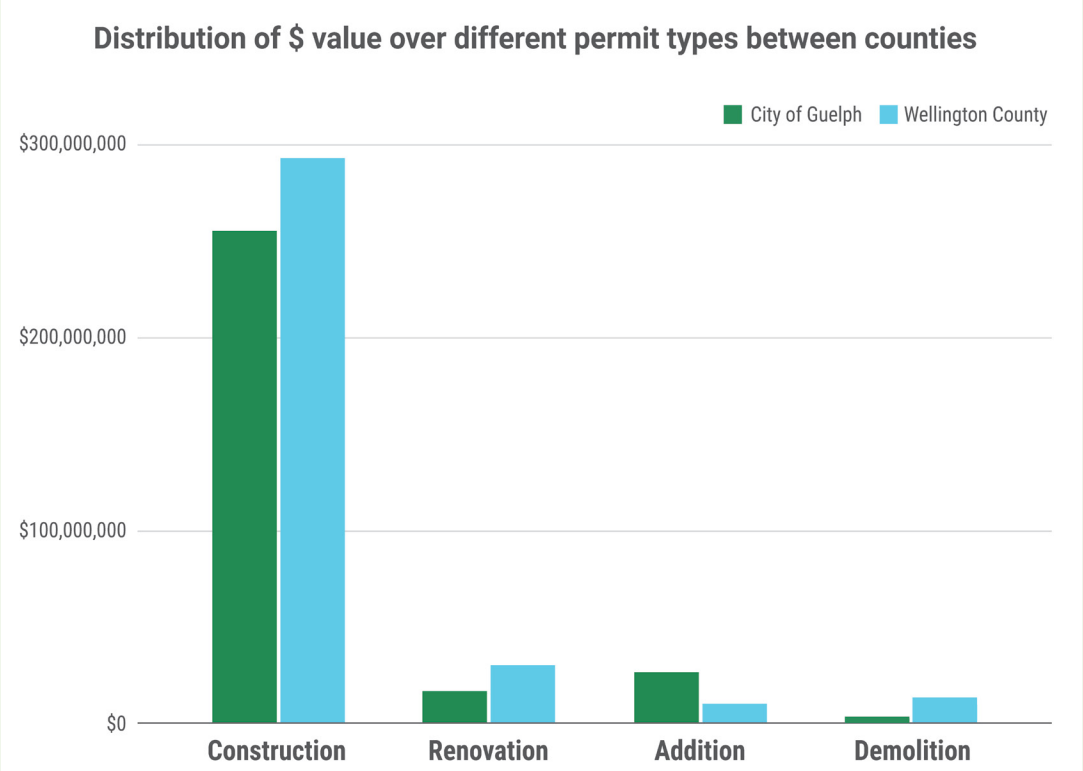


Figure 11. Distribution of $ value over different permit types between counties

Value of permits

City of Guelph:	$301,790,423
Wellington County:	$290,503,278

Area of permits

City of Guelph:	198,182 m^2
Wellington County:	228,490 m^2

The Guelph-Wellington area, which includes seven townships and the City of Guelph, saw its value spent on all construction and demolition permits roughly equally distributed between the County and the City. In 2021, the City spent just over $300 million, slightly more than the County (Figure 11).

If we zoom in on the types of activities, we see that in both municipalities more is spent on building than demolition activities (Figure 11). Both in terms of value spent and area built, Wellington County saw more renovation and demolition activities than the City of Guelph and less addition. As for building permits, the value granted for the City of Guelph is slightly higher than for the Wellington County while the permit area is greater for the latter. This difference can be explained by the significantly high amount of construction of less expensive building types per area such as industrial buildings.

Demolition activities represent an insignificant portion of the total value spent in the sector, about 0.2%. However, it is interesting to note that Wellington County spent significantly more than the city on demolition in the reference year: $889,900 versus $262,700, or about three times as much.

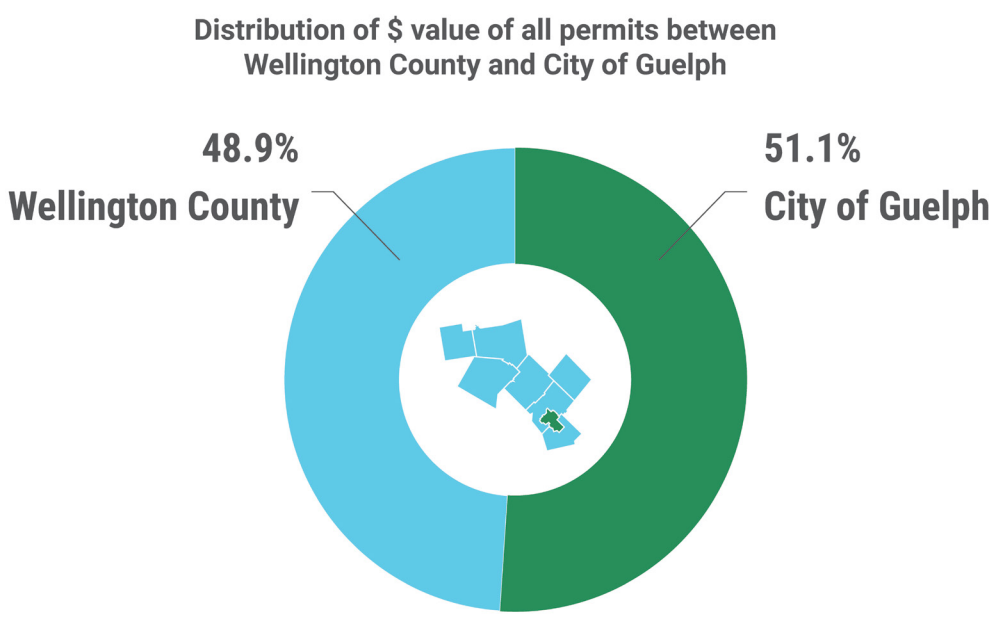


Figure 12. Distribution of monetary value over different permit types

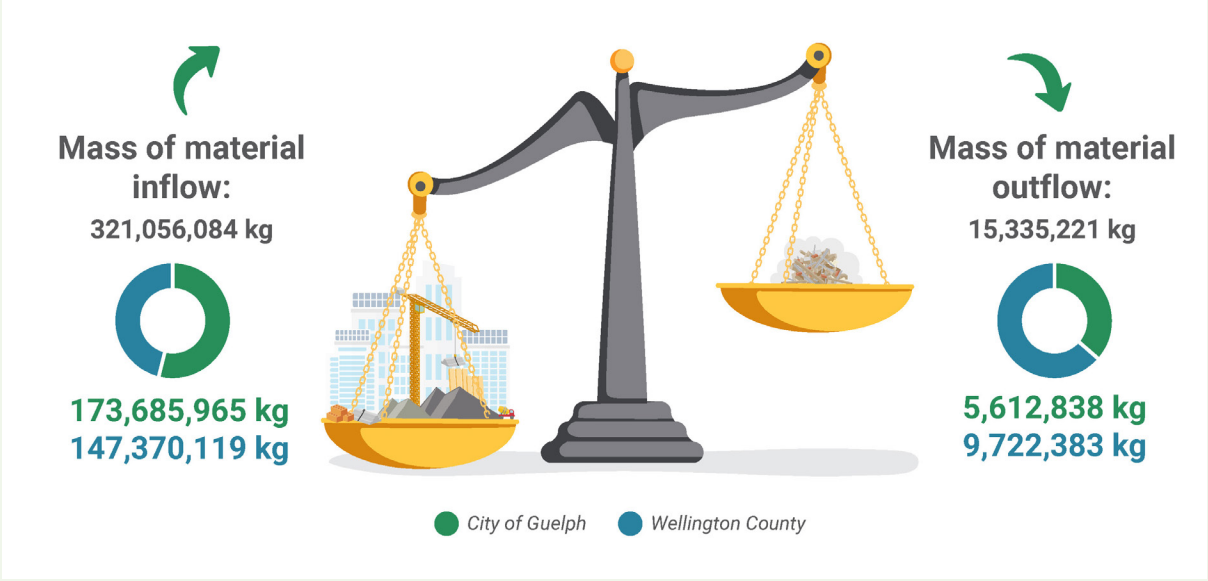


Figure 13. Distribution of material flows

Similarly to the distribution of the monetary value and floor area of permits, materials entering the built environment are higher for both regions than the ones exiting (Figure 13).

Although both regions having a material need relatively similar for each type of permits requested, the mass materials waste generated by demolition activities is more than four times larger for Wellington County than for the City of Guelph.

Hotspots & Conclusion

In analyzing the inflow and outflow of construction, renovation and demolition materials in Guelph-Wellington, we highlighted the following points that stand out as requiring additional attention.

Data transparency

Based on the modeling exercise presented in this report, we were able to estimate the C&D material flows in the Guelph-Wellington area using Metabolic's Urban mining model (see Appendix I). This provides an estimation of materials used for new construction and waste generated by demolition, but doesn't provide information on sourcing of consumed materials nor processing methods of waste generated. Although many attempts were made to gather data through local stakeholders in the C&D waste processing sector, none were able or willing to provide data on waste processed at their facilities. Unavailability of procurement and CRD waste collection/processing data prevents the identification of hotspots or more targeted opportunities in the current supply chain or processes. To move towards a circular and sustainable construction and demolition sector it is vital to know where and how waste is being processed, so that circular opportunities for reuse of waste streams can be identified.

Flow imbalance

Just a quick glance at the MFA diagram picturing the inflows and outflows in the study area shows that there is an imbalance between the material mass entering the built environment and the one exiting. In fact, it is estimated that there is about 21 times more new material used than there is waste generated. While a relatively small amount of waste is a good thing, this imbalance also is typical for the urban sprawl that is occurring in the study area, a typical pattern in the North American context.

While being present in lower quantities, the waste generated in Guelph-Wellington has a similar composition as the materials needed for new constructions and renovations. Concrete, wood, and bricks represent the largest proportion (by mass) of materials inputs and outputs. Outflowing materials are characterized by a higher relative share of wood and bricks than concrete, as compared to inflows. The match between incoming and outgoing streams, combined with the recyclability of these materials, provides a great opportunity for reuse of waste materials. Although not a large proportion of the region's material needs, the outflows could replace a decent share of needed construction materials.

It is good to note that the baseline year chosen for the permits used in the modeling exercise (2021) is slightly different from a typical year in terms of total construction and demolition activities. In other years it is quite possible that the flow imbalance is smaller, but still ingoing material flows always far outweigh outgoing material flows. In Appendix III a comparison between permits issued in the year 2021 and other years can be seen.

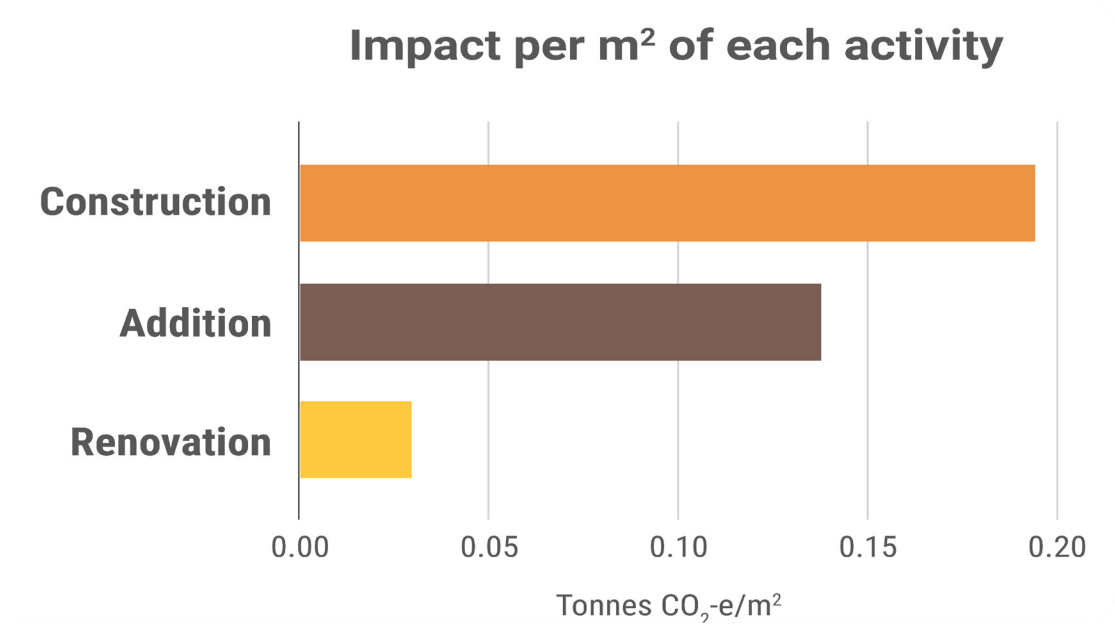


Figure 14. Impact per unit area of building activities

Construction vs. Renovation

When zooming in on the type of activities at the origin of the large quantity of inflowing materials, we see that the majority is used for new construction (86%) compared to renovation or addition on existing buildings. The current housing crisis explains the large number of residential building activities in the region, accounting for 72% of all building activities based on floor area of permits. When looking at the impact per square meter of building activities, we clearly see that construction, due to its higher material density, has a much higher impact than renovation and additions (Figure 14).

As well as being more sustainable, renovation and addition to existing buildings would cost about 1.5 times less per square meter built than new construction (Figure 15). The value spent on new constructions in Guelph-Wellington accounts for 10 times as much as what is spent on renovation and addition, while about seven times the renovation and addition area represents the new construction area.

Permit value comparison in Guelph-Wellington

New construction

$1,480/m²

Renovation & addition to existing buildings

$1,010/m²

Figure 15. Permit cost per unit area comparison

Housing impact analysis

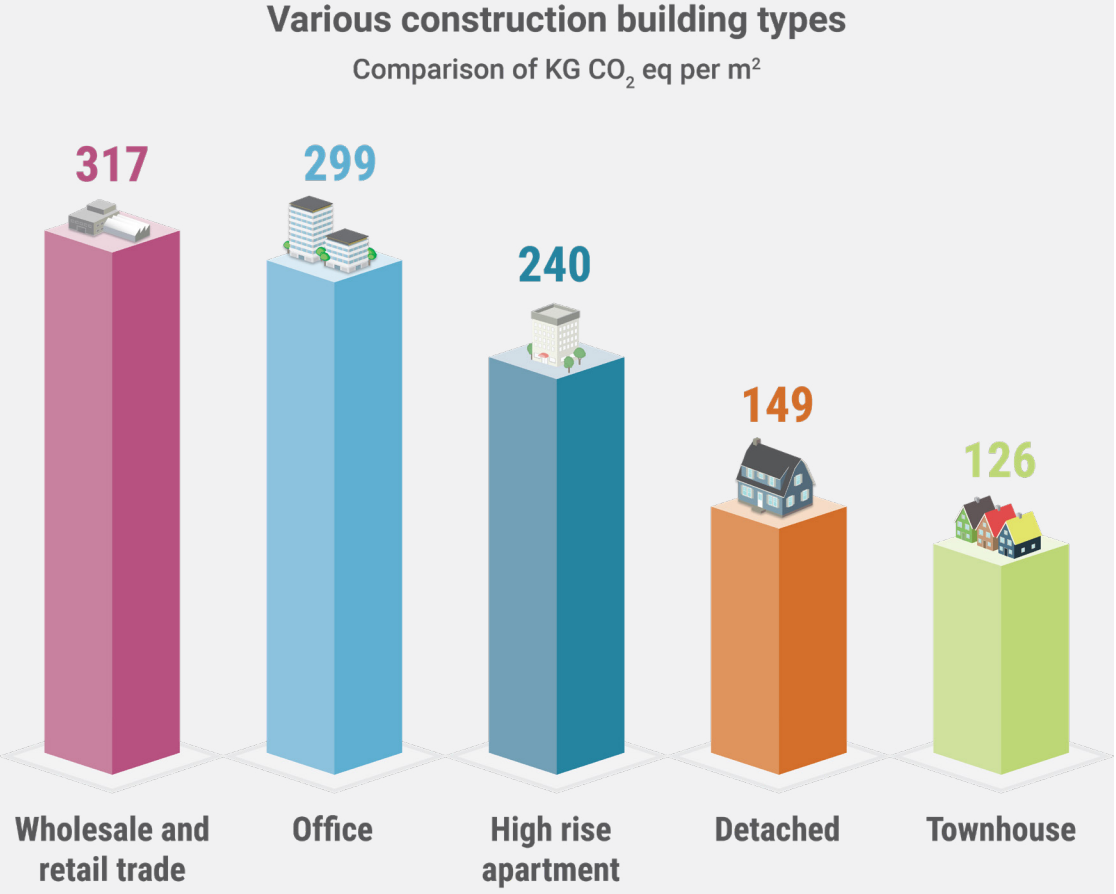


Figure 16. Impacts per unit area of building types

Figure 16 shows the environmental impact per unit area of the five most impactful building types in Guelph-Wellington. From them, three are residential buildings. Due to its extensive use of high-impact materials – concrete and steel as seen in Appendix I – wholesale and retail trade buildings stand as the most impactful building type per unit area built. Due to a similar composition, high rise apartments and office buildings follow, followed by buildings using less impactful materials.

Although using relatively less impactful materials in their construction, the average living area per housing unit is about 1.6 times larger for detached homes than for high rise apartments (Figure 17). Therefore, the impacts per housing type can be compared on a per housing unit basis for better insights (Figure 18). With this comparison, detached homes are the most impactful, followed by high rise apartments, semi-detached homes, townhouses, and apartments in dwelling.

Material Flows in the CRD
Section in Guelph-Wellington

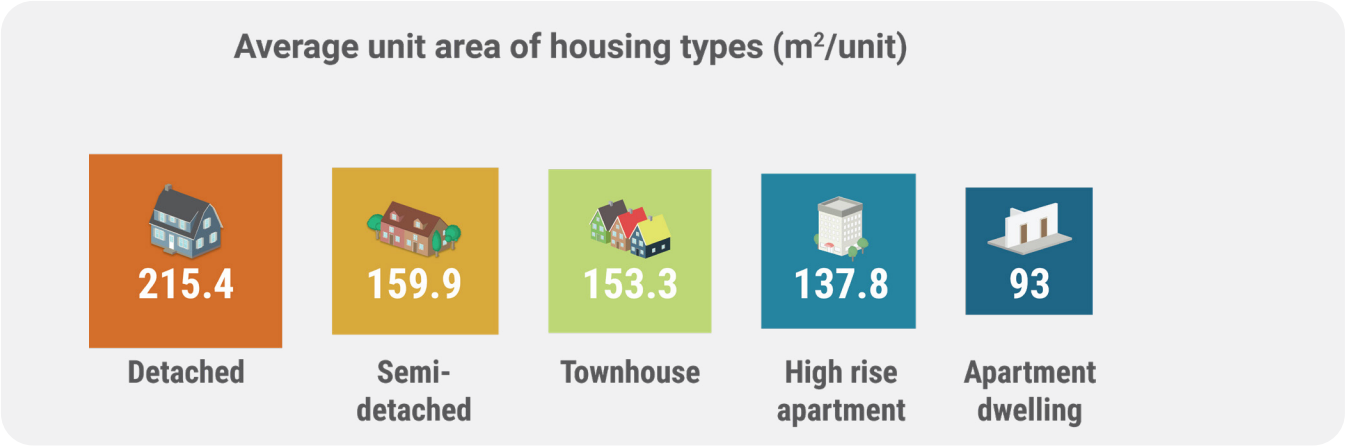


Figure 17. Average unit area of housing types

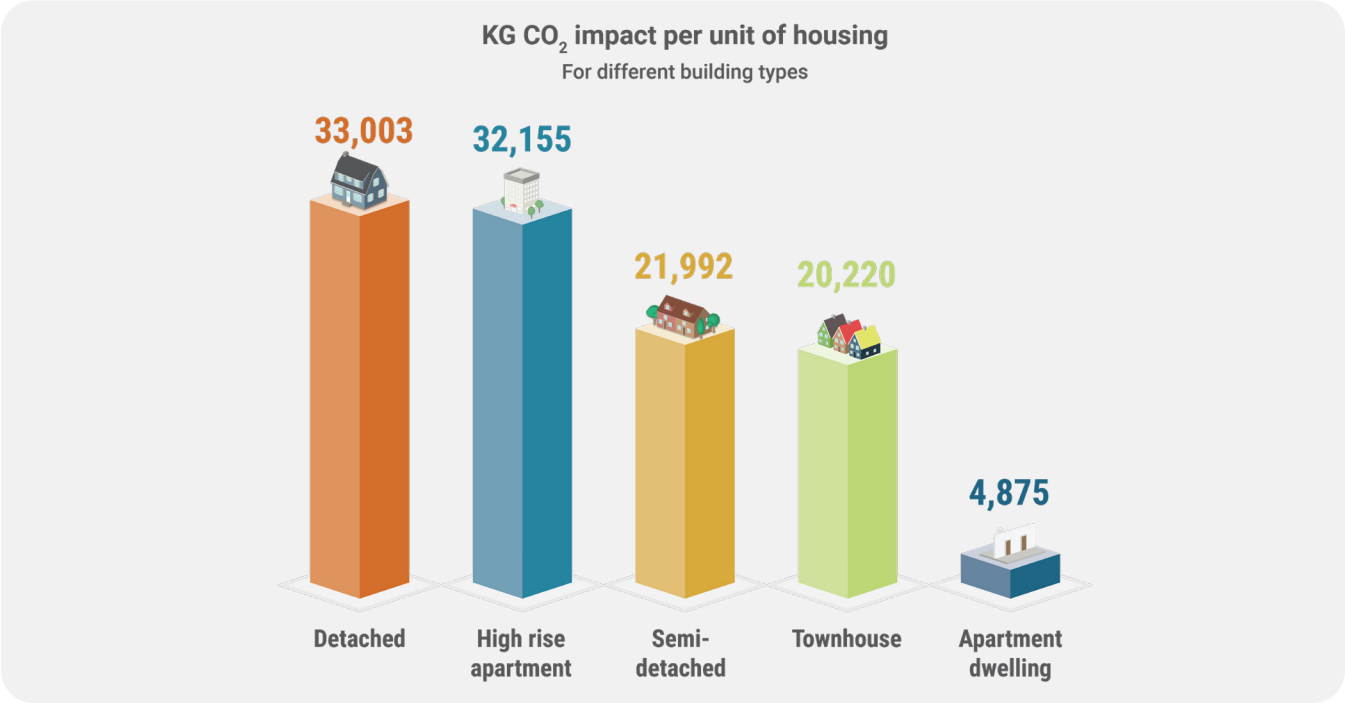


Figure 18. Impact per housing unit

Conclusion

The Guelph-Wellington study area can be considered to have relatively standard construction and demolition practices in the North American context. With approximately 20 times more material entering the built environment than exiting, the region meets its housing and industrial space needs through urban expansion rather than reuse of what is already present in the local building stock. In addition, as is the case in many U.S. cities, tracking procurement and end-of-life processes has not yet become a common practice, making it difficult to adequately discover the potential of currently wasted materials and to identify more thorough pathways for action.

Towards A Circular Construction Sector

Develop and implement a circular roadmap for the C&D sector

Throughout this report we presented what the current state of the construction and demolition waste sector resembles like in the Guelph-Wellington region. Using this analysis as a starting point, the Guelph-Wellington region can work towards a circular state with the creation of a detailed strategy and roadmap. It is essential to prioritize tangible and achievable cross-sectoral actions to move the sector towards a more sustainable and circular state. It is clear from this assessment that better data would be needed to better understand exactly what is happening throughout the life cycle of building materials and that space should be used more efficiently to reduce material needs.

Fill the data gaps

Further analysis and collaboration with local waste haulers and processors could provide greater understanding of current waste treatment practices and future circular opportunities. ZWETL could play an important role in generating interest from local haulers to start gathering and sharing data. If local stakeholders can be convinced of the benefits of going circular, they'll be motivated to cooperate and share their incoming waste streams. These benefits are numerous, there is environmental impact but more importantly: circularity can provide a better business case than landfilling or incineration by retaining monetary value already embodied in these waste products.

Space efficiency

Unlike certain parts of Europe, detached homes are relatively common in Ontario and the rest of Canada. The wide availability of space in suburban and rural areas often does not encourage a denser building pattern. This type of building, however, is inefficient in terms of space, land, materials, and utility uses, which makes it the most environmentally impactful type of housing. When comparing the impacts per housing unit of the various housing options, detached homes cause about 1.6 times more impact than townhouses or 13.7 times more than retrofitting basements into apartment units.

The conversion of basements into additional housing units is in fact a common practice in the Guelph-Wellington area. With the low impacts associated with renovating existing buildings, combined with the critical need for housing in Guelph-Wellington, this alternative presents itself as a sustainable and relatively low-cost solution to high-rise buildings (Figure 18)

Appendix I: Methodology

The methodology used for the material flow analysis (MFA) was largely dependent on data quality and quantity. Due to data gaps preventing the inclusion of building material inflow in the material flow analysis, Metabolic preferred a previously proposed methodology for this scenario, where the analysis would be built on their existing urban mining model and adapted to the Canadian (Ontario) context.

The urban mining model developed by Metabolic was originally developed for the Dutch context using data from building inspections, architectural and engineering drawings, maintenance plans, invoices and other technical references. These data were processed to provide materials, building components, and products for 12 building types through time. This data was linked to public spatial databases containing buildings, their type, size, and location in different geographic areas. In this project, Metabolic adapted this model to the Ontario context by selecting nine building profiles (Figure 19) where building materials were replaced based on the extensive research conducted and the validation session with a local architect.

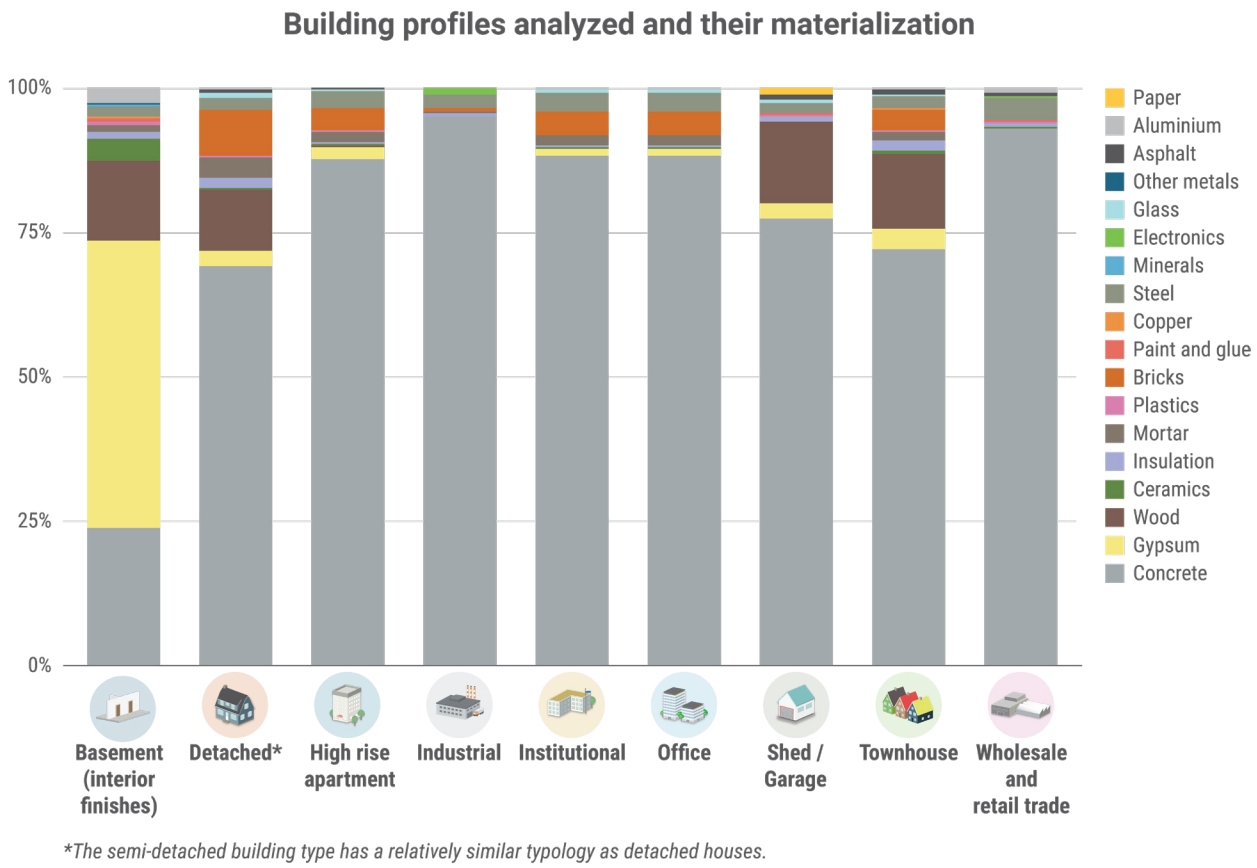
Data input

Construction, demolition and renovation permits from the City of Guelph (2021)

- Work description (addition, demolition, new building, wood deck, renovation)
- Building type (residential and non-residential)
- Floor area
- Construction and demolition costs

Value of permits for the Wellington County per type of building activity (2021)

- Construction and demolition costs
- Work description
- Building type



*The semi-detached building type has a relatively similar typology as detached houses.

Figure 19. Building profiles analyzed and their materialization

Material Flow Analysis of the Guelph-Wellington region

What is a material flow analysis?

A Material Flow Analysis (MFA) is a systematic assessment of material flows and stocks of (raw) materials within a system, with a defined scope in terms of space and time.

Why use an MFA?

This data-driven methodology for mapping out and quantifying resource flows is a crucial first step of any systems analysis, as it forms the baseline for finding effective leverage points and prioritizing possible interventions.

How to interpret a Material Flow Analysis (MFA)?

The outcome of the analysis is visualized in a Sankey diagram. A Sankey diagram shows from which sources a 'flow' comes (on the left), how it is used or transformed within the area (center), and how the 'flow' eventually leaves the system and becomes processed (on the right).

From the material flow analysis and the Urban Mining Model, we were able to build a picture of the materials that enter and exit the Guelph-Wellington built environment. Using the overall environmental impact factors for each product used in the construction, renovation, or addition of new or existing buildings, we were able to estimate which type of building or activity has the highest global warming potential. The environmental factors for each product are calculated based on the composition of the materials and the environmental impact of each material (Figure 20).

Assumptions & limitations

Assumptions:

- Activities on nine of the most frequent building typologies were modeled.
  - The building typologies were adapted from the Dutch ones based on desk research and validation with a local expert.
- Environmental impacts represent global average factors and not localized data.
- Building site waste is estimated to be 10-15% of the materials input due to off-cuts and overorders.
  - This share of building site waste is an estimation provided by an expert working on LEED certified building sites.

Limitations:

- End-of-life treatments of building waste are unknown
- Procurement processes of building materials are unknown
- The analysis only models construction, renovation, addition, and demolition activities requiring a permit
  - Most small renovation projects have not been included in the model due to the variety of the permits and of the weak relationship between permit value and material consumption/waste.
  - Only basement (interior finished) renovations were modeled.
  - Waste generated from renovation and addition is not included in the model.
- Only building materials are included in the Urban Mining Model (all S-Layers except Things (Figure 21))
  - All packaging materials found on building sites are excluded.

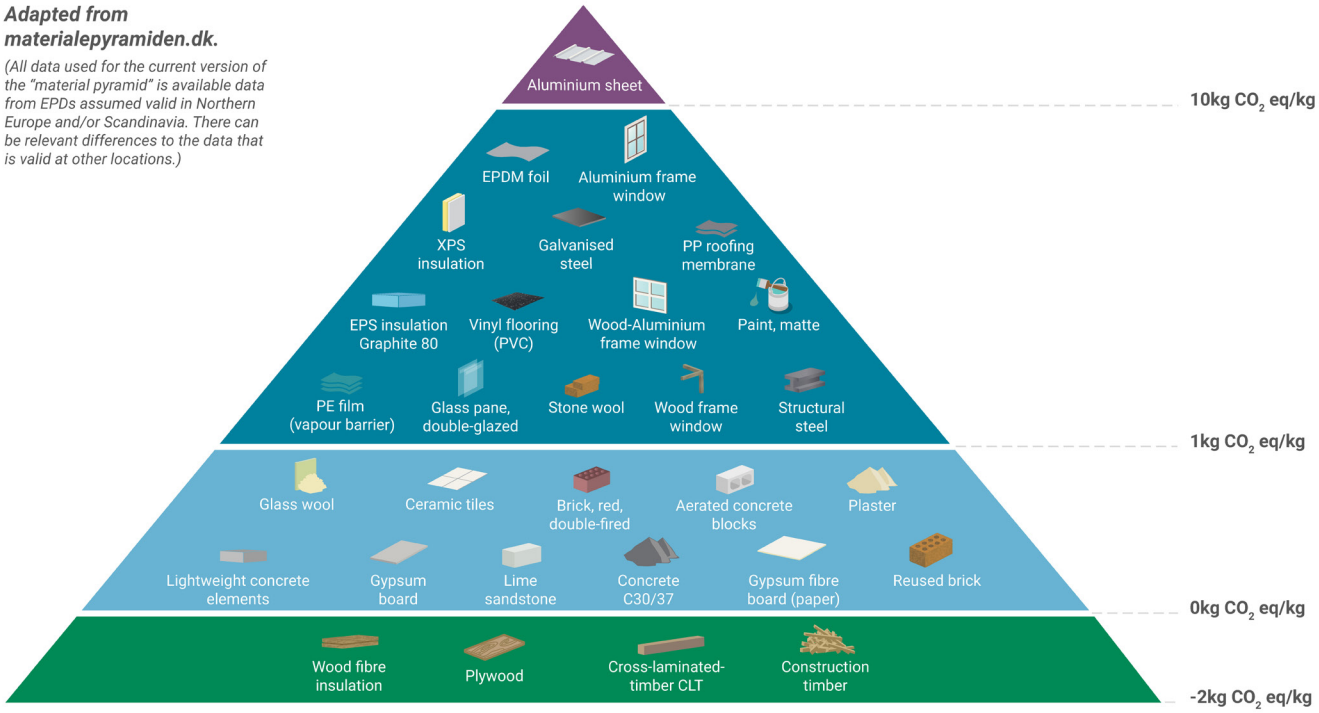


Figure 20. Material pyramid showing the global warming potential of commonly used building materials

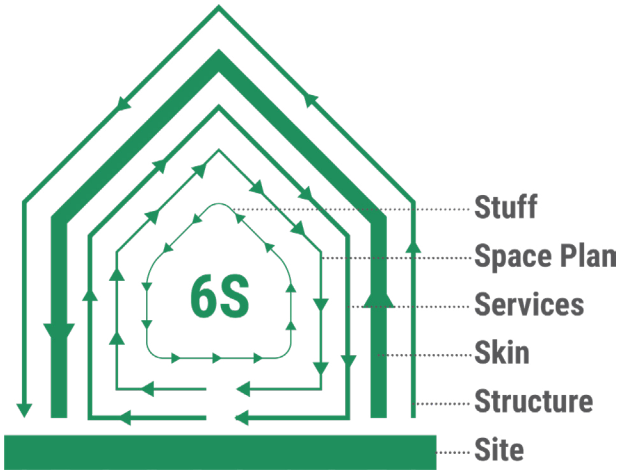


Figure 21. Shearing Layers (S-Layers) of the built environment

Appendix II: Transfer Station Waste Flows

The City of Guelph's transfer station processes a small fraction of the estimated CRD waste in the City of Guelph. In fact, in 2021, the station processed nearly 1,590 tonnes, hence about an eighth of the estimated waste generated in the city. From the small fraction collected, the majority was asphalt shingles that were recycled – ground up for use in asphalt mix – at the Try Recycling facility in London, ON. Another large fraction consists of concrete, brick, rubble, and toilets that are recycled at D&J Lockhart Excavating in Guelph.

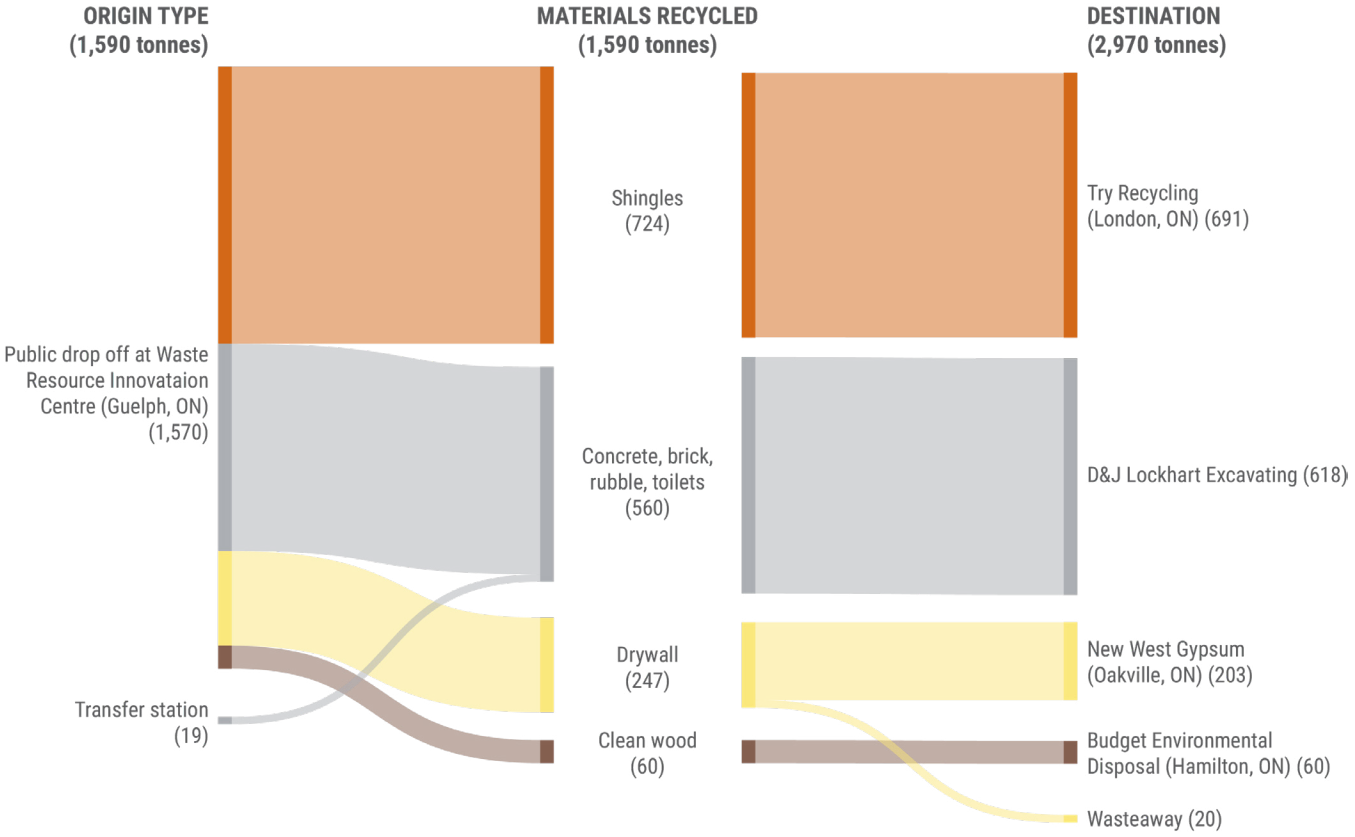


Figure 22. Material flow analysis of the C&D waste received at the municipal transfer station

Appendix III: Comparison Of Permit Values Per Year

For the current study, 2021 was chosen as the baseline year, since it was the most recent year with complete permit data available. This year was of course characterized by the covid pandemic, and as such might not be representative of a normal year in terms of CRD activity. When looking at the figure below, it can be seen that the total value of construction permits in 2021 ($273,675,550) was higher than the average ($184,225,724), potentially making up for delayed permits in the year 2020. On the other hand, demolition permits were much lower than other years, with 2021 seeing $262,500 of demolition activity, almost 4 times lower than the average of $867,200.

The deviation from the averages can be part of the explanation for the big difference in construction and demolition activities, and thus also for the discrepancy between incoming and outgoing material flows. In other years, the total ingoing and outgoing material flows could very well have a smaller discrepancy. This means that in other years the share of demand for new materials could be fulfilled to a greater extent than presented in this report.

For this comparison, only 8 months of data from 2022 have been used and extrapolated to represent a full 12 months, i.e. by multiplying the values with 1.5x.

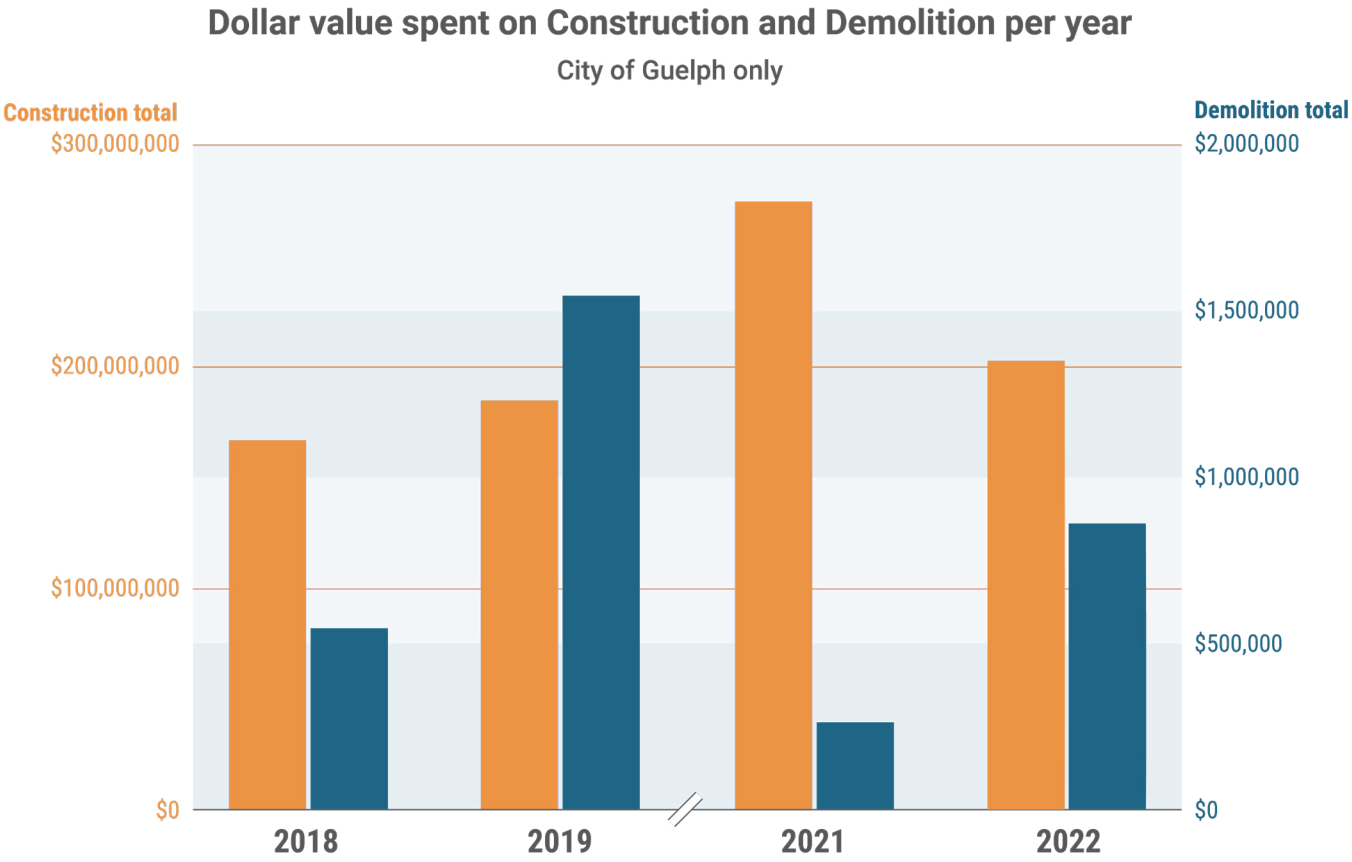


Figure 23. Comparison of permit values across various years

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