Scrap Tire Recovery and Recycling in Manitoba, 2018–2023

CATRA 2021 Scrap Tire Life Cycle Assessment
Year-over-year update 2024-1

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for CATRA / TSM

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Contents

Revision History

Update 1 – November 20, 2024 – Correct water footprint for steel scrap; add circularity indicator.

1 Introduction

End-of-life tires are one of the largest waste streams in Canada. Responsible management of end-of-life tires can provide significant environmental benefits by reducing demand for new materials and energy, and also avoiding landfill waste.

For the past five years, the Canadian Association of Tire Recycling Agencies (CATRA) and Scope 3 Consulting have worked together to create an ongoing study of the life-cycle benefits of scrap tire management. This document reports the material flows and environmental impacts and benefits of scrap tire management in Manitoba during 2018–2023.

1.1 About Scope 3 Consulting

We are experienced sustainability professionals with a dedication to preparing accurate and useful environmental footprint studies for firms, industry groups and public agencies throughout the United States and Canada. We believe in empowering decision makers with credible information presented clearly and concisely. Our Antelope software is an engine for creating powerful and responsive life cycle assessment and circularity studies.

Scope 3 Consulting LLC is based in Santa Barbara, California, USA.

1.2 Study Basis

This report is based on a *material flow analysis* (MFA) of scrap tires and tire-derived products collected and managed under the scrap tire management program operated by Tire Stewardship Manitoba (TSM). The MFA uses primary data provided by the agency to estimate the quantity of scrap tires under management, their origins, processing locations, and ultimate fates. The MFA results are coupled to a *life cycle model* that is used to generate estimates of environmental impact. The life cycle model was based on a life cycle assessment (LCA) study commissioned by CATRA in 2019. The final study report was critically reviewed according to ISO 14044, and was released in July 2022.

A previous *provincial report* was prepared for TSM which included province-specific results through the year 2020. These results were extended, year-over-year, to 2022. The present report extends the study timeline through the year 2023 with updated data provided by TSM. For further details and documentation of the study background and methodology, please consult the study report and provincial report.

1.3 2024 Core Model Update

In 2024, the life cycle model was revised to use the most up-to-date data sources. In the update, most of the 108 system models in the study underwent some changes to the results, but for the most part these changes were minimal in magnitude. Electricity grids generally got greener, but most other activities saw small increases in impact scores. This is due to the trend toward increased completeness in the background databases that were the center of the upgrade. Truck transportation models were revised, leading to slightly higher impacts across the board for transportation. These results were driven by increases in the upstream life cycle impacts for the truck processes, especially diesel fuel production and truck manufacture. Many displaced activities also saw their impact scores increase in the update. Since these scores are subtracted from the incurred scores, they tended to offset the increases in incurred impacts. Consequently, most provincial KPIs saw little change as a result of the update.

The updated data sets did enable us to add a water footprint impact indicator to the study (see Section 4.2). Further details about the model update will be provided in an annex to the Study Report later this year. The results of the core model update have not been critically reviewed.

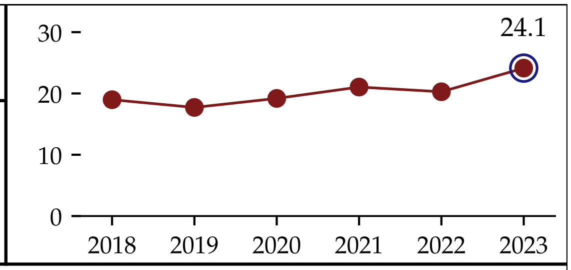
2 Key Performance Indicators

2.1 Total Processing

TIRES PROCESSED - MB

thousand metric tonnes (kt)

Value for 2023	24.1	kt
Change since 2022	+19.0	%
Change since 2018	+27.2	%
Total	121.3	kt



This is the amount of tires that enter processing in the province in a given year

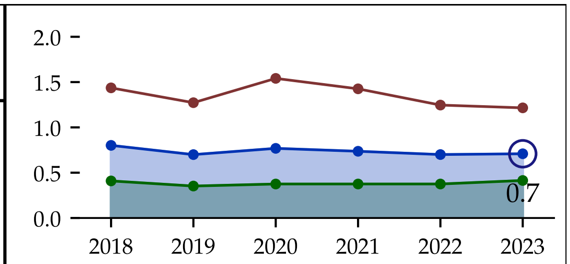
This chart shows the total amount of tires that were converted to products within the TSM program during the years 2018–2023. This includes tires from collection, as well as stock drawdown. Overall, the quantity of materials managed by the program has grown steadily in recent years, to a current high of 24.1 kt delivered to processors in 2023.

2.2 Incurred Impacts

INCURRED EMISSIONS - MB

Global Warming Intensity (kg CO2e/PLT)

Reverse Logistics, 2023	0.4	kg CO2e/PLT
add Processor emissions, 2023	0.7	kg CO2e/PLT
add downstream, 2023	1.2	kg CO2e/PLT



Emissions intensity of all activities that occur during scrap tire collection (shaded green), processing (shaded blue), and downstream production (unshaded, includes further processing and transport to market). Values are reported per PLT-equivalent (10.5 kg) processed. Reported values include both direct and indirect emissions.

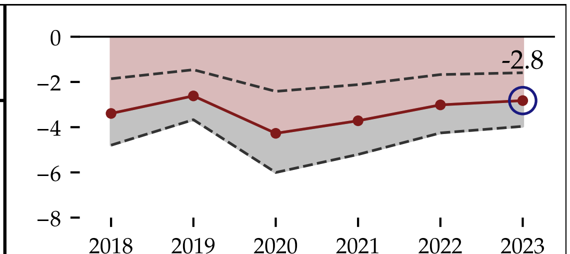
Incurred emissions are generated during collection and processing of scrap tires, as well as during further processing of tire-derived materials to make them into products. This chart shows global warming potential (GWP) impacts on a per-tire basis. These emissions can be attributed to the operation of the scrap tire management program in Manitoba, and represent the environmental cost of operating the program. Incurred impacts in Manitoba are low for a number of reasons. Manitoba has a low average transport distance, though this may be partially due to incomplete reporting (see Section 3.2 for details.) Manitoba also has a clean electricity grid, and the product mix is generally comprised of products that require minimal processing energy (aggregate, blast mats, sidewalls). Emissions per PLT-equivalent peaked in 2020 along with a maximum amount of tires processed into higher-value crumb.

2.3 Avoided Impacts

AVOIDED EMISSIONS - MB

Global Warming Intensity (kg CO2e/PLT)

Value for 2023	-2.8	kg CO2e/PLT
Change since 2022	-6.3	%
Change since 2018	-16.8	%
Average, Avoided Emissions	-3.3	kg CO2e/PLT



Emissions intensity of all activities expected to be displaced through the marketing of scrap tire-derived products. Red shaded area indicates median range; dashed lines indicate uncertainty with respect to modeled displacement rate.

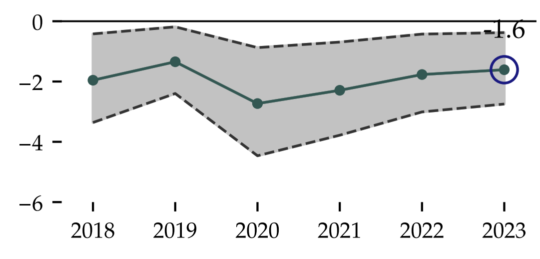
Potentially avoided emissions report the impact of producing goods and services that compete with tire-derived products in the marketplace. Under the assumption of displacement, some competing products were not produced because of the availability of tire-derived alternatives. Avoided impacts are shown as a negative score with an uncertainty range (see discussion of displacement uncertainty in Section 4.1). Although the majority of scrap tires were used as aggregate, the avoided impacts were largely driven by displaced primary rubber (from crumb and molded products) and steel (from blasting mats, as well as recovered scrap steel). Because the mix of tire-derived products is increasingly dominated by aggregate for various applications, the magnitude of the avoided impacts is steadily decreasing over time.

2.4 Net Impacts

NET EMISSIONS - MB

Global Warming Intensity (kg CO2e/PLT)

Value for 2023	-1.6	kg CO2e/PLT
Change since 2022	-9.0	%
Change since 2018	-17.8	%
Average, Net Emissions	-1.9	kg CO2e/PLT



Estimated net environmental impact resulting from incurred and potentially avoided activities. A negative value indicates a potential environmental benefit. The net total is shown as the blue line, with the uncertainty due to modeled displacement rate shown by the dashed lines and shaded region.

Net emissions report the combination of (positive) incurred and (negative) avoided emissions. The study results indicate that scrap tire management led to modest reductions in environmental impacts through the displacement of primary production by tire-derived products. The net improvement is getting smaller, however, again due to the increasing production of aggregate.

2.5 KPI Table

Table 1 on the next page reports impacts across all six indicators measured for the study, over the time period 2018–2023. Impacts are reported on both per-PLT-equivalent and Provincial basis. The net impact scores in three categories are also reported in terms of *equivalency factors*, which are meant to be more tangible and easy to understand:

- **Private vehicle travel–** net global warming impacts are compared to the use of a private vehicle weighing approximately 1,600 kg and having a fuel economy of 28.5 miles per gallon / 46 km per gallon / 8.2 liters per 100 km.
- **Diesel loader operation–** net smog impacts are compared to the operation of a 100 hp diesel loader for one hour at a low duty cycle (1.8-2 gal/hr).
- **Coal-fired electricity–** net particulate impacts are compared to the combustion of one kg of coal in a power plant to generate electricity.

For each of these impact categories, the net total impact scores (under the median displacement assumption) for scrap tire management are described in terms of the equivalency. If the net impacts are negative, the effect of the program is comparable to *avoiding* the reported amounts of each activity. *(Note: these different equivalencies are for comparison purposes only, and are not cumulative with each other.)*

Table 1: Tabulated KPI Scores for Manitoba.

Indicator	unit	2021	2022	2023	5 year
Global Warming Air					
Facility Impacts (per PLT eq)	kg CO2 eq	0.361	0.325	0.295	0.344
Total Incurred Impacts (per PLT eq)	kg CO2 eq	1.426	1.246	1.216	1.343
Net Impacts (per PLT eq)	kg CO2 eq	-2.291	-1.768	-1.609	-1.955
Net Impacts (Provincial)	kt CO2 eq	-4.592	-3.414	-3.698	-18.964
Equivalency (negative = avoided)					
Private vehicle travel	million km	-13.56	-10.08	-10.92	-56.00
1600 kg vehicle; Equivalent to 28.5 mpg | 46 kpg | 8.2 l/100km fuel economy					
Smog Air					
Facility Impacts (per PLT eq)	g O3 eq	39.3	38.1	37.1	38.8
Total Incurred Impacts (per PLT eq)	g O3 eq	79.5	73.2	72.3	76.6
Net Impacts (per PLT eq)	g O3 eq	-130.9	-95.8	-88.5	-108.9
Net Impacts (Provincial)	t O3 eq	-262.3	-185.0	-203.4	-1056.6
Equivalency (negative = avoided)					
Diesel loader operation	thousand hour	-144.3	-101.7	-111.9	-581.2
100 hp diesel engine with low load factor, 1.8-2 gallons per hour					
Human Health Particulates Air					
Facility Impacts (per PLT eq)	g PM2.5 eq	0.356	0.315	0.287	0.336
Total Incurred Impacts (per PLT eq)	g PM2.5 eq	0.988	0.866	0.841	0.930
Net Impacts (per PLT eq)	g PM2.5 eq	-0.721	-0.565	-0.367	-0.594
Net Impacts (Provincial)	t PM2.5 eq	-1.445	-1.090	-0.843	-5.764
Equivalency (negative = avoided)					
Coal-fired electricity	million kg	-1.301	-0.981	-0.759	-5.189
Burning 1 kg of coal in a typical coal power plant					
Acidification Air					
Facility Impacts (per PLT eq)	g SO2 eq	1.958	1.848	1.753	1.908
Total Incurred Impacts (per PLT eq)	g SO2 eq	4.666	4.114	4.030	4.393
Net Impacts (per PLT eq)	g SO2 eq	-6.248	-4.612	-4.112	-5.219
Net Impacts (Provincial)	t SO2 eq	-12.52	-8.91	-9.45	-50.62
Ozone Depletion					
Facility Impacts (per PLT eq)	mg CFC-11 eq	0.203	0.173	0.156	0.195
Total Incurred Impacts (per PLT eq)	mg CFC-11 eq	0.984	0.827	0.818	0.910
Net Impacts (per PLT eq)	mg CFC-11 eq	0.313	0.257	0.241	0.273
Net Impacts (Provincial)	g CFC-11 eq	626.4	495.9	554.2	2647.8
Eutrophication Air + Water					
Facility Impacts (per PLT eq)	g N eq	1.254	1.118	1.037	1.196
Total Incurred Impacts (per PLT eq)	g N eq	2.914	2.520	2.455	2.720
Net Impacts (per PLT eq)	g N eq	-2.205	-1.694	-1.032	-1.784
Net Impacts (Provincial)	t N eq	-4.419	-3.271	-2.371	-17.305
Blue water depletion					
Facility Impacts (per PLT eq)	m3	0.0285	0.0247	0.0217	0.0264
Total Incurred Impacts (per PLT eq)	m3	0.041	0.0347	0.032	0.0374
Net Impacts (per PLT eq)	m3	-0.02	-0.0152	-0.0165	-0.0176
Net Impacts (Provincial)	m3	-4.01e+04	-2.94e+04	-3.78e+04	-1.71e+05

3 Scrap Tire Material Flows

We obtained detailed data about the collection and processing of scrap tires from TSM. We used this information to calculate the flow of scrap tires and tire-derived materials from the points of collection, through processing, to final products. A Sankey diagram showing reported scrap flows for 2023 is found in Figure 1.

TSM provided two data files: one reporting incentive claims for tire collections and tire-derived products, the other reporting collections by tire type and pickup location, including distance to the processor. In general, the total quantity of tires reported by pickup location (designated "MB Retail" on the Sankey diagram) is smaller than the quantity of tire deliveries reported by the processor (designated "MB Other"). Tires were also delivered to the processor from neighboring provinces (only Ontario in 2023). Though these tires were not eligible for incentive payments, they were still included in the scope of tires processed in Manitoba.

2023 - 24.1 kt Processed

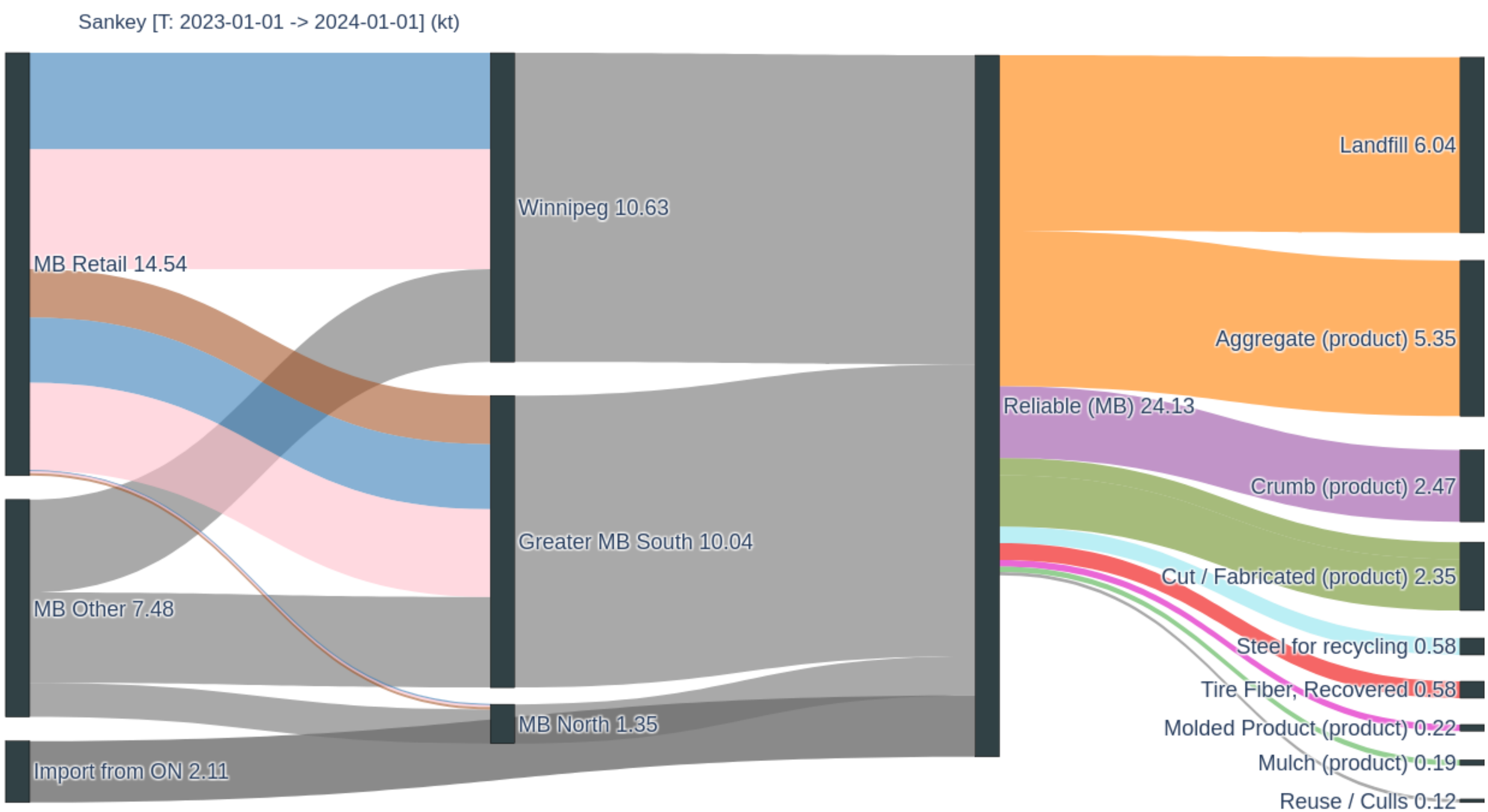


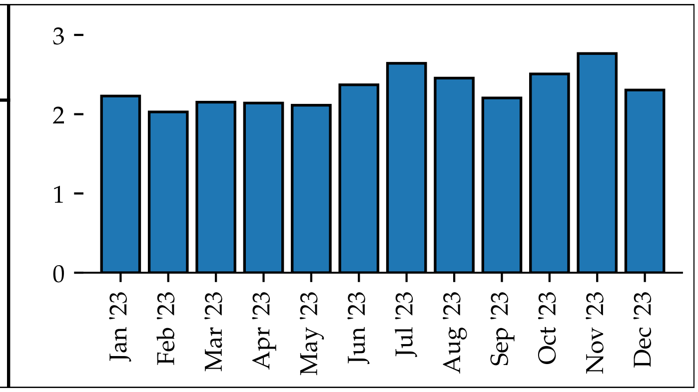
Figure 1: Scrap tire flows for 2023 as a Sankey diagram. On the collection side (left), the pink traces correspond to PLTs, the blue traces to MTs, the brown traces to all OTR tires, and the grey traces to mixed tires.

3.1 Focus on 2023

Monthly charts of tire collections, freight, and processor activity are shown below. Collection was approximately even, though total freight was higher in the summer and Fall. This is consistent with increased transport from remote locations during warmer weather.

COLLECTIONS
Mixed Tires - MB (kt)

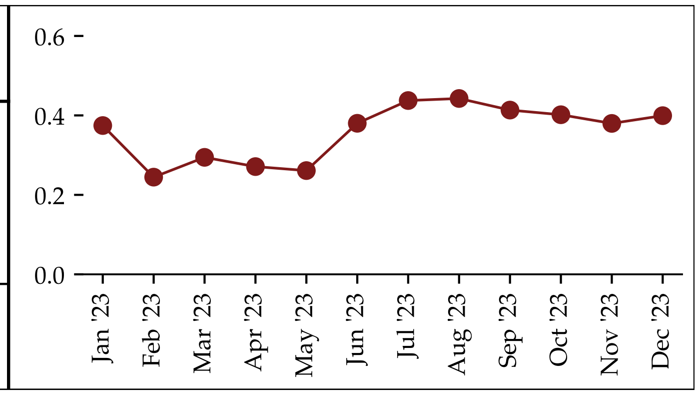
Total 27.9 kt



TOTAL FREIGHT
Mixed Tires - SK (10^6 t*km)

Total 4.3 10^6 t*km

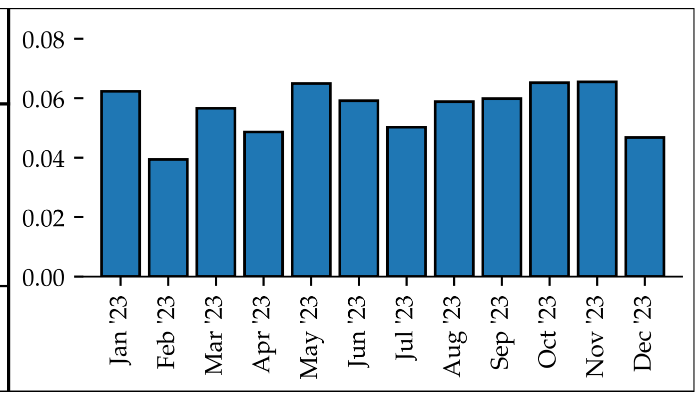
Total freight requirements, across all transport modes, to all destinations



PROCESSOR IMPACTS
Global Warming Air (kt CO2 eq)

Total 0.7 kt CO2 eq
Mean impact per tire 2.7 kg CO2e/PLT

Total processor burdens by month (Global Warming Potential)
Assumed average PLT weight of 10.5 kg



3.2 Collection and Freight

Estimated freight requirements for scrap tire collections by year are shown in Table 2. The average shipping distance for each tire is also reported, and is calculated by dividing total freight requirements by total collections.

As mentioned at the beginning of this section, only a portion of tires collected were explicitly reported by retailers ("MB Retail" on Figure 1). For these loads, freight requirements were determined based on the distance to the processor.

For the remaining tires, which constituted roughly a third, distance was estimated based on a population-weighted average distance from municipalities in the province to processors. This approach may result in under-estimation if the non-retail tires were predominantly collected from outlying areas.

Tires received from out-of-province were assigned representative starting locations for freight (Calgary, AB and Thunder Bay, ON) and these transport distances were included in the logistics. The increasing prevalence of out-of-province tires is the reason for the increase in average transport distance, from 131 km in 2021 to 178 km in 2023.

Table 2: Logistics requirements for scrap tire collection in Manitoba (million tonne*km).

	2018	2019	2020	2021	2022	2023
Transport truck_20t	0.550	0.275	0.296	0.358	1.251	2.007
Transport truck_13t	1.420	1.046	1.299	1.470	1.051	1.362
Transport truck_8t	0.771	0.730	0.800	0.825	0.697	0.821
Transport truck_5t	0.088	0.085	0.089	0.098	0.095	0.107
Transport light_truck_1.5t	0.003	0.003	0.003	0.003	0.003	0.003
Total	2.832	2.138	2.486	2.755	3.097	4.300
Average Distance (km)	149.	121.	133.	131.	153.	178.

3.3 Processing Outputs

Tire-derived products in Manitoba reported from all processing sites are shown in Table 3, and compared to total collections. Any tire-derived wastes reported are shown as well. Differences between tires collected and products generated are assumed to reflect changes in stock-on-hand at the processors. Steel and fiber recovery were not directly reported by processors, so these amounts were estimated as 15% each of whole tire weight used for crumb and molded products. Cut and fabricated includes both sidewalls (55%) and blasting mats (45%).

The processor in Manitoba produces an eclectic range of products, including crumb, molded products, mulch, and blasting mats, but about 60% of tires are processed into tire derived aggregate (TDA). Over the last several years, the TDA has been increasingly used in landfill as alternative daily cover.

3.4 Displaced Products

The products potentially displaced by tire-derived products are shown in Table 4. The amounts of potentially displaced products were calculated according to the displacement methodology de-

Table 3: Tire-derived products in Manitoba (tonnes).

	2018	2019	2020	2021	2022	2023
Aggregate (product)	10,034	10,135	9,216	9,600	6,133	5,354
Tubes / other	1,520	1,651	1,571	1,529	1,534	1,767
Crumb (product)	1,769	1,411	2,669	2,670	2,016	2,471
Molded Product (product)	371	397	278	291	217	221
Steel for recycling	459	387	632	635	479	577
Tire Fiber, Recovered	459	387	632	635	479	577
Cut / Fabricated (product)	1,252	382	1,534	1,114	1,002	582
Mulch (product)	847	344	356	303	188	188
Waste / Alternative Daily Cover	346	324	2,150	2,011	5,695	6,037
Reuse / Culls	284	14	130	56	53	116
TDF fibre (product)	0	0	25	24	0	0
Total Products	17,341	15,433	19,191	18,867	17,796	17,890
Net Facility Stock Change	1,637	2,286	-531	2,177	2,479	6,242
Total Collections	18,978	17,719	18,660	21,045	20,275	24,132

scribed in the study report (Section 3.5) and in the provincial report (Appendix B).

The environmental effects of tire-derived products depend on their end-use fate. We modeled the likely end-uses of tire derived products in Manitoba based on a review of the processor's website and marketing materials, as well as information about the international market for tire-derived crumb. TDA, whether used for civil engineering projects or for landfill applications, tends to displace earthen material, modeled as gravel.

Table 4: Primary products displaced by tire-derived products in Manitoba, as modeled.

		2019	2020	2021	2022	2023
Aggregate, gravel, displaced	t	13,335	14,491	14,803	15,081	14,523
Concrete product, displaced	t	1,402	2,097	2,113	1,592	1,899
Silage weight, displaced	t	1,239	1,178	1,146	1,151	1,325
Sand, displaced	t	658	680	579	360	361
Primary rubber, polybutadiene	t	476	901	901	680	834
Primary rubber, in product, displaced	t	409	614	618	466	556
Wood Chips, displaced	t	310	320	273	170	170
Steel, displaced	t	291	474	476	359	433
New tire, displaced	kg	3,470	32,615	14,005	13,350	29,005
Blast Mat, steel cord, displaced	m2	1,466	5,889	4,279	3,848	2,235
Heat, coal, in cement kiln, displaced	GJ	0	693	670	0	0

3.5 Circularity

Tire-derived products in Manitoba can be described in terms of their circularity, which is a measurement of the degree to which products embody the principle of a circular economy. We use the

Material Circularity Index (MCI) methodology developed by the Ellen MacArthur Foundation to compute a circularity index for the various tire-derived products generated in the province. For more information on the MCI, please consult Annex-II to the LCA report (November 2024).

Table 5 below reports the cumulative MCI index for Manitoba over the study period. The table body reports the share of production for each product in the province, while the last row reports the weighted-average MCI score.

This score is dominated by tire-derived aggregate, but a few products are produced with a higher MCI value, which push the provincial score slightly higher to around 0.60–0.61.

Table 5: Cumulative Material Circularity Index for Manitoba.

	MCI	2018	2019	2020	2021	2022	2023
Shred, tire-derived	0.59	64 %	71 %	63 %	65 %	70 %	68 %
Sidewalls, Tubes, other	0.55	9 %	11 %	8 %	8 %	9 %	10 %
Molded Product	0.61	8 %	8 %	10 %	10 %	8 %	9 %
Blast Mat, Tire derived	0.68	7 %	2 %	8 %	6 %	5 %	3 %
Mulch, tire-derived	0.81	5 %	2 %	1 %	1 %	1 %	1 %
Crumb rubber, tire-derived	0.62	4 %	4 %	6 %	6 %	5 %	6 %
Processing waste	0.54	-	-	0.0 %	0.0 %	-	-
Heat from combustion, tire-derived fuel	0.54	-	-	0.0 %	0.0 %	-	-
Provincial MCI Score		0.61	0.60	0.60	0.60	0.60	0.60

4 Results and Interpretation

This section reports quantitative results of the life cycle impact assessment for the recent years. Results have two types of contributions: positive-valued (incurred) contributions and negative-valued (displaced) contributions.

- Positive-valued contributions result from direct actions taken within the scrap tire management system that have environmental impacts. These include emissions from transportation of tires from collection centers to processors, direct emissions from facility operations, upstream emissions from materials used by processors, and emissions from electricity generation.
- Negative-valued contributions represent emissions associated with the production of products that compete with tire-derived products in the marketplace, and so are potentially avoided by the use of scrap tires.

The sum of these positive and negative impacts indicates the potential net environmental impacts that could occur if tire-derived products are displacing primary products.

4.1 Uncertainty

The LCA model includes uncertainty in the recycling process inventories, and in the market effects of tire-derived products. The charts in this section indicate uncertainty in the results by including error bars or "whiskers" that extend upward and downward from an indicated result or a net total. The size of the error bar indicates the uncertainty in the estimate.

Uncertainty is applied to the following parameters (please consult the study report, Section 4.2, for details):

- In the displacement relationship between tire-derived products and the products with which they compete, we apply uncertainty to the amount of displacement according to the type of product being displaced;
- Inventory parameters that describe scrap tire processing, such as electricity and diesel
- Freight requirements for scrap tire collection;
- Aspects of tire composition, including biogenic carbon and zinc content.

Each unit of tire-derived product is considered to replace anywhere between 0.2–1 equivalent unit of displaced product, depending on the nature of the product. This is called the displacement rate. Error bars on the negative-valued contributions reflect this uncertainty only, while error bars on net results reflect all uncertainties. Displacement relationships are reported in Appendix B of the provincial report.

2023

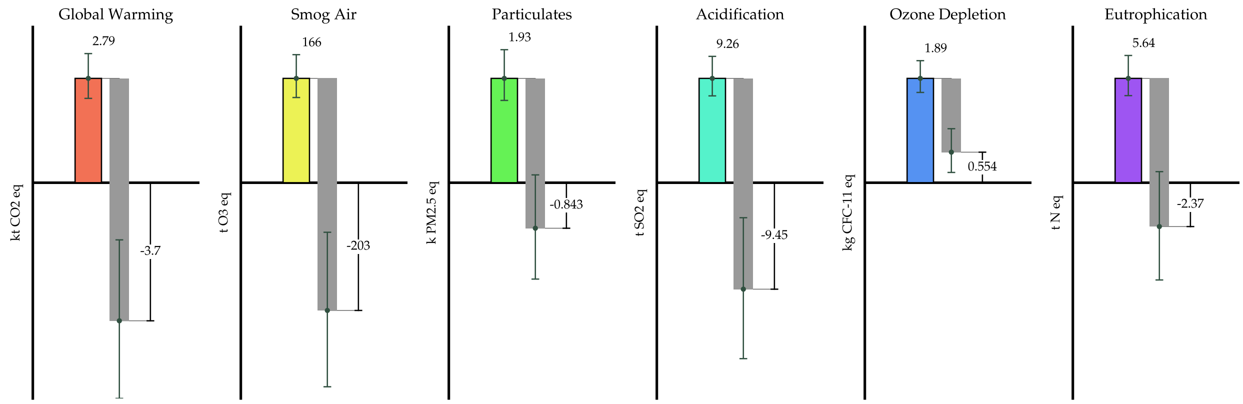


Figure 2: Total impacts incurred and avoided due to scrap tire management during 2021 (top) and 2022 (bottom). The colored bar in each panel indicates incurred emissions in the named category, while the gray bar indicates potentially avoided emissions in that category.

Table 6: Total impacts incurred, total impacts avoided, and net total impacts due to tire recycling in Manitoba during 2023.

	Unit	Incurred Impacts	Avoided Impacts	Net Total
Global Warming Air	kt CO2 eq	2.79	-6.49	-3.7
Smog Air	t O3 eq	166	-370	-203
Human Health Particulates Air	k PM2.5 eq	1.93	-2.78	-0.843
Acidification Air	t SO2 eq	9.26	-18.7	-9.45
Ozone Depletion	kg CFC-11 eq	1.9	-1.3	0.55
Eutrophication Air + Water	t N eq	5.64	-8.01	-2.37
Blue water depletion	k m3	76.5	-114	-37.8

The results are shown graphically in Figure 2. The same data can be found in tabular form in Table 6. Blue water was omitted from Figure 2 and is shown separately in Figure 3 The most-negative point on each bar indicates the most favorable displacement assumption (i.e. a tonne of tires displaces nearly a tonne of primary product).

In four of six indicators, plus water depletion (see next section), the operation of the scrap tire management program in Manitoba has resulted in the reduction of environmental impacts through displaced production. In the category of particulates, the incurred and avoided emissions are comparable, and in Ozone Depletion, incurred burdens exceed potentially avoided emissions.

4.2 Water Depletion

(November 18, 2024) The steel industry dataset has been revised to update the apparent water use benefitsits water use, which has been reduced by about three-quarters.

In the 2024 update, we added water depletion to the set of indicators we measured for the study. Water depletion is measured in terms of net water withdrawals from natural reservoirs, also known as "Blue Water", and comprises the sum of total water withdrawals, minus total returns to water. Water depletion is measured in cubic meters.

Our results showed that electricity production is often the main source of water demand, while steel recycling is the most prominent driver of avoided net water withdrawals. Other recycling products also offer moderate improvements.

Note that water depletion is a global indicator, and water withdrawals will not necessarily occur near the location of the process being modeled. More information on the water depletion indicator will be available in the 2024 update report later this year.

The results for Manitoba in 2023 are shown on the Waterfall chart in Figure 3. On the waterfall chart, incurred impacts (i.e. withdrawals of water) are represented as bars growing toward the right, and avoided impacts (i.e. avoided water withdrawals) are shown as bars growing toward the left. The net result, which is the accumulation of all bars, is shown by the red triangle at the bottom.

The chart shows that a variety of activities contribute to the reduction of water use, including steel recycling and molded products, with avoided gravel production making up most of the rest. On net, the benefits from scrap tire management offset the incurred impacts, leading to a likely net reduction in water use due to scrap tire management.

4.3 Stage Contribution Analysis

The impact category scores are disaggregated into different stages in Figure 4. Thes chart enables a visual comparison of the relative contributions of different parts of the scrap tire management system in each impact category. Figure 5 shows the same information on a year-over-year basis for 2018–2023, providing a depiction of how the results changed over time.

The results show that collection and handling, which includes both reverse logistics and heavy equipment operation, is the largest driver of emissions in several categories. Although molded products are a relatively small share of production, they make up a substantial contribution to the net environmental benefit. 'Displaced: Other' includes aggregate, as well as mulch and blasting mats.

Incurred and displaced downstream transport (yellow bars) are mainly driven by the transport of TDA and displaced transport of gravel.

Over time, the net environmental indicators have fluctuated as the mix of products varies. However, no variations have been large enough to cause the indicator scores to change signs or cross the break-even point. The only exception is ozone depletion in 2018, when the volume of culled tires to reuse (light blue) was large enough to offset the incurred impacts.

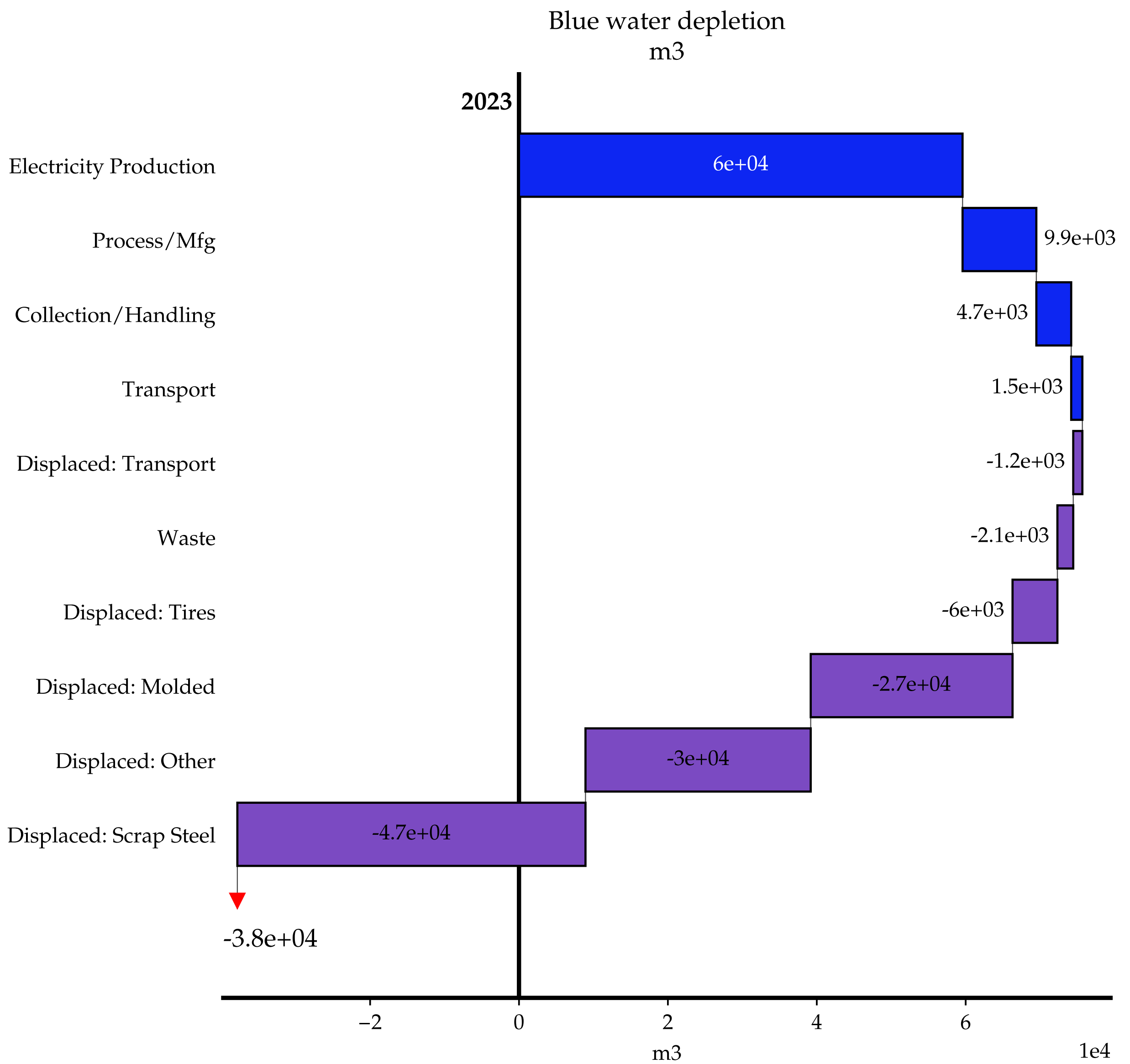


Figure 3: Waterfall chart indicating the contributors to the newly-added water depletion score. The chart shows that the electric grid is the largest source of net water withdrawals. A mix of different tire-derived products contribute to avoided water withdrawals.

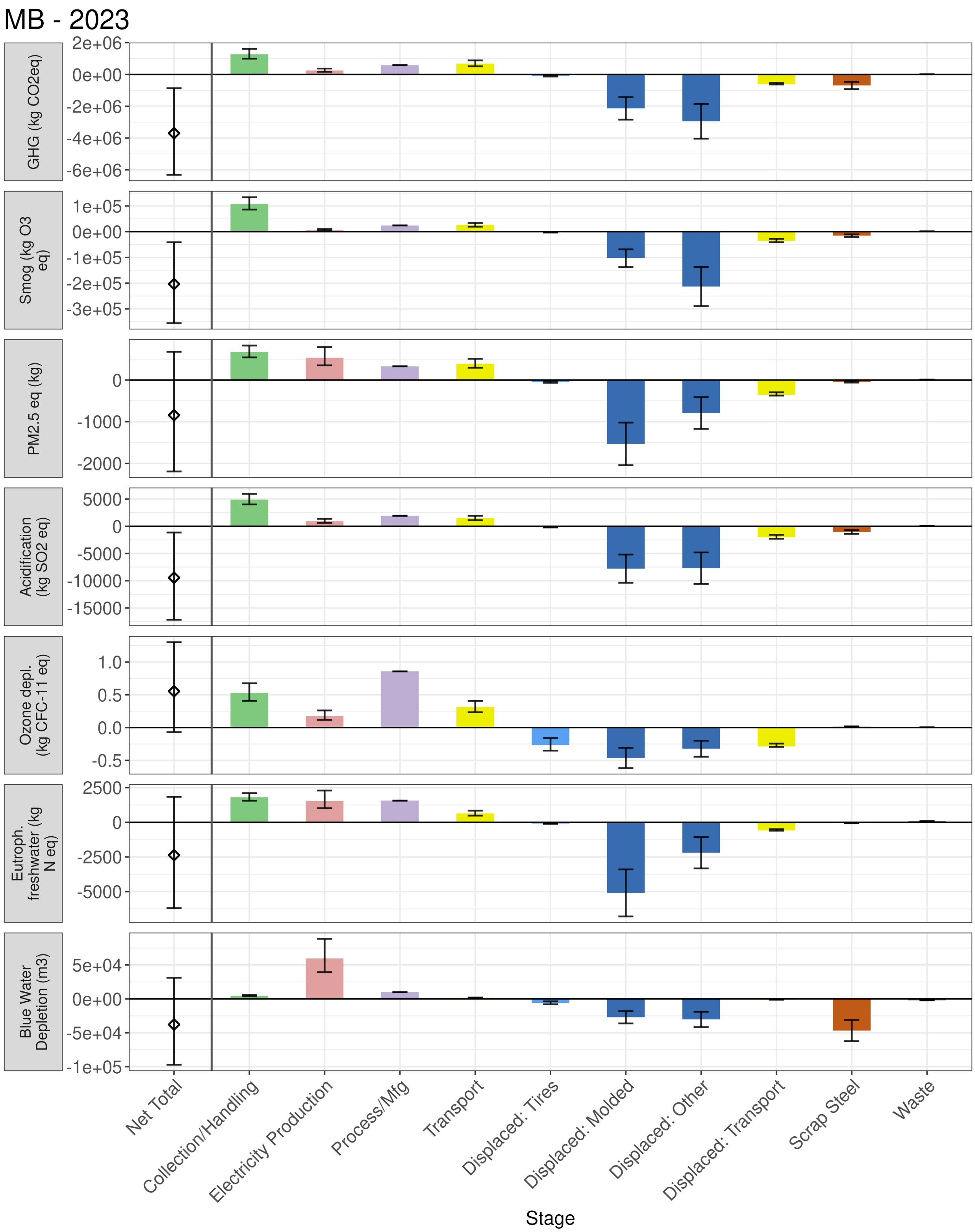


Figure 4: Province-wide environmental impacts of managing scrap tires in MB during 2023, stage contribution analysis. Net impacts, which take into account avoided production due to tire recycling, are indicated by the diamond symbol on the left. Colored bars show contributions by individual stages in the tire recycling system. Modeled uncertainty is indicated for each bar.

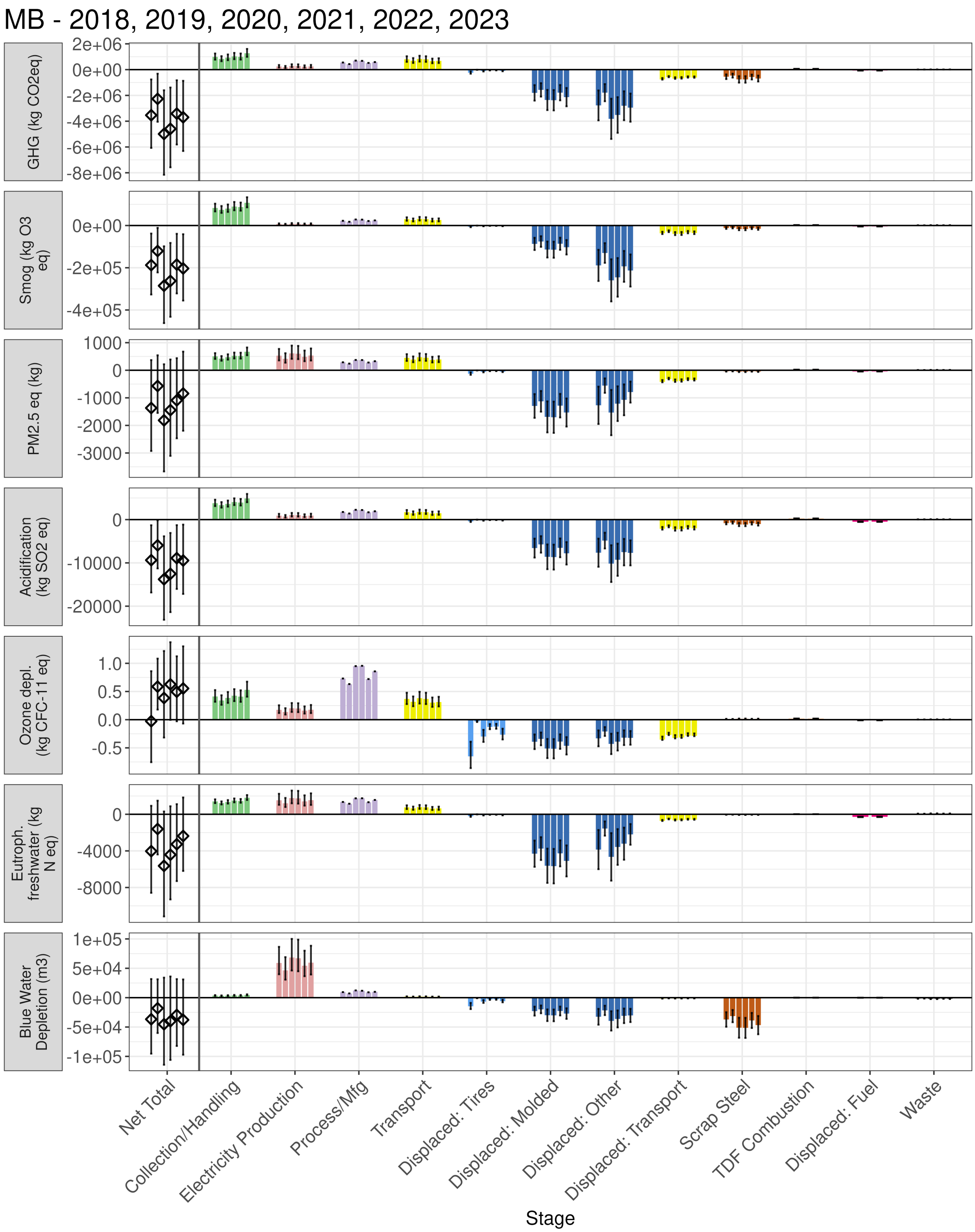


Figure 5: Province-wide environmental impacts of managing scrap tires in MB during 2018–2023, stage contribution analysis, by year. Net impacts, which take into account avoided production due to tire recycling, are indicated by the diamond symbol on the left. Colored bars show contributions by individual stages in the tire recycling system. Modeled uncertainty is indicated for each bar.