U of T Trash Team

DOWNTOWN Yonge

Getting into Garbage Bins: Understanding the relationship between garbage bin design, pedestrian use, and litter

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Executive Summary

Background: Garbage bins play a critical role in maintaining clean streets for local communities and tourists. They also play a role in reducing plastic pollution.

Need for a pilot to trial different garbage bin designs: In the City of Toronto, public complaints about overflowing garbage bins and poor bin condition (damage, odour, and uncleanliness) have been growing. In parallel, the Downtown Yonge Business Improvement Area (DYBIA) has been recording observations of local bins since 2015. To inform a solution, the DYBIA, with support from the City of Toronto's Solid Waste Litter Operations Team, piloted new garbage bins and compared them with the current bins to assess whether bin design could improve waste management in the city, address complaints, improve observed issues, and reduce litter. The City of Toronto's garbage bins are currently contracted out to Astral Media. The pilot comes at a useful time, as the Astral contract is reaching its end and the DYBIA is looking to suggest to the City of Toronto the best street furniture (including garbage bins) as part of the redesign of Yonge Street under yongeTOmorrow.

Project Objectives: The aim of the project is to quantitatively and qualitatively measure the effects of different garbage bin designs in the City of Toronto (older model Astral bins, WR4; newer model Astral bins, WR5; two brands of solar powered self-compacting bins (Bigbelly and CleanCUBE). We are measuring how the amount of litter on the sidewalk, the condition of the bins, and waste sorting varies by bin type.

Results:

Litter: We observed the most litter around the older Astral WR4 bins. We observed the least litter around both self-compacting pilot bins. The most common item of litter was cigarette butts, constituting ~60% of all observed litter around bins at the DYBIA.

Bin Condition: The solar powered self-compacting bins maintained the best condition over both Astral bin models relevant to odour and decals. However, the older WR4 Astral bins were consistently more clean in appearance. Both self-compacting bins had persistent observations of food waste along the front of the bins, which remained present over numerous visits. Only one self-compacting bin was observed to have less incidences of being full or overflowing (Bigbelly) than the other bins. No significant damage was seen on any bins in the three-month study period; however, the Astral bins were more likely to have peeling decals. Break-in frequency was similar across all bin types, with one exception of a reoccurring break-in for a single Astral WR4 bin.

User Observations: Although the self-compacting bins have more clear labelling relevant to waste sorting, there was no clear pattern among bins. People disposed of waste in the correct slot about 40 – 60% of the time. The top 5 items most often

disposed of incorrectly include paper, disposable coffee cups, boba tea cups, and straws (both plastic and paper).

Recommendations and Next Steps:

With our data we can make the following recommendations:

1. **Expand the pilot of the self-compacting bins**. In this pilot, we saw that the self-compacting bins can reduce litter, modestly impact overflow (more specifically for the Bigbelly bin), and decrease odour. Moreover, in addition to these observed advantages, it is likely that the sensors within self-compacting bins can make bin management more efficient – saving time and costs and reducing greenhouse gas emissions. A larger pilot could include bins in more diverse locations and a cost-benefit analysis for a further comparison with the new Astral WR5 bins to better understand any benefits and identify any potential issues with a larger roll-out.
2. **Consider ways to help the public better sort their waste.** Contamination was not significantly different across bin design, or indicative of any particular design (Astral vs self-compacting) being superior. It is necessary to determine better ways to reduce contamination to facilitate higher diversion from landfill and move towards a more circular economy. Changes to the wraps, decals and designs could be piloted to see if better signage and/or design affects whether people put waste in the correct slot.
3. **Pilot new solutions for the collection of cigarette butts.** The new pilot bins have the same type of receptacle slot for cigarette butts as the old Astral WR4 bins. Overall, these slots are rarely used and cigarette butts are commonly reported as litter items in the water and on land, and thus are a prevalent form of plastic pollution. New designs of receptacles for cigarette filters should be piloted with educational campaigns to see if we can reduce this common source of plastic pollution while providing greater awareness that cigarette butts are plastic litter.

Background

High-quality garbage bins are critical pieces of infrastructure for keeping streets clean and appealing to the local community and visitors. A garbage bin that is well-maintained, resistant to vandalism and break-ins, and that is easy to use correctly (e.g., properly sort waste and put it in the appropriate opening) will improve the aesthetics of city streets, elevate the pedestrian experience, and reduce emissions of plastic pollution to nearby ecosystems.

Plastic pollution has become ubiquitous globally, and Toronto is no exception. Once in the environment, animals are well-known to interact with plastic macrodebris and microdebris through entanglement and ingestion – which can cause harm (Bucci et al., 2020; Mehinto et al., 2022). Researchers think environmental accumulations of plastic will increase under business-as-usual and without significant intervention (Borrelle et al., 2020). In Toronto, hundreds of kgs of plastic pollution are removed from Lake Ontario and nearby public parks each year through cleanups led by community organizations as well as trash traps (U of T Trash Team, 2023) managed by the Toronto Inner Harbour Floatables Strategy and monitored by the U of T Trash Team (a science-based community outreach organization). Fish sampled from the Toronto waterfront have been reported to have 100s of pieces of microplastics in their gut content and dozens in the muscle – i.e., the fillet that we eat (Munno et al., 2022; Milne et al., 2024). A recent study predicts that mismanaged waste makes up the largest proportion of local plastic pollution emissions (i.e., plastic that escapes into the environment from local sources; Zhu et al., 2024). In Toronto, this mismanaged waste includes litter from pedestrians, overflowing garbage bins, and waste that falls from trucks upon emptying garbage bins, among other sources. Litter escaping local garbage bins is likely a major source of mismanaged plastic waste, which becomes plastic pollution, in Toronto.

Research has shown that high numbers of easily-accessible garbage bins can mitigate littering (City of Philadelphia). However, motives for upgrading garbage bins go beyond the environment. Garbage bins are vulnerable to destructive vandalism, break-ins in pursuit of food and cigarettes, as well as general wear and tear. Sturdy garbage bins can reduce these issues. Garbage bin design is also pertinent to waste management beyond the point of collection. Bins with ineffective sorting design between landfill waste, recyclables, and cigarettes are vulnerable to contamination (i.e. incorrect sorting of litter). This limits our ability to meet national goals for a circular economy. Bins with better signage for sorting may reduce contamination. A combination of colour-coding, lists of accepted materials, and quickly recognizable item visuals may help, thereby diverting waste from local landfills (RecycleBC 2016).

Any strategy pursuant to managing waste, maintaining clean and safe roads, and keeping the city an attractive destination for Torontonians and tourists alike must consider the importance of effective garbage bins. As one initiative, the City of Toronto rolled out a new type of Astral bin as a pilot in 2024 with improved durability and a larger opening. Moreover, the Downtown Yonge Business Improvement Area (DYBIA), with support from the Solid Waste Litter Operations Team, procured solar-powered self-compacting bins (i.e., one Bigbelly and one CleanCUBE) with fill sensors as a pilot. These were installed in August, 2024. The DYBIA hope that the new pilot bins will look aesthetically pleasing, be less prone to break-ins and vandalism, be user friendly, and ultimately reduce litter. They hope that this pilot will inform how to improve some current issues observed across the City (See Figure 1 for an example). To determine whether different types of bins reduce litter, increase aesthetics, improve waste management, and promote proper use of bins (i.e., reduce contamination), we synthesized data collected by the DYBIA, and us (the U of T Trash Team). The DYBIA collected observational data on aesthetics of all bins from 2019 through 2025, before and during the pilots. We (the U of T Trash Team) collected observational data on litter, bin usage, and bin aesthetics in the summer months of 2025 (about one year after all pilot bins were installed).

Figure 1: An example of an overflowing old Astral WR4 bin in the DYBIA.

To measure the effectiveness of different bins, we aimed to quantify and measure the following:

- **Litter:** We predicted that different bin designs affect the amount of litter observed on the street, due to proper usage and less overflow.
- **Fullness of bins:** At times, bins were overflowing or nearing capacity, preventing additional customers from using them to dispose of their waste, which contributes

to litter on top of and around the bins. Better bins can reduce the frequency of management while reducing overflow.

- **Bin quality:** Common issues with the bins include damage to decals, missing liners, and waste being lodged behind liners causing a bad smell. Better bins can be made using more durable materials that are less likely to be tampered with and last longer.
- **Vandalism:** Garbage bins are vulnerable to break-ins and theft. Better bin designs can prevent break-ins, damage and changes to decals.
- **Misuse/Contamination:** Customers might not understand the difference between types of waste and the correct way to dispose of it. Better bins can more clearly inform the public how to dispose of waste in accordance with the City's policies.

Our research objectives were to understand how the design of garbage bins affect litter, aesthetics, maintenance, and waste sorting. We hope that better bin designs can mitigate observed issues and reduce emissions of plastic pollution from litter in our city.

Long-Term Objectives

Determine the best bin design that can be used across the City of Toronto to increase aesthetics of the City, inform correct waste disposal, make collection more efficient, and reduce litter and plastic pollution.

Research Methods for Data Collection

The research for this report involved collecting both quantitative and qualitative data comparing three types of garbage bins. These include an older bin model that is one of the more common types employed across the City (herein referred to as old Astral WR4), newer bins that are being rolled out across the City now (herein also referred to as new Astral WR5), and two types of new pilot bins that have solar powered trash compactors (herein referred to as self-compacting): the Bigbelly and the CleanCUBE (see Figure 2 for examples of the bins relevant to our study). For years, the City of Toronto has been under contract with Astral – which has provided several types of different bins to the City over time (Figure 3).

Figure 2: Left: Old Astral WR4 bins that are most common across the City of Toronto today; Middle: New Astral WR5 bins that are being rolled out across the City of Toronto; Right: The Bigbelly, one of the two types of self-compacting solar-powered garbage bins.

Figure 3: The City of Toronto's internal designations for the Astral-made garbage bins. The WR4 bins (referred to here as the old Astral bins) and the WR5 bins (referred to here as the new Astral bins) are the bins of interest for the DYBIA.

Our measurements include quantifying litter across bin designs, recording observations of the visual appearance of the bins to assess durability, vandalism, break-ins, and overflows, and quantifying user behaviour to assess how the bins are being used. Further, we synthesized DYBIA data to get further observational data.

Below is a map of the study area within the DYBIA, showing the location of the 6 bins we included in this location for our research in July through August 2025 (Figure 5). All six bins (2 of each type: WR4, WR5 and self-compacting) were in the same intersection within the DYBIA to avoid confounding factors associated with location. Moreover, we assessed two additional bins (one Astral WR4 and one Astral WR5) from within the Waterfront Business Improvement Area (WFBIA) to show how patterns vary across the city.

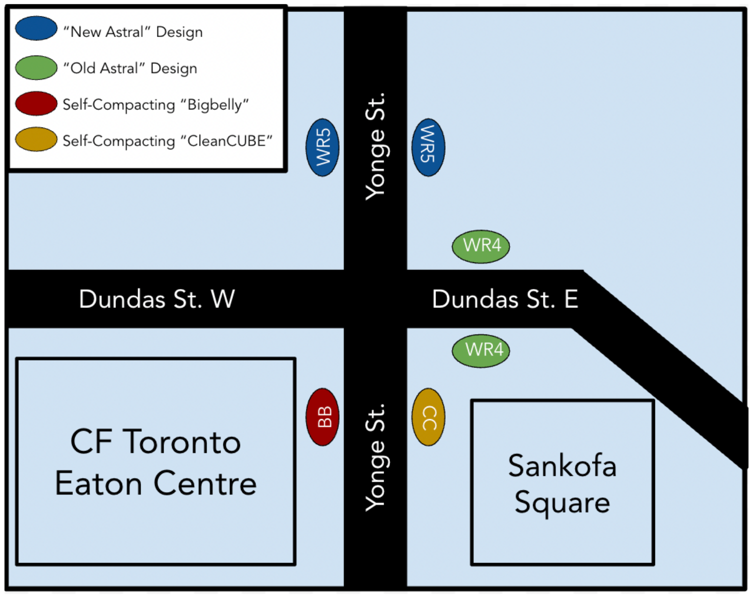


Figure 4. Map of the DYBIA with all studied bins. Old Astral WR4 bins are in green, New Astral WR5 bins in blue, and the self-compacting bins in red Bigbelly) and orange (CleanCUBE). The locations of the two waterfront (WFBIA) Astral bins are not included in this map.

Litter Transects: Quantify Litter Around and Near Bins

We collected quantitative data on the amount of litter found in front of each individual bin (Figure 4) within a transect size of roughly 5m x 2.5m (Figure 5). Some transect sizes were adjusted to accommodate sidewalk availability, items obstructing the regular transect area, and areas of accumulation such as sidewalk cracks. Once transect tape was laid down to form a visible quadrant in front of the bins, a zig-zag scanning method was employed to find and record the quantity and type of litter (e.g., cigarette butt, bottle cap, plastic bag). On each of six days, litter was measured and recorded in transects near all bins (n = 6 per bin). The days of measurement included 4 weekdays and 2 weekend dates, sampling across various times between 11:00-17:00 to account for a wide range of foot traffic. The metric "items per m^2" was calculated for each bin to accurately compare the amount of litter across bins. These litter transect methods were replicated in the WFBIA on two Astral bins. See Appendix B for a copy of the datasheet used.

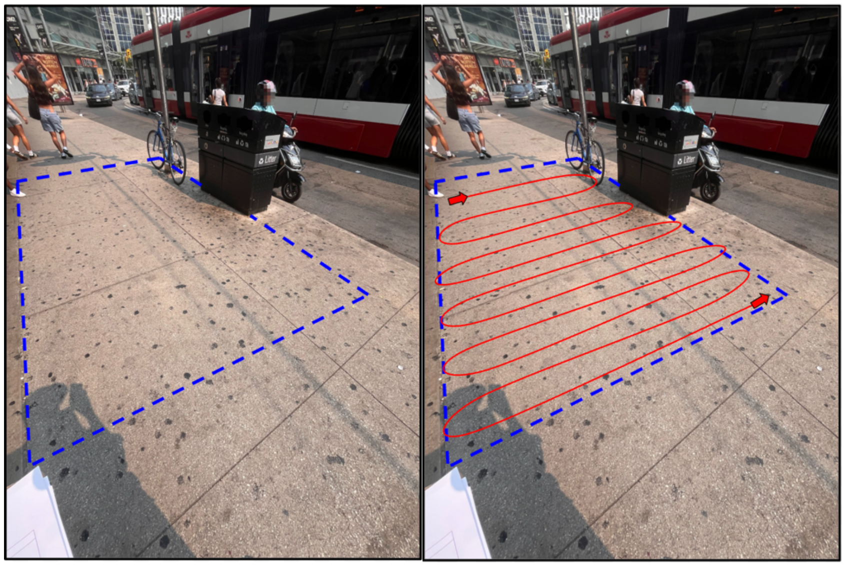


Figure 5. Litter transects involve defining a rectangle of known dimensions around a waste bin and counting every litter item within that rectangle. Litter is identified by walking a zigzagging line up and down the rectangle.

Bin Audits: Observing the quality of the bins

As noted earlier, before starting our research in Summer 2025, the DYBIA collected observational data from 2019 through March of 2025 (see Appendix A for locations). They assessed bins spread out across the DYBIA. They chose old Astral WR4 bins that were going to be replaced with new Astral WR5 or self-compacting bins. This allowed them to conduct observations in the same location before and after the installation of new pilot bins. To increase data collection, we did our own observations on bins in Sankofa Square (Figure 4) using similar methods to harmonize with their data collection. We conducted observations of the status of the bins each time we were at the bins for data collection for litter and user observations (i.e., n = 12 audits per bin).

Here, we collected observational data relevant to:

- The fullness of the bins, including whether or not the bins were overflowing (based on predetermined discrete scale of Empty, ¼, ½, ¾, Full, Overflow; see Figure 6 for an example of overflowing bins)
- The condition of the bin (e.g., whether there was vandalism, break-ins, changes to the decals)
- The intensity of the bin odour, if any

Here, we filled out a datasheet each day and recorded what we observed. See Appendix C for a copy of the datasheet used for each observation.

Figure 6: Left: An example of a New Astral WR5 bin overflowing from every slot in front of St. George subway station. Right: An example of an overflowing cigarette filter slot (or a filter not being discarded all the way into the slot) also in front of St. George subway station.

User Observations

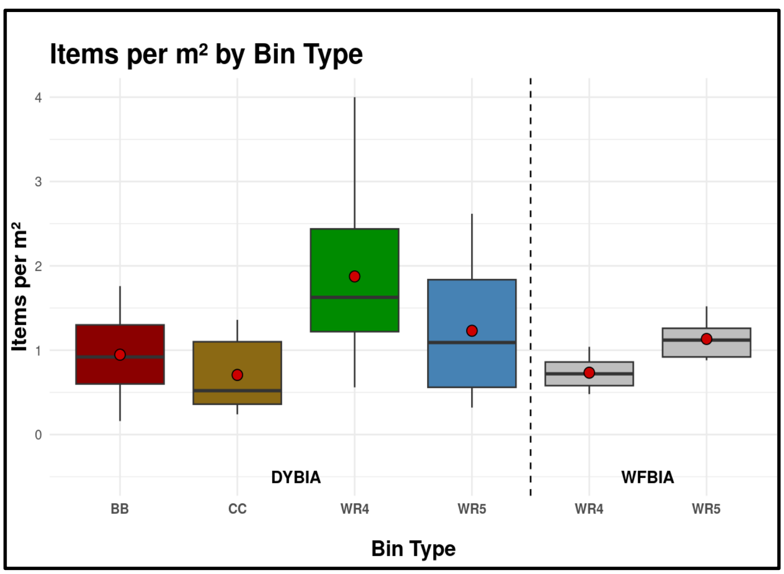
Ultimately, the success of a new bin design is largely dependent on how the users react to it and use it. Here, we observed the usage of each bin for a period of 20 minutes (See Appendix D for relevant datasheets). By observing users at all bins, we are able to compare usability among the old Astral WR4 bins, the new Astral WR5 bins, and the self-compacting bins. Each bin observation was conducted a total of 6 times, with each round of observations conducted for each bin on the same day, similar to the litter transects, to hold constant weather and foot traffic conditions.

For the observations, we found a place where we could sit discreetly to clearly observe people using the bins for a 20-minute period. The observation point had to be close enough to identify the type of trash being deposited. During the observation window, we collected data for each person that interacted with the bin, noting the type/item of waste, which bin slot the item was placed in (landfill, recycling or cigarette receptacle), whether this was the correct slot (as determined by the publicly available WasteWizard Toronto protocols), and alternatively noted if the person kept the item (i.e. the person chose not to use the bin) or littered the item. If a waste item was not put into the correct slot when deposited into the bin (i.e., putting landfill waste into recycling), this is referred to as contamination. Our aim was to understand how users approach bins, how they react to bins, and whether they are putting waste in the appropriate slots. Data was compared to determine whether or not the bin design affects user behaviour.

Results & Discussion

Litter Transects

Across all bins, during each observation at DYBIA and WFBIA, we always observed litter (Figure 7). Although the average amounts of litter were similar among bins at the DYBIA and the WFBIA, the variability was much greater at the DYBIA. In general, we observed less litter around all new bin types (new Astral WR5 and self-compacting) at DYBIA (mean of 1.2 items per m^2 for new Astral WR5 and 0.8 items per m^2 for self-compacting) compared to the old Astral WR4 designs (mean of 1.9 items per m^2; Figure 7). Between the oldest (Astral WR4) and newest (self-compacting) waste bin models, we observed an approximate 56% reduction in litter. Between the newer Astral WR5 and the self-compacting bins we observed a 32% reduction in litter. In terms of individual bin performance, the CleanCUBE had the lowest mean amount of litter, with 0.71 items per m^2. Our observations in the DYBIA suggest that garbage bin design has a recognizable impact on littering.



Average Litter Density by Bin Type

Bin Type	Average Litter per m^2
DYBIA	
BB	0.95
CC	0.71
WR5	1.23
WR4	1.87
WFBIA	
WR5	1.13
WR4	0.73

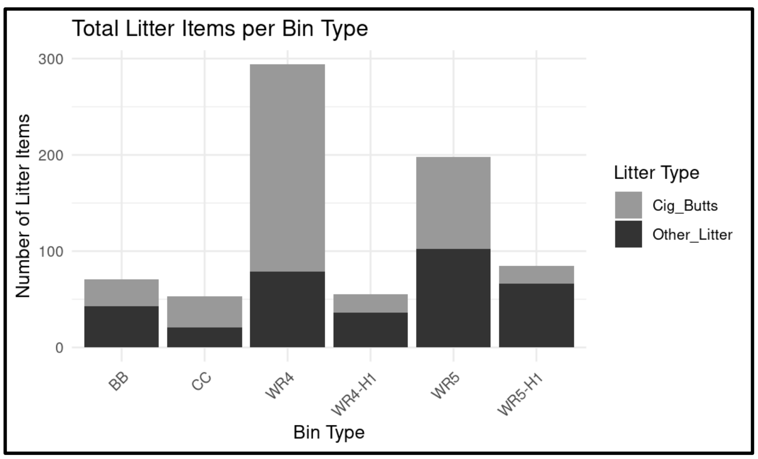
Figure 7. The boxplots show the litter items per m^2 (average indicated by red dot) at each bin type between the old Astral (WR4, green) and the new bin designs (New Astral WR5, blue; Bigbelly, Red; CleanCUBE, Orange) surveyed in the DYBIA. Data collected at one WR4 and one WR5 bin in the Waterfront Business Improvement Area (WFBIA) are included in the plot (gray). The table on the right shows the averages per bin type (n = 6).

Of all of the litter that we observed at both locations and across all bin designs, cigarette butts were the most common item by far (Figures 8 and 9). This is similar to the patterns we observe during cleanups and in our trash trapping devices. The other types of items were more variable, but included gum, other plastic waste (eg. plastic fragments), paper, food wrappers, and glass shards (Figure 8).

Total Counts of Litter Items

Item	Total Count
Cig Butts	409
Gum	62
Other Platic Waste	57
Paper	52
Food Wrapper	42
Glass Shards	40
Gum Wrapper	12

Figure 8. The table shows the top 7 items collected in litter transects around DYBIA and WFBIA bins. The totals are the total recorded number of litter items across all bins and sampling points.



Cigarette Waste as Percentage of Total DYBIA Litter

Total Litter	Total Cig Butts	Cig Percentage
616	371	60.2

Figure 9. This figure shows the proportion of cigarette butts compared to the rest of the litter types recorded at each location across all transects at the DYBIA. Across all bins, cigarettes were the most common litter item. The figure also shows the dominance of cigarette litter across the DYBIA, making up 60.2% of all collected litter.

Bin Condition

Overall, bin conditions in the DYBIA were assessed 12 times per bin, for a total of 72 assessments. We also did 6 audits at each of the WFBIA Astral WR4 and WR5 bins. Full and/or overflowing bins is common in the City of Toronto, which is confirmed here for bins at both the DYBIA and the WFBIA (Figure 10). Determining true fill level (based on the discrete scale ranging from empty to overflow) was not possible for all bins, as key/fob access to look inside the bins through the service hatch was only possible for the new self-compacting bins. Nonetheless, bins that were “Full” or “Overflowing” were readily apparent on all bins and assessed. A “Full” bin meant that the actual removable/lined bins inside were filled to the top, whereas “Overflow” meant that items were sitting on the inner lip/overhang inside of the bins (Astral WR4/WR5) or, alternatively, stuck in the hatches (self-compacting models). The WR4 and WR5 models had a full recycle or landfill slot 16.7% and 18.8% of the time respectivley, compared to the CleanCUBE with 16.7%, and the Bigbelly with 8.3%. As such, the Bigbelly self-compacting bin was full about half as much as the other bins. Break-ins (i.e., noted as bins left open, as opposed to closed and locked) were rare across all bins, and largely isolated to a single Astral WR4 bin located at the southeast corner of the Yonge-Dundas intersection (with 9 events in total). This accounted for 75% of observed break-ins, with a single break-in (the main door found opened) witnessed for a self-compacting bin (CleanCUBE) and two for the new Astral WR5 bins.

Full or Overflow Occurrences by Bin Type (Combined Garbage & Recycling)

Bin Type	Total Full/Overflow (Garbage + Recycling)	Total Observations	% Full/Overflow
DYBIA			
BB	2	24	8.3
CC	4	24	16.7
WR5	9	48	18.8
WR4	8	48	16.7
WFBIA			
WR5	0	12	0.0
WR4	4	12	33.3

Figure 10. The number and rate of observed full/overflow occurrences in either the recycling or landfill slots of bins in the DYBIA. The “% Full/Overflow” is not substantially different across bins, but there is slightly better performance by self-compacting models, and particularly the Bigbelly.

Poor odour incidents were much higher for Astral bins (Figure 11). For the self-compacting bin models, “no odour” was reported for ≥75% of audits and there were no incidences of “high” odour. The Astral WR4 and WR5 models had more regular “moderate” and “high” odour incidents (Figure 11). Less odour in the self-compacting bins is likely attributable to the closed slot/hinged door design.

The condition of the decals was best for the self-compacting bins – with only one recorded altered decal for the CleanCUBE during one sampling event. At DYBIA, there were 23 recorded altered decal incidents for new Astral WR5 bins and 20 for old Astral WR4 bins. At WFBIA, there were 6 altered decal incidents for old Astral WR4 bins. Observations included smudged cigarette receptacles and letters falling off of the "Recycling" and "Litter" labels (Figure 12). The damage to these decal features may, over time, confuse users in their interactions with the bins, increasing contamination. The self-compacting bins, with full body wraps and bright/colourful design, maintained good decal condition, with their signage constantly clear for users to read.

At the DYBIA, self-compacting models had the highest observations of bad and fair cleanliness (Figure 11). However, they did perform better in this metric than the Astral bins at the WFBIA. The self-compacting bins had persistent food waste across their fronts, often covering the handles of the waste hatches. Still, the foot pedal remains an alternative way for users to open the self-compacting bins. Issues related to cleanliness could be attributable to the hatch-design of the Bigbelly and CleanCUBE models, allowing for spilling liquid and solid waste to leak out before landing in the lined garbage bags inside. When looking into these hatches during assessment, they were often covered in the same food waste seen across the fronts of the bins.

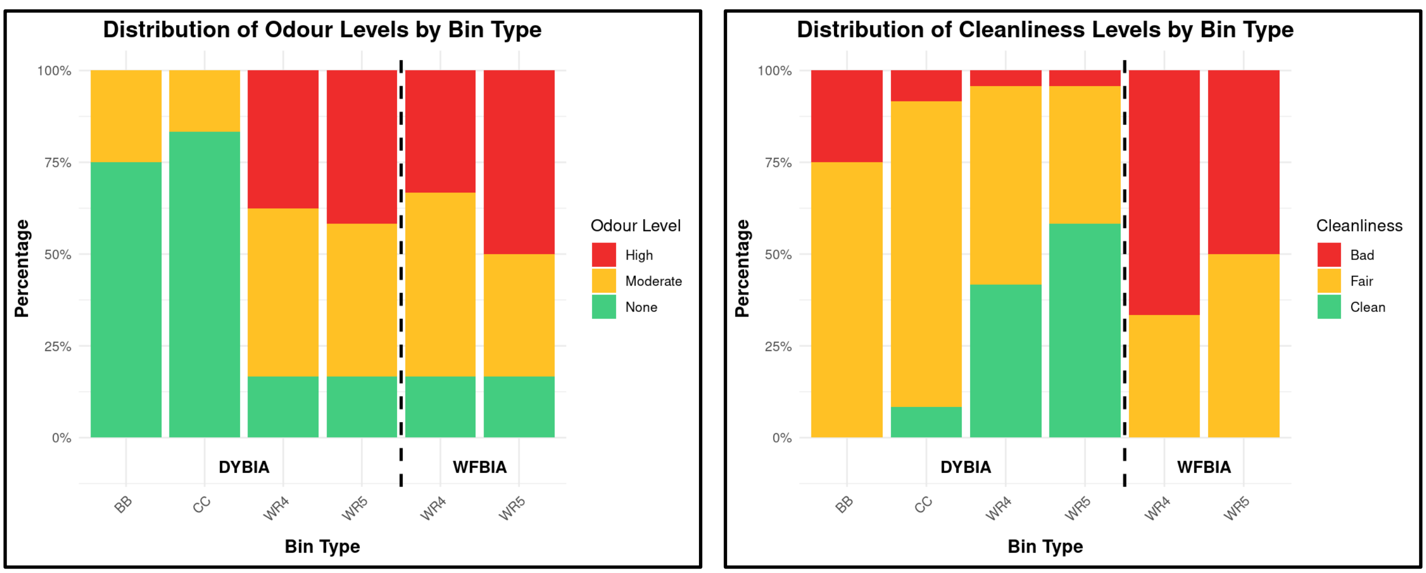


Figure 11. The Figure compares levels of odour (left) and cleanliness (right) across bin types. The newest self-compacting and hinge door models have the lowest odour events, with over 75% incidence rate of "no odour". The Astral models, with open slot designs have comparably higher rates of odour and particularly "high" odour. However, the self-compacting models had the worst conditions of cleanliness in the DYBIA.

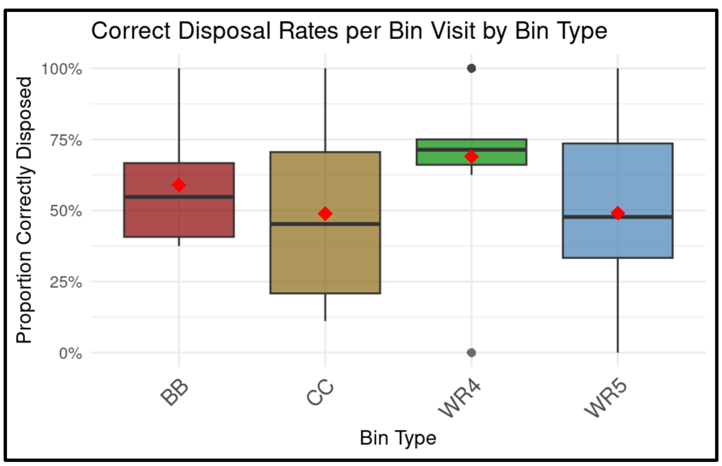
Figure 12. The figure demonstrates the common decal and break-in concerns of the Astral WR4 and WR5 models. Peeling signage/lettering and damaged cigarette receptacles was persistent among them. The WR4 Astral image also shows an example (marked by an arrow) of a bin break-in with the doors left open.

In addition to our observations in summer 2025, the DYBIA also collected data on bin conditions before and after new bins were installed. In 2023, observations over a 3-month period on old Astral WR4 bins showed 16 incidents across 6 bins of overflows, vandalism, spills, and missing liners. In 2024, after new bins were introduced, new bins at the same locations and over the same three-month period showed only 5 incidents of overflow, vandalism, and spills. An overflow was only observed once, and for an Astral WR5 only. In the Winter 2025 (during a 3-month period), the DYBIA observed 9 incidents – 6 with the Astral WR5 bins and 3 with the self-compacting bins. These incidents were again a mix of overflows, vandalism, and damage. Winter observations by the DYBIA are the first time damage was observed with the new bins, which may be expected since at this point the bins were older. During our own study of the bins in a three month period, after the Winter 2025 observations, no occurrences of damage were observed on any of the bins in the DYBIA. See Appendix A for the DYBIA data.

User Observations

Our user observations assessed whether users put landfill and/or recycling waste into the correct slot. If they did not, we refer to this as contamination (i.e. placing an aluminum can in the landfill slot instead of the recycling slot, or placing a black plastic container into the recycling slot instead of the landfill slot). Contamination is a serious challenge, especially to help ensure materials are recycled and kept in a circular economy. Having a user properly sort waste is critical to helping our government reach their goals for the diversion of waste from landfill. User observations were conducted 6 times on each bin at the DYBIA only. For all observations, we observed the least amount of people interacting with the Bigbelly, which could affect patterns in our data. This could be due to the presence of street vendors and religious preachers that frequently are next to this bin.

We did not observe a clear pattern among bin type, and did observe contamination across all bins. Of all discarded items, 32% were discarded incorrectly in the old Astral WR4 bins, 43% in the new Astral WR5 bins and the Bigbelly, and 56% in the CleanCUBE (Figure 13). We did not observe a pattern suggesting the wraps of the self-compacting bins made a difference, as the CleanCUBE performed the worst and the Old Astral WR4 bins the best. We were surprised to see the most contamination at the CleanCUBE because we noticed that individuals tended to spend greater amounts of time at these self-compacting bins. People seemed to spend more time assessing the signage/instructions and disposal options of the bins. People spent much less time at the Astral bins, possibly due to a familiarity with these bins as they have a more widespread presence in the city of Toronto. Over time, the self-compacting models (if rolled out on a larger scale) may gain this same benefit of familiarity, with people coming to better understand these novel visual/written disposal cues incorporated into the design of the bins, and potentially improving rates of proper use. However, overall, rates of proper use were low across all bins and further work should be done to improve contamination rates.



Correct Disposal Summary by Bin Type

Bin Type	Total Items	Correct Items	Correct Rate
WR4	75	51	0.68
BB	33	19	0.58
WR5	51	29	0.57
CC	35	14	0.4

Figure 13. (Left) The graph shows the rate of correct waste item disposal in DYBIA bins at each visit, otherwise meaning the avoidance of contamination. The red dot is the average. (Right) The table shows all items observed and the amount that went into the correct slot. Across all litter items thrown in each bin, the WR4s perform the best with 68% correct disposal, followed by the Bigbelly and WR5 with 57%, and then the CleanCUBE with 44%.

The most common items discarded improperly (and thus leading to contamination) were paper, disposable coffee cups, boba tea cups, and paper/plastic straws (Figure 14). The issue of coffee cups is one which could be addressed with updated signage on the self-compacting bins which currently instructs users to discard them into "landfill", which is inconsistent with 2024 regulations which now accept these items as recyclable materials (CityNews 2024). Likewise, both paper and plastic straws are of concern, having near 50% contamination rates and accompanied with the many drink cups disposed of in the bins. This contamination may be explained by the notable absence of this very common item on any of the bin signage.

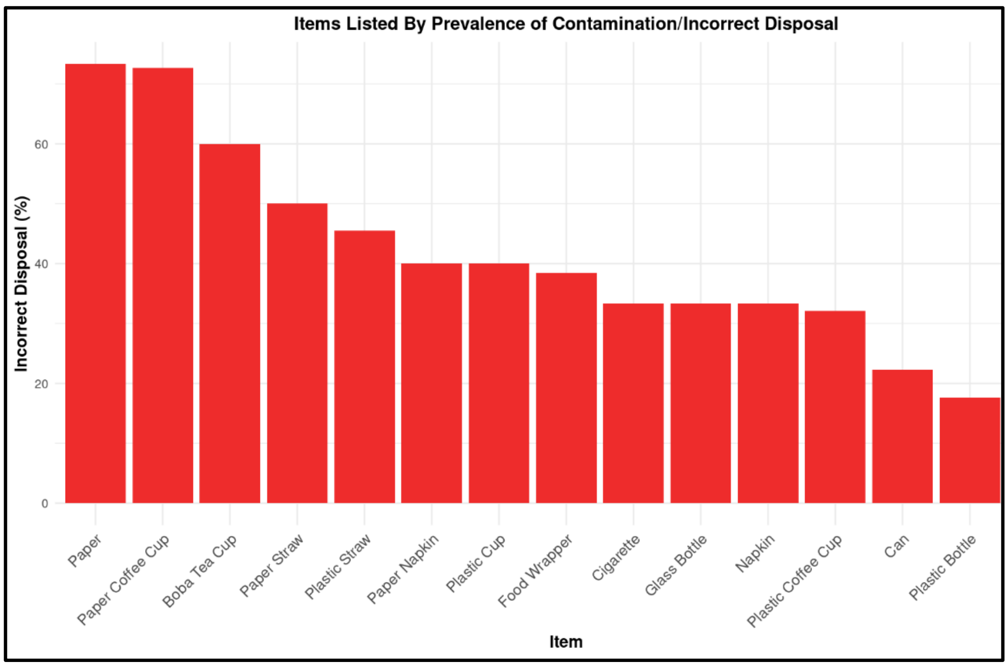


Figure 14. A list of items most incorrectly disposed of in the DYBIA. This graph shows the percentage of times a particular item was discarded incorrectly as a proportion of the total amount of times the item was observed being discarded. Alternatively, it is the proportion of times a particular item was discarded resulting in contamination.

Conclusions and Recommendations

In summary:

Litter: The new Astral WR5 bins and the solar powered self-compacting pilot bins reduce litter, with the self-compacting bins performing best on average. The most common littered item across all bins by far was cigarette butts.

Bin Condition: Bin condition was generally improved with the new pilot bins, and the self-compacting bins performed the best in long-term durability.

User Observations: Very few people use the cigarette butt filter slots for disposal. Moreover, the data did not reveal a clearly superior design between bins as it related to reducing contamination.

Recommendations and Next Steps:

With our data we can make the following recommendations:

1. **Expand the pilot of the self-compacting bins**. In this pilot, we saw that the self-compacting bins can reduce litter, modestly impact overflow (more specifically for the Bigbelly bin), and decrease odour. Moreover, in addition to these observed advantages, sensors within self-compacting bins likely make bin management more efficient – saving time and costs and reducing greenhouse gas emissions. A larger pilot could include bins in more diverse locations and a cost-benefit analysis for a further comparison with the new Astral WR5 bins to better understand any benefits and identify any potential issues with a larger roll-out.
2. **Consider ways to help the public better sort their waste.** Contamination was not significantly different across bin design, or indicative of any particular design (Astral vs self-compacting) being superior. It is necessary to determine better ways to reduce contamination to facilitate higher diversion from landfill and move towards a more circular economy. Changes to the wraps, decals and designs could be piloted to see if better signage and/or design affects whether people put waste in the correct slot.
3. **Pilot new solutions for the collection of cigarette butts.** The new pilot bins have the same type of receptacle slot for cigarette butts as the old Astral WR4 bins. Overall, these slots are rarely used and cigarette butts are commonly reported as litter items in the water and on land, and thus are a prevalent form of plastic pollution. New designs of receptacles for cigarette filters should be piloted with educational campaigns to see if we can reduce this common source of plastic pollution while providing greater awareness that cigarette butts are plastic litter.

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APPENDIX A: OBSERVATIONAL DATA COLLECTED FROM THE DYBIA (2019 – 2025)

The two starred locations are the sites of the new compacting bins. The bin at 10 Dundas St. E is near one of the Astral WR4s assessed by the U of T Trash Team. The bin at 302 Yonge St is near one of the Astral WR5s assessed by the U of T Trash Team.

GeoPal Reports Data Capture							
	2019 - 2024 Obervation period: August to October						
Year	**2019**	**2022**	**2023**	2024		2025 Obervation Period: Jan - Mar	
Location (locations with most issues prior to pilot)	WR 4	WR 4	WR 4	**WR 5**	**Self Compacting Bin**	**WR 5**	**Self Compacting Bin**
444 Yonge St.	4 ❷❶❻	2 ❶❸	6 ❶❸❹	2 ❶❷		1 ❷	
10 Dundas St. E	10 ❶	1 ❶	2 ❸❹	1 ❷		2 ❻❷	
1 Dundas St. E *	3 ❻❷	0	2 ❶		1 ❼		0
290 Yonge St. *	0	2 ❶	3 ❸		1 ❸		3 ❶ ❻
302 Yonge St.	0	1 ❷	3 ❸❺	0		2 ❻❷	
2 Queen St. W	1 ❶	1 ❶	0	0		1 ❷	
				3	**2**	**6**	**3**
Total	**14**	**7**	**16**	**5**		**9**	

Types of Damage

❶ Overflowing
❷ Decal
❸ Messy Spill
❹ Missing liner
❺ Bin surface issue (paint)
❻ Bin Damage
❼ Bin surface issue (wrap)

APPENDIX B:

Litter Transect Datasheet –

Transect Length (m): ____________________________

Transect Width (m): _____________________________

Item Type	Item Tally	Total Item

APPENDIX C: BIN CONDITION DATASHEET

Bin Condition Datasheet –

Name: ____________________________

SITE INFORMATION			
Date	**Study Area** ❑ Downtown Yonge ❑ Waterfront	**Address**	**Coordinates** **Bin ID**
Type of Bin	**Temperature (°C)**	**Weather** ❑ Sunny ❑ Overcast ❑ Rain	**Start Time** **End Time**

BIN CONDITION ON ARRIVAL			
Capacity ❑ Empty ❑ ¾ ❑ ¼ ❑ Full ❑ ½ ❑ Overflow	**Damage?** ❑ No ❑ Yes (explain):	**Liner?** ❑ No ❑ Yes	**Break-in?** ❑ No ❑ Yes
Odor? ❑ None ❑ Mod. ❑ Low ❑ High	**Cleanliness?** ❑ Clean ❑ Bad ❑ Fair ❑ Very bad		

APPENDIX D: USER OBSERVATION DATASHEET

User Observation Datasheet –

Item(s) Observed	**Correct Slot?**	**Kept Item?**	**Littered Item?**