Outdoor Receptacle Audit

By: Kathryn Smith

Office for Sustainability
Spring 2014
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I. Executive Summary

Western Michigan University is a leader in sustainable practices for the recycling and solid waste reduction programs that are coordinated through the Office for Sustainability. The outdoor receptacles on the WMU campus are differentiated between two designs: the old, two-bin system of paper/cardboard (P/C) and glass/plastic/metal (GPM) without a landfill (LF) option and the new, three-bin system including P/C, GPM, and LF. This provides the Office for Sustainability the opportunity to research the contamination rates of the two designs to determine which is more effective.

The 2012 Climate Action Plan found that solid waste made up nearly 2.6% of all GHG (green house gas) emissions; this data came from a 2009 GHG inventory. The rates of contamination determined from auditing the outdoor receptacles are useful in determining how much further WMU needs to go to become GHG neutral by 2065.

The focus of this study was to (1) weigh, sort, and record the total LF, P/C, and GPM found within six outdoor receptacles (three old design, three new design) and (2) compare the weights and rates of contamination of the old design to the new design of receptacles. Another focus of this study was to compare cold weather contamination rates with warm weather contamination rates. This study will be used as a baseline report for future analysis of the outdoor receptacles on the WMU campus.

This research project aims to address the issue of proper recycling and waste management. It gives insight as to how effective the newer designs are compared to the older designs where students and faculty need to walk elsewhere to properly dispose of their landfill waste. The six receptacles that were audited were chosen in high-traffic areas. The new receptacle locations included: the Office for Sustainability, the bus stop, and the Reid Fieldhouse. The old receptacle locations included: Schneider Hall, the Bernhard Center, and the Chemistry Building.

This study began as a four-week cold weather data collection with one week of warm weather collection. Due to the number of cold weather days, the study evolved into an eight-week analysis; seven of the eight weeks experienced some level of snowfall.

The methods remained unchanged throughout the study. The data collector was driven to each of the six locations where the LF, P/C, and GPM bags were removed and labeled with a Sharpie marker by location and type (LF, P/C, or GPM). These bags were then taken to the Office for Sustainability where weighing and sorting occurred.

The results in this baseline audit show that there were significantly higher levels of contamination in the P/C in the older receptacles but there were slightly lower levels of contamination in the GPM of in the older receptacles. This difference in contamination rates can be explained through the overall weights in the old and the new receptacles. Overall, the newer receptacles contained approximately 16 pounds more than the older receptacles in the P/C alone; whereas the newer receptacles contained approximately 1.6 pounds more than the older receptacles in the GPM.

Due to the lack of warm weather days, this research should be repeated in the fall semester to compare the cold weather results recorded in this study to warm weather, keeping a similar demography on campus.
II. Introduction

In 2009, President John Dunn signed the ACUPCC (American College and University President’s Climate Commitment) an agreement to make Western Michigan University a more sustainable university. In order to achieve the goal of waste-free by 2065 recycling and contamination rates need to be determined to monitor progress. In order to determine waste reduction rates on the WMU campus, many small and large-scale audits need to be performed. These audits are necessary in determining the overall waste reduction and the amount still required to reach the goal of waste-free by 2065. These audits need to encompass all areas and populations of students and faculty on Western Michigan University’s campus.

This study was a baseline audit of the outdoor receptacles on the WMU campus. This study focused on comparing the new receptacles to the old receptacle design. Another focus of this study was to compare cold weather contamination with warm weather contamination. Landfill (LF), paper/cardboard (P/C), and glass/plastic/metal (GPM) and contamination weights of both the LF and recycling were recorded once per day on Monday, Wednesday, and Friday afternoons during the weeks of January 27 through April 4. The contamination collected (recyclable items in the landfill or in the wrong recycling and trash in either recycling) was removed and placed into the appropriate “LF,” “P/C,” or “LF” bag. This weight was then recorded at the end of each day and contamination rates were determined at the end of each week.

The outdoor receptacles are accessible to all faculty and students, thus providing an equal comparison for proper waste management. The six receptacles were chosen for the audit based on highly populated areas. Three receptacles were the new stainless steel receptacles with designated areas for LF, P/C, and GPM. The remaining three receptacles were stainless steel receptacles with designated areas for only P/C and GPM.

III. Methodology and Data

During the weeks of January 27 through April 4, 2014 six of the outdoor receptacles experienced a waste audit. These outdoor receptacles included three new-design receptacles and three old-designed receptacles. The new-design receptacle locations included the Office for Sustainability, the bus stop, and the Reid Fieldhouse. The older receptacle locations included the Bernhard Center, Schneider Hall, and the Chemistry Building. The landfill (LF), paper/cardboard (P/C), and glass/plastic/metal (GPM) were emptied and sorted. The weights before sorting were recorded and any contamination (recyclable items found in landfill or trash found in recycling) were weighed and recorded.

Beginning at 12:00 pm every Monday, Wednesday, and 11:00 am on Friday sorting occurred. The data collector was driven to the six designated receptacles where bags were removed, labeled with a Sharpie indicating their location and bag type, and brought back to the WMU Office for Sustainability where weighing and sorting occurred. This occurred in the bike stable with a large gray tarp laid over a table.

Data was entered directly into an excel spreadsheet while sorting occurred. This eliminated the need for printed-paper and to later transfer data. Bags were weighed using the new CPWplus 150L scale
purchased for waste audits and other projects at the Office for Sustainability. This scale allowed bags to be placed directly onto the scale without the need to tare the weight of the sorter.

Contamination rates were determined at the end of every week throughout the audit. Rates were calculated for new receptacles and old receptacles. These results were then compared to determine the effectiveness of each receptacle design. Contamination rates were determined using the following equations.

Equation 1. Contamination rate of recycling in landfill

\[
\left( \frac{\text{Recycling in Landfill}}{\text{Total Landfill}} \right) \times 100 = \text{Landfill Contamination Rate}
\]

Equation 2. Contamination rate of trash in recycling

\[
\left( \frac{\text{Trash in Recycling}}{\text{Total Recycling}} \right) \times 100 = \text{Recycling Contamination Rate}
\]

Figures 1, 2 and 3 show the process for weighing and sorting. Figure 1 shows one of the old stainless steel receptacles. Figure 2 shows the process to extracting and labeling the bags. Figure 3 shows the area in which weighing and sorting occurred.

Figure 1. Bernhard Center Receptacle  Figure 2. Labeling bags  Figure 3. Sorting area
In week one, contamination rates for both GPM and P/C were higher in the older stainless steel receptacles. The old receptacles showed approximately 94.1% contamination of P/C compared to 78.6% contamination of the new receptacles. The old receptacles showed approximately 57.7% in the GPM compared to 37.5% in the new receptacles. This figure also shows that there was no contamination in the LF.

Figure 5 shows the contamination rates for week 2 of the waste audit. This figure shows that the contamination rates for both GPM and P/C were higher in the older stainless receptacles than in the new stainless steel receptacles. The old receptacles showed a contamination rate of 66.7% in the P/C compared to 34.8% in the new receptacles. The old receptacles showed a contamination rate of 33.3% in the GPM compared to 2.4% in the new receptacles. This figure shows an extremely low contamination rate in the LF of 4.3%.
Figure 6. Week 3 Contamination Rates

Figure 6 shows the contamination rates for week three of the study. These results show a higher rate of contamination in the P/C in the old stainless steel receptacles (approximately 46.7% compared to 40% in the new receptacles) but a higher rate of contamination in the new receptacles for GPM (30.2% compared to 2% in the old receptacles). This figure also shows a consistently small amount of contamination in the LF, approximately 4.3%.

Figure 7. Week 4 Contamination Rates

Figure 7 shows the contamination rates for week 4 of the study. These results show a higher rate of contamination in the new stainless steel receptacles for P/C (approximately 71.4% compared to 50% in the old receptacles) but lower in GPM (approximately 22.7% compared to 25.8% in the old receptacles). This figure also shows a consistently small amount of contamination in the LF, approximately 7.8%.
Figure 8. Week 5 Contamination Rates

Figure 8 shows the contamination rates for week 5 of the study. This figure shows nearly double the rates of contamination of P/C in the old stainless steel receptacles (approximately 85% in the old receptacles and 45.5% in the new receptacles). This figure also shows similar contamination rates for the GPM, 15.8% and 19.4% for the old and new stainless steel receptacles respectively. This week also shows a significantly higher rate of contamination of LF compared to previous weeks, approximately 33%.

Figure 9. Week 6 Contamination Rates

Figure 9 shows the contamination rates for week 6 of the study. This figure shows a slightly higher rate of contamination in the P/C in the older stainless steel receptacles (38% compared to 36% in the new receptacles) but higher rates of contamination in the GPM of the new stainless steel receptacles (26% compared to 6.8% in the old receptacles). This week also showed a contamination of 4.4% of LF.
Figure 10 shows the contamination rates for week 7 of the study. This week showed high rates of P/C contamination in both the new and old stainless steel receptacles but was slightly higher in the old receptacles (approximately 73.9% compared to 55.5%). Contamination in the GPM was approximately equal in the new and old stainless steel receptacles with the old receptacles at 4.1% and the new receptacles at 4.6% contamination. The level of contamination in the LF was consistent with previous weeks at approximately 6.1%.

Figure 11 shows the contamination rates for week 8 of the study. This figure shows higher rates of contamination in the P/C in the older stainless steel receptacles (approximately 6.9% compared to 3.2% in the new receptacles). It also shows higher rates of contamination in the GPM in the newer receptacles (approximately 22% compared to 1.5% in the old receptacles). Contamination in the LF was approximately 6.9%.
Figure 12 shows the contamination rates of the new and old receptacles. They show only the contamination of the GPM and the P/C. The contamination of the P/C was significantly higher in the old receptacles, approximately 62.6% compared to 15% in the new receptacles. The overall contamination of the GPM was slightly higher, approximately 21.3%, in the newer receptacles compared to 10% in the old receptacles.

**IV. Discussion**

Week 1 shows that the contamination rates for both the GPM and P/C were higher in the older stainless steel receptacles. The contamination rate for the GPM in the old receptacles was 57.7% compared to the contamination rate for the new receptacles that was 37.5%. The contamination rate for the P/C in the old receptacles was 94.1% compared to the new receptacles that had a contamination rate of 78.6%. This week’s highest temperature was 12 degrees. This data could be used to compare warm weather results in the future.

Week 2 shows that the contamination rates for both the GPM and P/C were higher in the older stainless steel receptacles. The contamination rate for the GPM in the older receptacles was 33.3% compared to the contamination rate of GPM in the new receptacles that was 2.4%. The contamination rate for the P/C was 66.7% for the older receptacles and 34.8% in the new receptacles. This week’s highest temperature was 20 degrees.

Week 3 shows that the contamination rates for the P/C was higher in the older receptacles but the GPM was lower. The contamination rate for the P/C in the older receptacles was 46.7% compared to the contamination rate of P/C in the new receptacles at 40% contamination. The contamination rate for the GPM in the older receptacles was found to be 2% compared to 30.2% in the new receptacles. This significant difference is due to the small amount of GPM present in the older receptacles compared to the new receptacles. This week’s highest temperature was 18 degrees.

Week 4 shows that the contamination rate of the P/C was higher in the new receptacles but the contamination rate of GPM was higher in the older receptacles. The contamination rate for P/C in the new receptacles was 71.4% compared to 50% in the older receptacles. The contamination rate of GPM in the new receptacles was found to be 22.7% compared to 25.8% in the older receptacles. This week’s highest temperature was 21 degrees.
Week 5 shows the contamination rates of the P/C was much higher in the older receptacles but the GPM contamination rates were slightly lower. The contamination rate of P/C in the older receptacles was 85% compared to 45.5% in the new receptacles. The contamination rate of GPM in the older receptacles was found to be 15.8% compared to 19.4% in the new receptacles. This week’s highest temperature was 26 degrees.

Week 6 showed higher rates of contamination of P/C in the older receptacles but lower rates of contamination in GPM. The contamination rate of P/C in the older receptacles was 38% compared to 36% in the new receptacles. The contamination rate for GPM was found to be 6.8% in the older receptacles compared to 26% in the new receptacles. This week also has 14.2 pounds of newspaper found in the P/C with less than .1 pounds of contamination. This week’s highest temperature was 32 degrees.

Week 7 showed higher rates of contamination in the P/C in the older receptacles but slightly lower rates of contamination in the GPM. The contamination rate of P/C in the older receptacles was found to be 73.9% compared to 55.5% in the new receptacles. The contamination rate of GPM in the older receptacles was 4.1% compared to 4.6% in the new receptacles. This week’s highest temperature was 51 degrees.

Week 8 showed higher rates of contamination in the P/C in the older receptacles but slightly lower levels of contamination in the GPM. The contamination rate for the P/C in the older receptacles was 6.9% compared to 3.2% in the new receptacles. The contamination rate for the GPM in the older receptacles was found to be 1.5% compared to 22% in the new receptacles. This week also had evidence of an office clean out in the Bernhard center P/C. All materials were disposed of properly. This week’s highest temperature was 50 degrees.

The results show that there is a clear correlation between the new receptacles and the lower contamination rates for the P/C. The new receptacles showed higher weights of overall P/C compared to the older receptacles; the difference was approximately 16 pounds. The old receptacles showed similar weights of the overall GPM compared to the new receptacles; the difference was approximately 1.6 pounds. This means that even though there was significantly more weight in the P/C of the new receptacles, the contamination level was still lower than the old receptacles.

Snow piles and extremely cold weather could have affected the rates of contamination during this study. Numerous days throughout the study required snow to be shoveled from the front of the receptacles. The snow created a barrier so that students and faculty proper waste disposal was not the easiest option. Snow also was plowed up against the receptacles, blocking the slot to dispose of materials.

V. Limitations and Future Research

The major limitation to this study was the weather. The cold temperatures and snow pile up could have significantly contributed to the amount of contamination in the receptacles. Receptacles were not easily accessible; many of the days they needed to be shoveled out before collection could occur. The snow pile up prevented students and faculty from easily accessing the proper bins, which could
have contributed to contamination levels. Figures 1 and 2 show the snow pile-up on two different receptacles during the study.

Figure 13. Bus stop snow removal

Figure 14. Reid field house snow removal

This study should be repeated in the fall semester. The demography on campus will be similar to spring semester and the weather will be warmer. This data can then be used to compare the cold weather data collected in this baseline audit.

VI. Conclusions and Recommendations

In conclusion, it was found that contamination rates for the old receptacles were much higher in the P/C bin but slightly lower in the GPM. The newer receptacles were used at a much higher rate than the older receptacles. This could be due to the location of the receptacles audited, but further research would need to be done to determine the cause. An audit of different receptacles on campus could also provide insight as to whether these contamination rates are campus-wide or area specific.

The warm weather data was not sufficient enough to compare to the cold weather data due to the extreme winter weather that was experienced on campus. This study should be repeated in the fall semester. This will provide a similar demography on campus but give warm weather data that can be used to compare the cold weather data collected in this study.
VII. Appendices

Appendix A: Image Archive

- Balsamic rice bag found in LF
- Contamination of a full coffee cup in the P/C
- Leather backpack found in LF
- Broken umbrella found in the LF
Appendix B: Data Collection Protocol

General Procedures

-Every Monday, Wednesday, and Friday afternoon: Trash and recycling will be collected from the outdoor receptacles, labeled according to location and bag type, and brought back to the Office for Sustainability. Data collectors will then process it by sorting recycling from the landfill and trash from the recycling. The sorted recycling (glass/plastic/metal and paper/cardboard) and landfill will then be weighed separately and placed into the appropriate dumpsters.

-Once per week: Data collectors will perform the Interobserver Agreement Protocol.

Before Handling Waste

-Bandage all cuts and scrapes on hands and arms, even on areas that will be covered by gloves

After Handling Waste

-Follow steps to safely remove vinyl/nitrile gloves

1. With both hands gloved, peel off one glove starting from your wrist and continuing over your fingers. Hold the removed glove (now inside out) and remove other glove.
2. Use the inside out portion of the glove removed to peel off second glove. Both gloves should be inside out when removed. This prevents exposure to blood and other biohazard material.
3. Tuck the first glove inside the second. Dispose of the entire bundle properly.

-Dispose of vinyl/nitrile gloves in landfill bag

-Wash hands thoroughly

Dress Code

-While participating in any aspect of data collection, data collectors must AT ALL TIMES follow the dress code:
1. Leather or vinyl gloves, provided by the data-collector
2. Closed-toed shoes
3. Long pants
4. Long sleeves

Daily Protocol

-Handling Waste

1. Never load a bag or bin to the point where it is too heavy for you to carry
2. If it is necessary to lift a bag of waste out of a bin or brute barrel, tip the barrel on its side and draw out the bag slowly. This avoids creating a vacuum, making the bag extremely hard to lift and risks injury.
3. While carrying waste bags, hold them away from your body and do not let them rub against your legs. This may require you to carry only one bag at a time in order to have enough strength to hold away from your body.
4. Bags may leak liquid from the bottom, beware of this and clean up any spills.
5. Bags will be collected by the data collector and brought back to the Office for Sustainability
6. Once bags are at Office for Sustainability, separate bags into groups of recyclables (glass/plastic/metal and paper/cardboard) or landfill.

-Recyclables Sorting

1. Weigh each bag of recyclables individually. Once bag is weighed and recorded, place onto sorting table. Sort out any trash contamination and place into designated landfill bag. While sorting glass/plastic/metal bags, remove liquid from any bottles or cans and place into a large bucket. Place returnable items into a deposit bag kept separate from the other
glass/plastic/metal bag. These deposit items will be brought back to the Office for Sustainability and placed into deposit receptacle behind building.

2. Weigh and record the recycling totals in the Weighing protocol below.
3. Be aware of dangerous items (listed below) and if one is found, stop collection immediately and notify the data collection supervisor.

-Trash Sorting
1. Weigh each bag of landfill individually. Once bag is weighed and recorded, place onto sorting table.
2. Before sorting, open the bag as widely as possible by pulling outward on the upper edges. If necessary, cut a slit down the side of the bag in order to open wider. This prevents possible contamination with unknown, possibly hazardous items.
3. Sort out any recycling contamination and place into designated recycling bag (glass/plastic/metal or paper/plastic). Place returnable items into a deposit bag kept separate from the other glass/plastic/metal bag. These deposit items will be brought back to the Office for Sustainability and placed into deposit receptacle behind building.
4. Move trash inside the bag to uncover recyclable items only by using a push stick and never using your hand.
5. Remember to only touch items that are fully visible.
6. Do not allow fingers or hands to reach around a recyclable item where a syringe or sharp object might be concealed.
7. Be aware of dangerous items (listed below) and if one is found, stop collection immediately and notify the data collection supervisor.
8. Sorted and recycling bags must be weighed and recorded separately after sorting is complete and liquids are emptied. Reference the Emptying Liquids and Weighing/Disposing protocol below.

-Emptying Liquids
1. Some recyclable containers found in the trash or GPM bags will have liquids in them (soda cans, coffee cups, Gatorade bottles, etc.) Using either a bucket or the first large container found as a liquid reservoir, empty all other liquids while sorting.
2. Empty liquids slowly and from a close proximity so they do not splash.
3. Once data collection is complete for the day, empty the reservoir container into a toilet in the nearest restroom. Pour slowly to avoid splashing. If splashing does occur, wipe away with a disinfectant wipe.

-Dangerous Items
1. If potentially dangerous items are discovered, do not touch and immediately stop sorting. Report the item to the data-collector or data collection supervisor. They will then take the proper action for handling and disposal.
2. If you come into contact with a potentially harmful powdery or liquid substance, go immediately to the nearest restroom and wash thoroughly with soap and water. Notify the data collection supervisor after substance has been washed off.
3. If you become cut, scraped, or require other medical attention, notify the data collection supervisor immediately. A first aid kit will be located near sorting area.
4. Dangerous items can include the following:
   - Broken glass
   - Needles: plastic liquid laundry containers and soda cans may sometimes be used for diabetic needle disposal
- Empty containers for toxic, flammable, or otherwise harmful materials including cleaning agents, aerosol cans, etc.
- Bandages, Kleenex, or other items containing blood or other bodily fluid
- Toner cartridges or any powdery substance that could possibly be inhaled. If cartridge is intact, set it aside and continue sorting the bag. It will be processed as recycling
- Bottles that appear to be expanding, under pressure, or contain anything unusual such as chewing tobacco or unknown liquid substances

- Weighing
  1. All items need to be weighed after collection and sorting.
  2. Landfill and recycling should be weighed in bags designated as landfill, glass/plastic/metal, or paper/cardboard. Recycling sorted out of landfill is placed into the properly designated recycling bag. Trash that is sorted out of recycling is placed into the designated landfill bag.
  3. Data collectors will tare him/herself on the bathroom scale, then weigh him/herself holding the material, and subtract the tare weight to obtain the material weight.
  4. If weighing recyclables in a bin, subtract the weight of the bin from the total weight of the contents.
  5. Always weigh one bag at a time by holding it away from your body.

- Depositing
  1. Once bags are weighed and recorded, they may be deposited into the appropriate dumpster. Do not attempt to open dumpster lids while carrying waste bags. Either set the bags down first or open dumpster lids before carrying waste bags outside.
  2. When depositing bags, hold them over the open dumpster and drop them. Do not toss from any distance.
  3. Leave deposit container bag with data collection supervisor to be brought back to the Office for Sustainability.

**Interobserver Agreement Protocol**

1. When prompted by the data-collector during one data collection session per week, data collectors will perform the Interobserver Agreement Protocol.
2. The data-collector will select one bag of waste to test and one data collector will sort and weigh it according to the above protocol while a second data collector is out of sight.
3. Also out of sight of the second data collector, the data-collector will then mix the recycling back into the trash bag by setting the recycling items into the trash bag and using a push stick to mix them in.
4. The second data collector will then re-sort and weigh the same bag of waste.
5. The waste can then be deposited into the appropriate dumpsters.
Appendix C: Campus Map with Receptacle Location

A red “x” indicates the locations of the old receptacles; black “x” indicates the locations of the new receptacles.