APRA Data Report

Industrial Plastics in the Alberta Industrial Heartland

April 26th, 2022

Report for Alberta Plastics Recycling Association

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Approved by

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Executive Summary

Eunomia Research & Consulting Inc. (Eunomia), along with S- Cubed Environmental (S-Cubed), and AET were commissioned by the Alberta Plastics Recycling Association (APRA) to assess the status of plastic disposal in industrial waste in Alberta's Industrial Heartland (AIH) by analyzing AIH companies' waste streams through waste audits and subsequent data analysis.

The primary objective of this study was to:

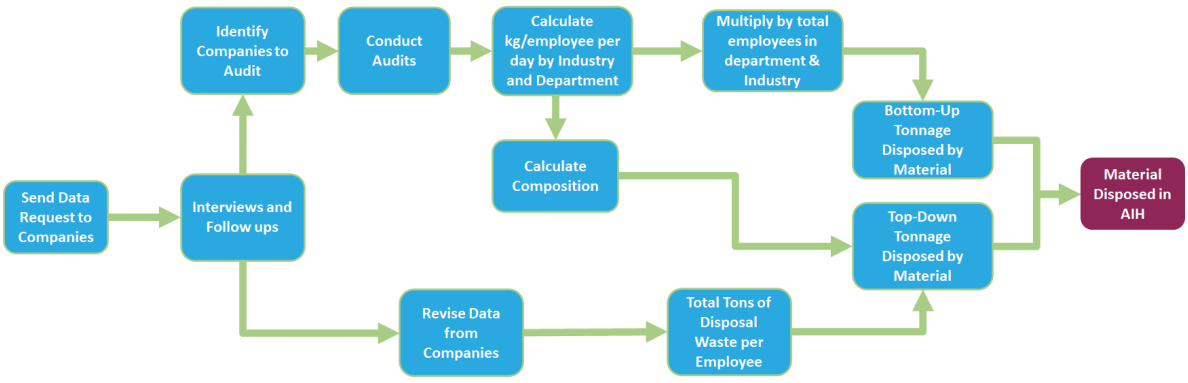
- Quantify the amounts of different plastics generated by material type.
- Record the resin and source of plastics from different operations (administrative vs operations).
- Identify some of the barriers to recycling; and
- Develop an audit guide and templates that can be used for future audits.

E.1.0 Approach

Figure 3 below summarizes the approach taken to gather and process data in order for Eunomia to estimate:

- the total amount of plastic across the study participants.
- the amount of plastic by resin.
- the mass of post-use plastic by activity as well as by business sector.

Figure 1: Data Process Flow



The number of businesses, by industry type, which were audited over a 6-week period in June and August are included in Table 1. Thirty-seven (37) detailed audits were conducted across 10 companies. Definitions of each of the activities are given in section 2.3.1.

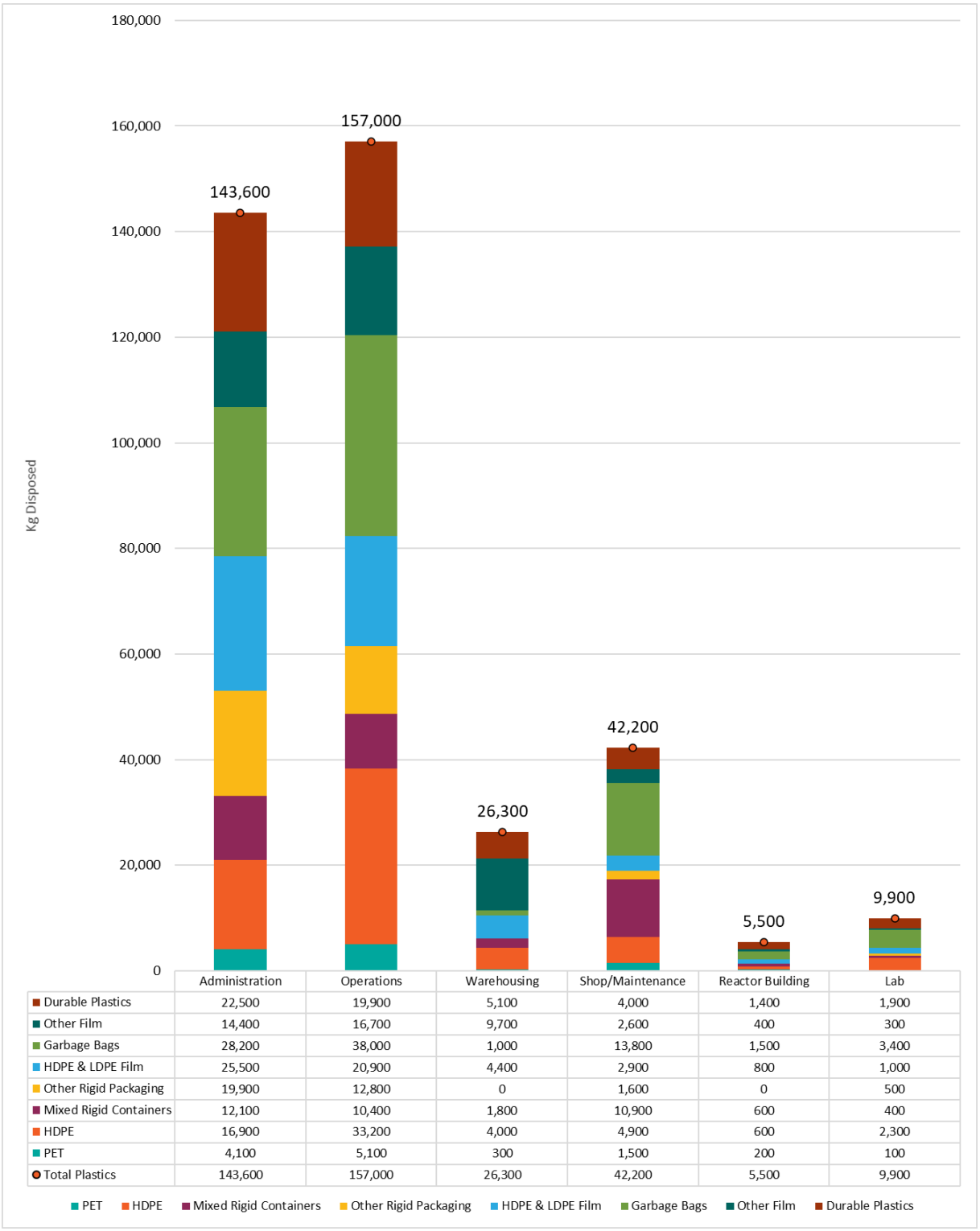
Table 1: Summary of Companies Audited and the Activities included in the Audit

Business Industry	Number of Companies	Activities Audited
Oil Transportation	2	Administration, Operations
Gas Processing	1	Administration
Chemicals	2	Administration, Operations, Warehouse, Shop/Maintenance, Reactor/Power Plant, Lab
Oil Production	2	Administration, Warehouse, Shop/Maintenance, Reactor/Powerplant, Lab
Agribusiness	1	Operations
Fertilizer Production	1	Administration, Operations
Metals Refining	1	Administration, Operations, Warehouse

E.2.0 Key Findings

The annual tonnage of plastics disposed of from 25 companies across the AIH in 2021 was estimated to be 391 tonnes. Figure 2 summarizes the amount of plastic disposed by plastic type. As can be seen in the figure, the department that created the most post-use plastic was the operations department, with garbage bags being the most prevalent plastic disposed as they contained all of the waste.

Figure 2: Kg of Plastic Disposed by Activity



	Administration	Operations	Warehousing	Shop/Maintenance	Reactor Building	Lab
Durable Plastics	22,500	19,900	5,100	4,000	1,400	1,900
Other Film	14,400	16,700	9,700	2,600	400	300
Garbage Bags	28,200	38,000	1,000	13,800	1,500	3,400
HDPE & LDPE Film	25,500	20,900	4,400	2,900	800	1,000
Other Rigid Packaging	19,900	12,800	0	1,600	0	500
Mixed Rigid Containers	12,100	10,400	1,800	10,900	600	400
HDPE	16,900	33,200	4,000	4,900	600	2,300
PET	4,100	5,100	300	1,500	200	100
Total Plastics	143,600	157,000	26,300	42,200	5,500	9,900

Source: Eunomia Modelling, S-cubed and AET Audit Data

Detailed charts showing the composition of each department can be found in section 3.2.

Post use plastic is predominately generated from activities related to industrial operations and administration. Many of the sites had materials delivered in returnable plastic packaging, which did not end up in the disposal stream. These returnable plastic packaging containers can be sent back to the supplier, or sent directly to a recycler, as it is a clean stream of recyclable plastics.

Some of the key types of plastics waste generated include:

- HDPE & LDPE Film.
- Other Film (e.g. laminated film, shrink wrap).
- HDPE containers.

E.3.0 Future Data Project Opportunities

Conducting this study over the course of nearly a year and facing unique challenges allowed the project team to determine opportunities for improvement of data collection and analysis. For instance, increasing the number of audit sorts per site will lead to a lower level of variance in the audit results, and subsequent data analysis.

Additionally, increased availability of staff on site to support the entire waste audit process allows for audit teams to choose the most representative waste bins to audit, as well as ensure they are collecting a comprehensive set of data. This ensure the data used for analysis is both representative and comprehensive of the study target.

Some additional opportunities which on-site staff can provide to achieve the benefits mentioned above include:

- Giving an on-site tour to view waste generation areas prior to the start of the audit period.
- On-site staff could record bin fullness for a week (bin fullness is used to estimate the bulk density of selected material) which can in turn be extrapolated to other bins which were not audited.

E.4.0 Challenges to Recycling

The challenges to recycling which were identified while completing the study included:

- Insufficient volumes to justify additional recycling containers.
- Contamination of administrative bins with waste from non-administrative areas.
- Changing the behaviors of site staff to ensure that post-use plastic is correctly separated.

- Difficulty for collectors to find end markets for low volumes of mixed post-use plastic.

E.5.0 Conclusions and Future Consideration

The volume of post-use plastic disposed from the 25 companies in this study is small compared to the total estimate plastic disposed from the Industrial and Commercial (ICI) sector province wide. The ICI sector disposes of an estimated 313,000 tonnes of plastic annually.[1] The post-use plastic disposed in the Heartland is therefore 0.12% of this total.

While not specifically a requirement of the study, other potential sources of post-use plastics were identified during the project which included:

- Hospital waste: It was the intention of the study to audit a regional hospital, however due to the COVID-19 pandemic, this was not possible. AET has previously carried out audits on hospital premises and identified post-use plastic disposal.
- Hazardous waste plastic stream: The project team was in contact with a company which processes hazardous waste plastics collected from industrial sites like those audited in this study. This waste stream may produce 600-700 tonnes of potentially divertible plastics.
- The commercial sector – one commercial sector audit was conducted for this study, and it revealed that 15% of the waste stream is plastic material.

[1] https://publications.gc.ca/collections/collection_2020/eccc/en14/En14-405-2020-eng.pdf

Contents

1.0 Introduction

1.1 Background

The Alberta government announced in October 2020 their intention to make Alberta "the western North America center of excellence for plastics recycling by 2030." Alberta aims to consider the programs, systems, and infrastructure that are needed to make Alberta a leader in plastics recycling, and to enable post-use plastics to become the feedstock for new products – creating a circular economy. Thus, an understanding of the quantity and flows of post-use plastics, by resin type, produced from the residential, industrial, commercial, institutional (ICI) and construction and demolition (C&D) sectors is critical.

Alberta's Industrial Heartland (AIH) is an area just northeast of the City of Edmonton in Alberta, Canada. Thirty-seven (37) companies operate in the AIH. Companies in the AIH fall under a range of economic industries. Below are examples of company industries in the AIH:

- Chemicals companies.
- Industrial oil and gas manufacturing companies.
- Agribusiness companies.
- Oil transportation companies.
- Minerals refining companies.

1.2 Objective

Eunomia Research and Consulting (Eunomia), S-Cubed Environmental (S-Cubed) and AET were commissioned by the Alberta Plastics Recycling Association (APRA) to assess the status of plastic disposed in industrial waste in the Alberta Industrial Heartland (AIH) by analyzing AIH companies' waste streams through waste audits and subsequent data analysis.

The primary objective of this study was to:

- Quantify the amounts of different post-use plastics generated by resin.
- Indicate the characteristics of the post-use plastics found in the waste audits.
- Record the resin and source of plastics from different operations (e.g. administrative vs operations).
- Identify some of the barriers to recycling and the current end fate of materials; and
- Develop an audit guide and templates that can be used for future audits.
- Describe the quality of the post-use plastic generated (including e.g. contamination, non-plastics material).

This project gathered data from companies within the AIH to establish:

- The types of post-use plastic generated in the AIH.
- The characteristics of the post use plastic disposed of in the AIH.

- The quality of the post use plastic disposed of in the AIH.
- The quantity of plastic disposed of in the AIH.

The waste streams of interest in this study are the non-hazardous garbage and recycling streams. The non-hazardous garbage waste stream was audited at industrial sites for this study. This study does not analyze the hazardous waste, separate collections, or C&D streams.

The study was carried out throughout 2021, when COVID-19 presented challenges towards logistical planning and on-site participation.

1.3 Report Structure

This report is split into the following sections:

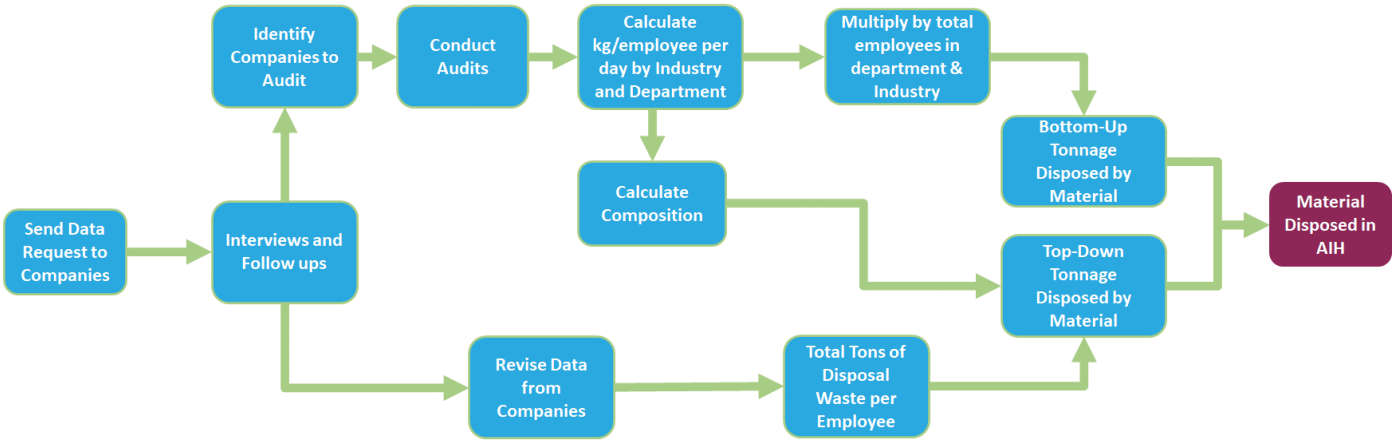
- **Approach & Data Collection**: data collection processes through the project, describing data requests, interviews, site audits, and follow-ups.
- **Data Compilation & Analysis Results**: analyzing the data received to show the composition and tonnage of material audited.
- **Challenges to Recycling**: the barriers to recycling material which is currently disposed of in the AIH.
- **Considerations for Future Studies**: describing best practice in methodology for similar future studies.
- **Conclusions:** the potential for future data projects and how this study can inform future research.

2.0 Approach – Data Collection

2.1 Overview

Figure 3 below shows the data collection approach to gather and process data to estimate the total disposal flows of the study participants.

Figure 3: Data Process Flow



2.2 Data Request & Desk Based Research

2.2.1 Request & Interviews

Contact and introductions were made with all companies in the AIH. Data requests were scheduled for companies in the AIH to capture initial tonnage estimates and provide contextual information on the industrial companies. The data requests included contextual questions on:

- The business description of the company.
- The number of employees who are on site in the AIH.
- The different departments each company has on-site (e.g. administration, warehouse, definitions for these departments can be found in section 2.3.1).
- The current configuration of how the disposal stream is managed on site.
- Mass of material disposed, separated by material type if possible.
- Number of waste bins on site.
- The volume of each waste bin.
- The frequency of collection of the waste bins.

A detailed example of the data request is provided in Appendix A.1.0.

The project team was not able to audit every industrial facility in the AIH due to the COVID-19 pandemic and budget and time constraints. The contextual data was used by the project

team to short list companies that should be audited to enable a cross section of businesses to be sampled and for the data to be disseminated to similar companies.

In addition to the contextual data gathered through the data requests, interviews took place with all companies that responded to the requests in order to gather more specific data on waste tonnages (if they were tracked) as well as understand in more detail the operation which subsequently informed the audit design and process. Of the 25 companies which completed data requests, 10 provided estimates on their non-hazardous disposed waste tonnage.

Table 2-1: Data Requests Completed Summary

	Companies Contacted	Data Requests Completed	Data Requests Completed with Tonnage Estimates
# of Companies	37	25	10

2.2.2 Data Quality and Problems

The project team received data request responses from 25 companies over the course of two to three weeks. Each response varied in the level of detail and completeness given. For example, one company filled out all its potential plastic generated from all waste generation areas of the site, while another only provided a company description and total employee numbers. The project team followed up with companies with instructions to provide more detailed information, however some companies declined to participate to this level.

Two pieces of the data requests should be addressed in how they varied in their responses:

- Annual waste mass.
- Employee figures by department.

Companies that provided waste tonnage data often provided estimates given to them by their waste haulers. Waste haulers supply companies with monthly estimates of the total weight of waste collected based on the volume collected from each company and using volume-to-weight estimates. Haulers will also make “milk-runs” between multiple companies in a single route, and thus must apply an estimate for how much weight came from each company per route. A further description of this data is discussed in Section 0.

Companies also provided an estimate of the number of employees at each site, in some cases by department type (e.g. administration, operations, warehouse). The granularity of the employees by department was mixed, and matching employees to their departments had to be clarified later in the project.

2.3 Company Audits

2.3.1 Audited Companies

The purpose of conducting waste characterizations on the disposed non-hazardous garbage in the AIH was to develop a representative sample of the waste, such that it could be extrapolated to the entire AIH. The project team used data points from the audits, which included both administrative and industrial post-use material, to create a "mass disposed per employee" metric for different departments/operational areas. The metric was the total mass of waste disposed (including admin + industrial post-use) divided by the total number of employees. This metric was then applied to companies which were not audited based on the activity and company industry. Company industries were determined by looking at the associated NAICS or SIC code description of each company.

The study began in spring of 2021. However, due to the COVID-19 pandemic and its related restrictions, some businesses asked for onsite characterization studies to be conducted later in the summer. Therefore, the audit team had two sort dates; One in July and one in August/September.

Additionally, the audit team surveyed different departments across the companies. The reason for this was that the operations department in one industry might produce different waste from an operations department of a company in a different industry. Audit data was then extrapolated to companies who were not audited on a department and industry-specific basis.

37 detailed waste audits were conducted across 10 companies in the AIH. The industries of companies audited were:

- Gas Processing.
- Oil and Gas production.
- Agribusiness.
- Chemicals.
- Oil Transportation.
- Fertilizer Production.
- Metals Refining.

In addition to the companies in the AIH, audits were also carried out for a commercial sector disposal stream. An audit was conducted on two loads worth of the disposal stream which was destined to be tipped at a landfill. This allowed for the project team to get a picture of plastics waste in the commercial waste stream.

The different company departments audited for the study are summarized in Table 2-2 below:

Table 2-2: Audited Department Descriptions

Department	Description	# of Audited Sites of this Department Type
Administration	Segment of the site with office-based staff and activities	13
Operations	Main industrial operations of the site. Activities related to producing the outputs of each site varied by company	8
Warehousing	Storage areas of the industrial sites	6
Shop/Maintenance	Facilities on-site for maintenance equipment	3
Reactor Building	Several audited companies have power plants or reactors on site – this is the waste generated from those activities	3
Lab	Research based facilities	3
Train Totes	Disposed waste near the areas where trains operate on site	1

2.3.2 Waste Categories

The post-industrial and post-administrative categories each had their own waste audit sort categorization. The aim of auditing in this fashion was to provide as much granular detail on the type and volume of post-use plastic as possible. The full sorting category list is detailed in Appendix A.2.0 and included metal containers, glass containers, compostable materials, beverage containers, recyclable paper, other waste, other recyclables, and recyclable plastic.

Plastic categories were also classified as either post-consumer or post-industrial. Using this classification allowed for identification of the source of post-use plastic, either from more administrative and office related activities, or from the operations of the site itself.

2.4 Analysis

The objective of the data analysis was to estimate the annual total plastic tonnage disposed of in the AIH in a year. For robustness and to account for data limitations (as described in Section 5.0), multiple methods were used to calculate the total tonnage of plastic material disposed of annually.

- A bottom-up approach.
- A top-down approach.

The bottom-up approach involved normalizing and averaging the audit data and scaling it to the companies which were not audited to estimate the kilograms disposed per person working in each department. The top-down approach normalized the tonnage data from the 10 companies which supplied annual estimates (either reported by their haulers or weighed by the companies themselves) and applied those estimates to the companies which did not provide estimates. The composition from audit data was then applied to the total annual tonnage.

The audit data, which is used for the bottom-up approach, provided very granular estimates at a department level, while the company data requests, which are used for the top-down approach, gave annual tonnage estimates.

To calculate the final estimates, which can be found in Section 3.0, the two methods above were averaged together. For example, if the total tonnage disposed from warehouses in the top-down approach was 200 tonnes, and in the bottom up it was 80 tons, the average of 140 was taken.

A more detailed description of the methodology is described below.

2.4.1 Bottom-up Approach

2.4.1.1 Normalizing Audit Data

The process of normalizing the audit data is summarized below. The analysis begins with normalizing over time, and then for the size of a company.

Equation (1) represents the calculation for normalizing over time

$$(1)\ kg\ disposed\ per\ day = \frac{audited\ sample\ disposed\ kg}{days\ of\ audit}$$

Equation (2) represents further normalizing the audit data by the size of a company to get the material on a per employee basis

(2) $$kg\ disposed\ per\ employee\ per\ day = \frac{kg\ disposed\ per\ day}{\#\ of\ employees\ in\ waste\ audit\ area}$$

Each material category had a recorded weight from the waste characterization audit. Thus, each material was normalized on a per employee per day basis. For example, this calculation was performed on the PET Bottles from the waste characterization such that, for example, an estimated kg of PET Bottles disposed of per employee per day could be derived.

The kilograms disposed per employee per day figure was then multiplied by the total number of employees in the AIH to estimate the total tonnage disposed of in the AIH.

This calculation was conducted for each department and each company industry from the study sample to account for variation in disposal rates across different areas of the study site (e.g, what was calculated in (2) was conducted for the administrative department of chemicals companies, which was then applied only to administrative employees in chemicals companies in the rest of the AIH).

2.4.2 Top-Down Approach

The top-down approach used annual waste disposal estimates from 10 companies who supplied them. The annual tonnages were normalized on a per-employee basis. The average amount disposed of the 10 responding companies was 810kg/employee per year.

This figure was then multiplied by the total number of employees supplied by companies who answered the data request. Finally, this total figure was then apportioned to material types by the waste composition data from the audit results.

2.5 Plastic Categories for Results

The results of the waste analysis are presented by plastic type. Table 2-3 below defines each of the plastic groups shown in the compositional results.

Table 2-3: Plastic Groupings for Compositional Results

Plastic Group	Description
PET Containers	Rigid containers made of PET plastic (water bottles, plastic trays etc.)
HDPE Containers	Rigid containers made of HDPE plastic (jugs, HDPE buckets etc.)
Mixed Rigid Containers	3-7 plastic containers
Other Rigid Packaging	Other rigid packaging includes unmarked/uncoded packaging
HDPE & LDPE Film	Retail bags, garment bags, raw materials bags, supplies bags

Plastic Group	Description
Garbage Bags	The bags which material was disposed in
Other Film	Film which does not fall under HDPE & LDPE category, e.g. laminated film, shrink wrap
Durable Plastics	Hard plastics such as pens, hard hats, pallets

2.6 Data Verification & Clarification

After conducting the initial data analysis, the project team decided to undergo a second round of data clarification questions with the participating companies. The project team needed further clarity on the data given by companies. These clarifications are detailed below.

Table 2-4 below describes the common clarifications of data across the study participants.

Table 2-4: Common Clarifications of Data

Clarifications	Description & Importance
Tonnage Data Verification	Companies that provided their annual disposed tonnages were used as a comparison point of the modelled tonnages. Therefore, knowing how accurately these tonnes were tracked, and what they were comprised of was important to guide modelling.
Employee # by Department	Employee numbers were used to standardize the collected audit data. Accurate employee numbers were necessary to produce accurate kg/employee measures. Multiple rounds of follow-up were conducted with companies, as different department definitions led to the need for clarification. Administrative workers were more likely to work from home than workers in the more operations focused departments during the COVID-19 pandemic, thus it was important to show that the administrative waste generated per employee was not being undercounted.
COVID-Related	Companies were asked for any COVID-19 measure related information they could give which might influence the data they supplied. This included tonnage numbers, employee numbers and operating days. All these data points are used in the data analysis.

3.0 Waste Data Analysis Results

The waste data analysis had two objectives:

1) To show the composition of disposed garbage in the AIH.
2) To quantify the tonnage of plastic disposed in the AIH.

Results are presented by department type to illustrate the variation in composition across the different areas of a company. The departments analyzed for composition and tonnage were:

- Administration.
- Operations.
- Warehouse.
- Shop/Maintenance.
- Reactor Building/Powerplant.
- Labs.

Descriptions of these departments are discussed in Section 2.3.1. The train totes department was not included separately in the results. Only one audit was conducted in this department, and thus the results were deemed non-representative.

3.1 Tonnage of Plastic Disposed

The tonnage per employee and the total waste disposed of was calculated using the method presented in Section 2.4, as the average of the top-down and bottom-up methodologies. The results of this analysis are shown below.

Table 3-1 below shows the calculated average kilogram of waste disposed of per employee by department type.

Table 3-1: Average Estimated mass/Employee Disposed per year by Department

Department	Admin.	Operations	Warehouse	Shop/ Maintenance	Reactor/Power Plant	Lab	Average
Kg/employee disposed per year	536	776	489	280	914	594	580

Source: Eunomia modelling, AET & S-cubed waste audit data

3.1.1.1 Extrapolation to Other Companies

Companies were asked to provide their total number of employees by department and to notify the project team about the proportion of employees who are working from home due to the COVID-19 pandemic. The company employee figures were summed by department

and company industry to calculate the total number of employees by department in the AIH for companies that responded. Table 3-2 below shows the total number of employees by department estimated in the analysis.

Table 3-2: # of Employees by Department for Companies that Responded

Department	Admin.	Operations	Warehouse	Shop/ Maintenance	Reactor/Power Plant	Lab	Total
# of Employees	884	1,535	278	862	60	45	3,665

Source: Company Data Requests, Eunomia modelling

These department totals were then multiplied by the kg/employee per day and the total number of working days per year to calculate the total waste disposed per year by department. Table 3-3 below shows the total waste disposed by each department type. The process described in this section was carried out for every individual material line in the waste audit.

Table 3-3: Total Annual Waste Disposed (Tonnes)

Department	Admin.	Operations	Warehouse	Shop/ Maintenance	Reactor/Power Plant	Lab	Total
Total tonnes Disposed	500	1,200	135	240	100	30	2,130

Source: Eunomia modelling, *AET & S-Cubed waste audit data*

The operations department had the greatest tonnage of waste disposed at 1,200 total tonnes disposed. Lab sites had the fewest tonnes disposed at 30 tonnes per year. Table 3-4 below shows the total tonnes disposed per year across the 25 companies who supplied employee data, broken down by plastic and non-post use plastic.

Table 3-4: Total Tonnes Disposed per year By Department, Plastic & Non-Plastic

Department	Admin.	Operations	Warehouse	Shop /Maintenance	Reactor/Power Plant	Lab	Total
Total tonnes disposed per year	500	1,200	140	240	60	30	2,130
Plastic	140	160	30	40	10	10	390
Non-Plastic	330	1,030	110	200	50	20	1,740

Source: Eunomia modelling, AET & S-Cubed waste audit data, totals may not add up due to rounding

The operations department disposed of the greatest amount of plastic with 160 tonnes disposed. Administrative sites had the second highest at 140 tonnes disposed. The activities

of each operations department are specific to each industry, however this section frequently had durable plastics, HDPE buckets and pails, and film packaging to transport materials across sites. Employees from the administrative department worked from home more frequently than employees in other departments, therefore if sites were operating at full capacity, the administrative sites may have the greatest amount of plastic disposed. Altogether, plastic makes up an estimated 18% of the disposal stream.

Table 3-5 below shows the total mass disposed per year by plastic type.

Table 3-5: Per Annum Total kg Disposed by Type and Source

Department	Admin. (kg)	Operations (kg)	Warehouse (kg)	Shop/ Maintenance (kg)	Reactor/ Power Plant (kg)	Lab (kg)	Total (kg)
PET	4,100	5,100	300	1,500	200	100	11,300
HDPE	16,900	33,200	4,000	4,900	600	2,300	61,900
Mixed Rigid Containers	12,100	10,400	1,800	10,900	600	400	36,200
Other Rigid Packaging	19,900	12,800	-	1,600	-	500	34,800
HDPE & LDPE Film	25,500	20,900	4,400	2,900	800	1,000	55,500
Garbage Bags	28,200	38,000	1,000	13,800	1,500	3,400	85,900
Other Film	14,400	16,700	9,700	2,600	400	300	44,100
Durable Plastics	22,500	19,900	5,100	4,000	1,400	1,900	54,800
Non-plastic	330,200	1,034,300	109,400	199,000	49,400	16,900	1,739,200
Total	473,800	1,191,300	135,700	241,200	54,900	26,800	2,123,700

Source: Eunomia modelling, AET & S-Cubed waste audit data

Garbage bags, HDPE containers, and plastic film represent the largest sources of disposed post-use plastic. Adding HDPE & LDPE film together with Other Film results in just under 100,000 kg of material disposed.

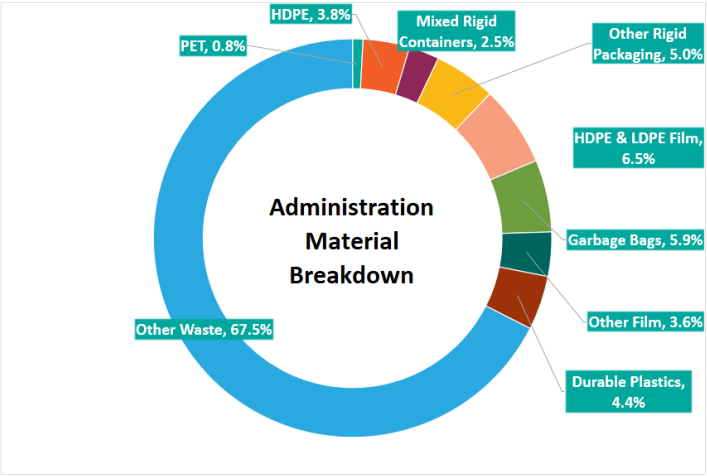
3.2 Composition by Department

The material breakdown for each department is shown in this section. “Other waste” in each section refers to non-post-use plastic.

3.2.1 Administrative

Figure 4 below shows the material breakdown of the audited administration department waste.

Figure 4: Administration Material Breakdown

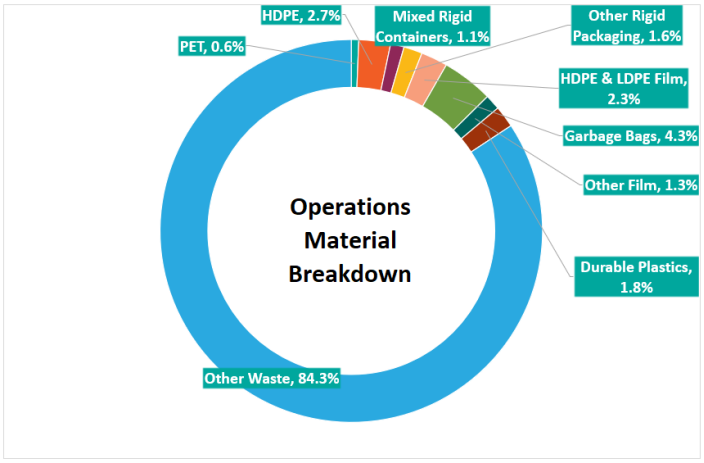


The administrative department disposed waste is 32.5% post-use plastic. HDPE & LDPE film are the largest sub-category of post-use plastic. 5.9% of the waste generated from the administrative department is from the garbage bags the domestic garbage is placed in when set out for disposal. Administration has the second highest percentage of post-use plastic of the departments audited, primarily due to post-consumer plastic disposal, such as PET bottles and film packaging.

3.2.2 Operations

Figure 5 below shows the material breakdown of the audited operations department waste.

Figure 5: Operations Material Breakdown



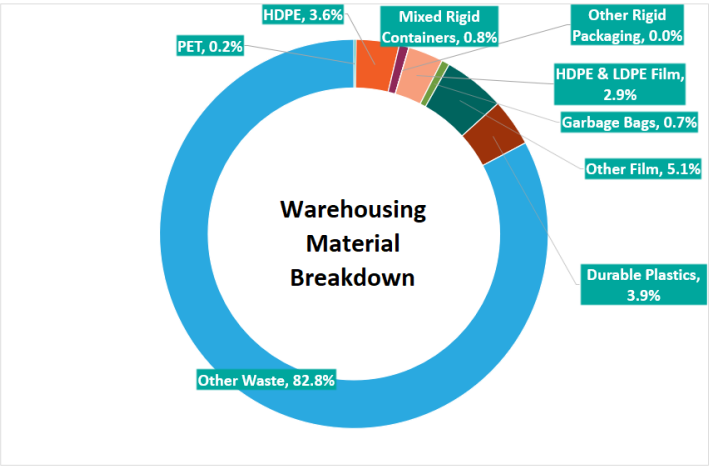
Plastics form only 15.7% of the operations department waste. The largest category of waste plastics are garbage bags (4.3%) followed by HDPE containers (2.7%). HDPE & LDPE film and other film together represent 3.6% of the disposal stream in the operations department.

3.2.3 Warehousing

Figure 6 below shows the material breakdown of the audited warehouse garbage.

Plastic made up 17.2% of the waste disposed from warehousing sites in the audited companies. Films such as shrink wrap & laminated films were the largest plastic group at 5.1%. Films may be the largest percentage of plastics due to warehouses being used for storage, where material is often wrapped in flexible packaging.

Figure 6: Warehousing Material Breakdown

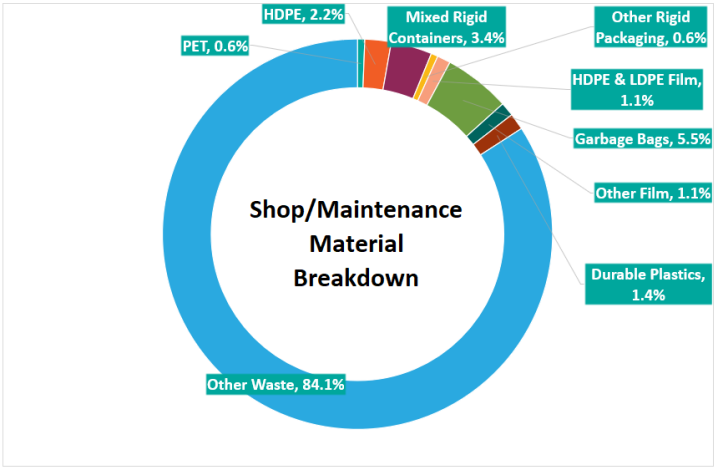


3.2.4 Shop/Maintenance

Figure 7 below shows the material breakdown for the shop/maintenance department.

Disposed waste in the shop/maintenance department contained 13.9% post-use plastic. Garbage bags (5.5%) and mixed rigid containers (3.4%) were the two greatest sources of post-use plastic. Shops/maintenance sites often sell or rent material to site staff for use in operations.

Figure 7: Shop/Maintenance Material Breakdown

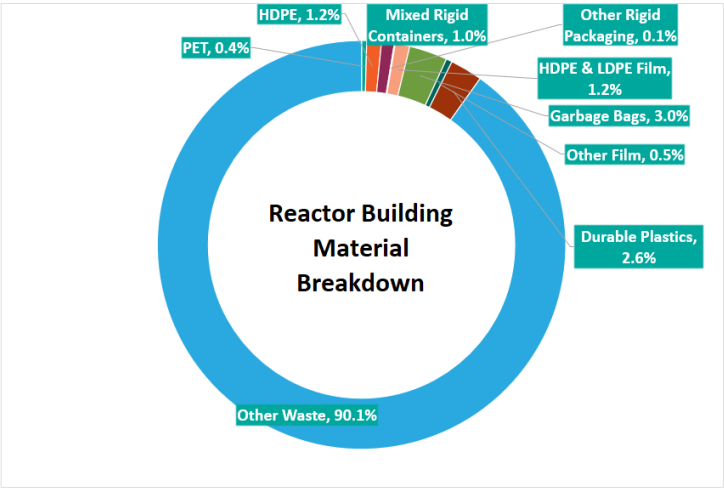


3.2.5 Reactor/Power Plant

Figure 8 below shows the material breakdown of samples taken from disposed waste in reactor buildings/power plants from the audit.

Figure 8: Reactor/Power Plant Material Breakdown

Total disposed waste in the reactor/power plant department was comprised of only 9.9% post-use plastic. This is the lowest value of the audited departments. Garbage bags (3.0%) and durable plastics were the two largest categories of post-use plastic in the reactor/power plant department.

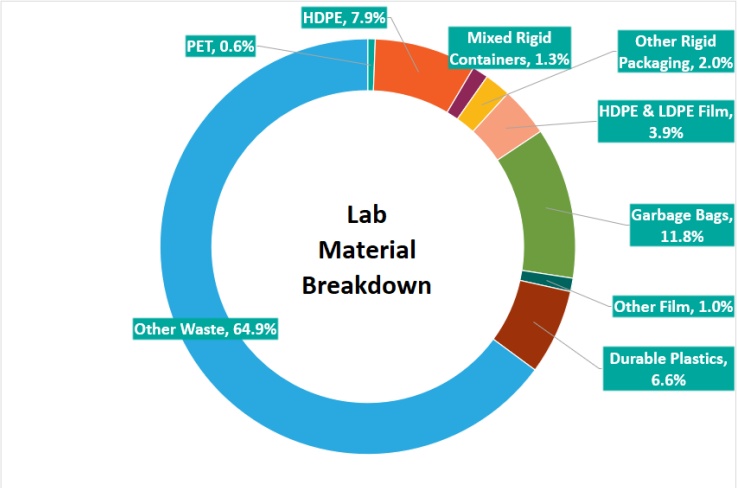


3.2.6 Lab

Figure 9 below shows the material breakdown of samples taken from disposed lab waste.

Figure 9: Lab Material Breakdown

Lab sites had the highest proportion of plastic in their disposed waste at 35.1%. Garbage bags (11.8%) and HDPE (7.9%) were the two largest groups of plastic present. Industrial HDPE buckets alone were 6.5% of the waste stream.

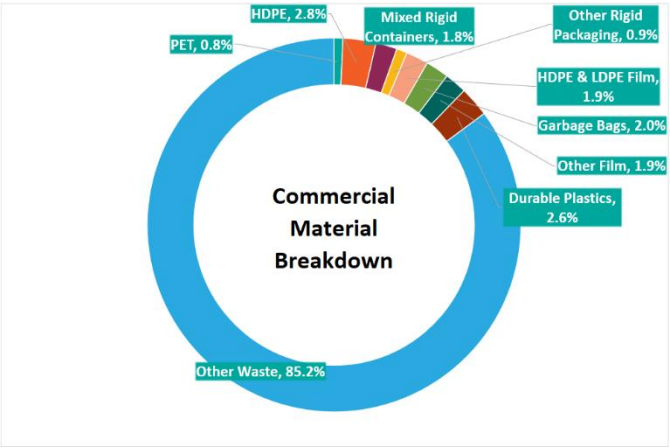


3.2.7 Commercial Sector

While not a part of the AIH, a commercial sector audit was completed by the project team on disposed commercial waste which would have otherwise been sent to a municipally run waste facility. Two audits were conducted on 260 kilograms of material. Results of the commercial sector audit can be seen in Figure 10.

Figure 10: Commercial Sector Material Breakdown

The commercial sector audit revealed 15% of the waste disposed is post-use plastic. Plastic films, such as garbage bags, HDPE & LDPE film and other films made up 4.8% of the disposed stream. Figure 10 is a weighted average of the two commercial audits shown in Table 6.



The commercial sector audit was composed of two departments: administrative and operations. The administrative section included office-related activities, while the operations included some vehicle mechanical functions and public works functions. Results for each individual audit can be seen in Table 6 below:

Table 6: Commercial Sector Audit Results by Department

	Operations	Admin
PET	0.4%	3.1%
HDPE	3.3%	0.1%
Mixed Rigid Containers	1.3%	5.1%
Other Rigid Packaging	1.0%	0.7%
HDPE & LDPE Film	1.9%	2.3%
Garbage Bags	1.3%	6.4%
Other Film	1.9%	1.8%
Durable Plastics	2.8%	1.1%
Other Non-Plastic Waste	86.1%	79.5%
Total	100%	100%

Source: Eunomia modelling, AET & S-Cubed waste audit data

4.0 Challenges to Recycling

This section examines some of the challenges to recycling in the AIH, including logistical and economic barriers.

Not enough material available to justify additional recycling from these sites

As shown in the results of the waste data analysis, there is currently a limited tonnage available of post-use recyclable plastic which is currently being disposed. Separately collecting the post-use plastic may not be cost-effective at such low tonnages. Additionally, a percentage of the plastic currently disposed of is post-consumer plastic which is currently not generally accepted by recycling haulers (e.g. durable plastics, PVC plastic). There is a level of targetable material which recyclers may find insufficient to warrant collecting additional material.

Contamination and hazardous materials

Material generated in the AIH is hard to access because of the overlap between operations of industrial sites. Individual waste bins are often designated as “administrative” or “operations” bins but take in waste from various departments. For example, an operations employee may walk into an office space and dispose of their plastic gloves in the administrative waste bin, rather than the operations one. This creates inconsistencies in what material can be accessed through collection and can potentially add hazardous materials to a stream which is not meant to be hazardous.

To be recycled, post-use plastic material must be approved by the purchasers of the scrap material. There are limits to the levels of contamination, specifications on the physical properties of the material, and feedstock requirements which companies must meet. If they do not, plastics reclaimers will not approve the material for their recycling processes. These variables related to the behavioral change below.

Behavioral Change

Companies interviewed for this study were asked how easy it would be to take a certain plastic that is currently disposed of and put it in a bin for recycling. Companies responded that installing a bin for collection would not be difficult but changing the behavior to put the material in the recycling bin would be a bigger hurdle. This barrier to recycling relates to another barrier of there not being enough material to justify a collection route for plastics, where if behavior does not change, it further reinforces that hauler will not receive an adequate amount of material to justify collection routes.

Setting up a new recycling bin would not necessarily yield the same tonnage of plastic as is currently disposed (i.e. the tonnage would not move completely from the disposal to the recycling stream, which means the plastic tonnage available to haulers would be less than the plastic tonnage currently disposed.). Variables such as limiting contamination, increased messaging, and better delineated waste bins (i.e. admin vs. other areas) must be addressed.

Plastic End Markets

Plastic resins each have their own opportunities and challenges to collection and recycling including differences in:

- The availability of end markets.[2]
- Ease or difficulty of collection due to the physical properties of each resin.
- The levels of contamination, particularly for plastic films.[3]

Post-consumer plastic films in particular have fewer end markets than post-consumer rigid packaging.[4] Some sites do have plastic films which are currently collected separately from the Municipal Solid Waste stream, however this is generally material which is post-industrial and does not come into contact with other material.[5] The domestic garbage stream, which was analyzed for this study, might be similar to the post-consumer stream, as the administration and operations departments in particular had high levels of post-consumer flexible packaging. The nature of the currently disposed plastic may mean that the end markets for this material are limited.

[2] MORE Recycling, "2018 Post-Consumer Plastics Recycling in Canada". 2020. https://www.plasticsmarkets.org/jsfcontent/CanadaReport18_jsf_1.pdf
[3] Interviews with plastics processors, August 10th, 2021.
[4] Ibid.
[5] Data received from company participants.

5.0 Considerations for Future Studies

5.1 Opportunities for Future Studies

While conducting this study over the course of nearly a year and facing unique challenges, the project team was able to determine key considerations for data collection and analysis. A summary of these opportunities is provided below.

Access to Site and Availability of Staff for Contextual Information

Increased availability of staff on site to support the entire waste audit process is critical to allow for audit teams to choose the most representative waste bins to audit, as well as ensure they are collecting a comprehensive set of data. Some of the activities which on-site staff could support include:

- Giving an on-site tour to view waste generation areas prior to the start of the audit period.
- Securing sample locations.
- On-site staff could record bin fullness for a week (bin fullness is used to estimate the bulk density of selected material) which can in turn be extrapolated to other bins which were not audited.

Additional Sorting

Including multiple audit periods per company, especially across different seasons, allows data teams to account for the seasonal variation in waste results. Multiple sorting periods also increase the sample size of the underlying dataset, which lowers the level of variance in the results.

Additionally, larger sites which have multiple domestic waste bins should have additional samples taken from those areas. Multiple sorting locations on a site ensures that the audit team captures a snapshot of the entire domestic waste stream, rather than a subset of one area. This is of particular importance for the larger industrial sites, as smaller companies have fewer bins and less risk of producing a non-representative sample of the site as a whole.

Auditing as many domestic waste bins as possible reduces the need to scale a company's audit data to its entire site through extrapolation of the audited sample. Scaling audit data from one area of an industrial site to a separate area of the industrial site assumes the two areas have the same material composition, which may not be the case. Instead, a study should strive to audit all bins, rather than extrapolate their composition from the sample.

Harmonized Company Tonnage Reporting

To achieve accurate data reporting across the Heartland, companies can standardize how they report on their annual domestic waste tonnages. Companies currently vary in how they

report their annual domestic waste tonnage. For example, some have on-site scales and weigh domestic garbage internally, while the others receive estimates from their haulers. Companies providing annual totals in a consistent method allows for more streamlined data analysis, and more clarity on what is included in the tonnage figures.

Furthermore, companies can report on the average fullness of their waste bins upon pickup. If the fullness of the bins being collected is documented along with the weight, a bulk density of that industrial domestic waste stream can be calculated. If a company were able to do this over multiple seasons, trends could be identified as well.

Lastly, better transparency on how haulers calculate tonnages and provide them to company's would facilitate more accurate interpretation of reported tonnages.

Ensuring Separate Containers for Different Departments

Relating to the opportunity of having greater access to the audit site, improving the delineation of waste streams on site would clarify the composition of disposed waste in each department within a company. Company waste bins currently have overlap between the departments which dispose of mixed solid waste (MSW) in the same bins (e.g., some operations employees dispose of trash in an administrative bin as they are passing through the administrative area).

The overlap of waste streams blurs the lines between department compositions and makes it more difficult to confidently apply a department average to other, non-audited departments. Gaining clarity on which departments use each bin (regardless of what the bin is labeled as), or better yet keeping bins from different departments separate, would improve data collection and synthesis. This would allow a project team to create more accurate waste profiles of different departments.

6.0 Conclusion

6.1 Plastic Volumes

It is estimated that 390 tonnes of plastics waste is disposed of per annum by companies in the AIH. Post-use plastic is predominately generated from activities related to industrial operations and administration.

Of the facilities which were surveyed for this project, 50% reported participating in non-hazardous recycling collection of a stream which would include plastics (i.e not just a separate cardboard recycling stream). However, in some cases this was restricted to the administrative buildings only, rather than including all other operations. Plastics specifically mentioned as being recycled included:

- Beverage containers
- Administrative packaging
- Large HDPE bottles

Additionally, several sites reporting returning some of the tertiary plastic used to deliver other goods to them back to the vendors. Sites reported returning:

- Large plastic tote bags
- Plastic sample containers
- HDPE pails

Other sites reported sending all non-hazardous plastic to landfill.

6.2 Future Consideration

There are additional waste generation areas which may be of interest when looking at diverting additional post-use plastic. This section will describe some of these areas.

Other Industrial Areas

The findings from this research relate only to the industries that were audited. Other industrial areas, for example construction and manufacturing, are likely to generate very different volumes of plastics waste.

Hospital Waste

Attempts were made to carry out an audit on hospital waste but due to COVID this was not possible. AET has previously carried out audits on hospitals and may be able to provide some data that could be used while APRA considers future projects.

Hazardous Waste

During the study period the team spoke to a hazardous waste management company. The services they offer result in large volumes of plastics containers, some of which contain

hazardous waste. Below are pictures of waste items from their Edmonton site. The majority of the contaminated post-use plastic that they collect from customers is HDPE oil pails.

Figure 11: Pictures from Hazardous Waste Plastic Site in Edmonton

Oil jugs

HDPE oil pails

Pail lids

End-pipe covers

Oil-covered end-pipe covers

Inside front-end loader filled with pails

Table 7 includes the kilograms of post-use plastic collected by hazardous management companies in 2019 and 2020 in Alberta.

Table 7: Kilogram of plastics waste managed by hazardous waste management companies

	2019	2020
Plastic kg Managed	666,000	740,000

Estimating Tool

The data from this project could be used to create a waste estimation tool for other similar industrial areas. The process for carrying out the audit and the data analysis process could also be developed into an online Excel based tool.

Commercial Sector

The project team conducted a waste audit on disposed commercial waste, as can been seen in section 3.2.7. The commercial sector audit revealed 15% of the waste disposed to be post-use plastic. Identifying commercial hubs close to the AIH and further auditing companies within the commercial hub could be beneficial.

APPENDICES

A.1.0 Data Request Sample

A.1.1 Introduction Letter Example

March 4, 2021

On behalf of the Alberta Plastics Data project, I would like to introduce you, as an industrial site within Alberta's Industrial Heartland or the Northeast Capital Industrial Association, to our contractors for the project.

This unique project brings together local, provincial, and federal partners to assess the generation of post-use plastic to help understand the use and management of plastic within the region. It is one of the first of its kind in Canada to assess plastics generation at industrial facilities. Your site was identified as a key partner to help provide information about post-use plastics generation. The study looks to identify plastics and then build a business case for opportunities to collect and divert plastics for recycling in the region. Our associations are extremely excited about the results of this study as it may bring about opportunities for collaboration, investment, and growth in local markets for post-use plastics.

All the data you provide will be de-identified and kept confidential with no attribution back to your company in the report that is scheduled to be released later this year.

Timeline:

> March - The data gathering portion of this project will take place over the next month, with a questionnaire being sent to your site contacts. You will be contacted

by a member of our project team who will lead you through the process. The questions may include the type of plastics you use onsite and current disposal or recycling practices.

April to June - After the data is compiled and results reviewed, the consulting team will follow up about next steps. There may be a request for a site visit (pending site restrictions due to COVID-19) to conduct a plastic composition study on the site. Further information and communication will be provided throughout the process.

End of July - The goal is to complete all data gathering for this project by the end of July 2021 so that analysis and a final report can be produced by December 1.

Your time commitment will depend on what information you are able to provide based on the data you already have onsite. We estimate that many questions will be easily completed, while others will require more attention and investigation. Our team will help walk you through the in-depth questions. We understand this is a busy time of year and we plan to work around your schedule as much as possible.

For your time and contributions to the project, the team will offer you a summary of the findings from the site.

More information about this project and its partners can be found here: https://albertaplasticsrecycling.com/alberta-partners-advance-plastics-data-project/

Please reach out at any time with questions or feedback,

Sincerely, Laurie – NCIA
Brian/Christina/Kendra - AIHA

A.1.2 Interview Questions

Information A through F was formatted with headings in an Excel workbook tab. Each letter grouping had its own tab. Breaking it down this way allowed for a company's information to be recorded as available.

A1. Basic Information

- Company name
- Does your company have multiple sites within the AIHA (yes/no)
- Site name(s) and address(es)
- What type of departments are present on your site:
  a) Administration, control room
  b) Warehousing, shipping and receiving
  c) Maintenance shop
  d) Cafeteria
  e) Power plant
  f) Plant operating area
  g) Sub-areas
  h) other areas (that generate waste)
- Breakdown of how many staff are: 1. on-site office/admin, 2. other on-site (e.g., production/operations), 2. primarily off-site (e.g. field technicians)?
- Are current on-site staffing levels impacted by COVID-19? How?
- Name and contact information of representative
- Brief description of business; provide NAICS code
- Which hauling company(ies) manage your plastic waste?
- Can we have permission to contact your hauler? If so, please provide the name and contact information of the account manager?
- Dates and time when our team can contact you to briefly discuss this data request (mid-March).
- Have you previously carried out a waste characterization on your site? If so, are you able to provide that report?
- Can you please provide a plot plan / site map of the facility (showing all the different areas of the facility)? On the map, if possible, please indicate the locations of garbage bins and recycling bins?
- Do you have a waste material flow chart for your processes that includes the amount of plastics generated? If so, can you please provide?

A2. Plastics Recycling Information

- Does the site currently recycle plastic? Yes or No
- If yes, which departments recycle plastic? Which generates the most?
- What are the types of plastic recycled? (plastic resin #1-7 and description of the item)

- Are types of plastics collected together or separately?
- Size of bin collecting plastic, type of bin, quantity and frequency of collection; or number of items per month?
- Where does the plastic go (i.e., reuse, another company, hauler)?
- Who manages the plastic (i.e., hauler name)?
- Plastic waste information (not recycled)
- What departments generate plastic waste that ends up in the mixed garbage bin?
- What types of plastic are most likely to be disposed of in the mixed garbage bin (i.e., shrink wrap, pails, strapping)? Please indicate if you do not know.
- Which department generates the most plastic waste?

A3. Waste Bin Information

- Size of waste bin
- Type of waste bin (front load, roll-off, gaylord)
- Number of bins
- Frequency of collection
- Where does the hauler take the waste (if known)?
- Who manages waste (i.e., hauler name)?
- What departments share common waste bins?
- Please provide details on the hazardous nature of any plastics waste and how it is managed.

A.4 Reporting

- What data do you receive from your waste services provider? Can you provide a copy of the data that is received either for a single month or preferably annually for 2019 and 2020?
- Do you report waste data that includes information on post-use plastics waste to any of the following (internal, provincial, federal organizations)? If so, can include a copy of what is reported?

B. Turnarounds

- How often, on average, do turnarounds occur at each site?
- Date for the 2021 turnaround and how long will it last?
- What activities will take place in the next turnaround?
- How does the waste produced during a turnaround differ from general operations?
- Please provide details of waste produced on tab 4. Turnarounds
- Who is the primary contractor that will be managing the next turnaround?
- Can we contact the primary turnaround contractor to better access data on plastics waste generated as part of turnaround activities?

- Please provide information on the waste produced during a typical annual turnaround. If available, please attach a turnaround waste management plan
- What are the main types of wastes produced?
- What types of plastic wastes are produced?
- Please provide details on the hazardous nature of any plastics waste and how it is managed.
- What types of plastics are currently recycled and where do they go?
- How is your plastics waste collected?
- How many streams of plastic waste are separately collected and what are they?
- Do you have scale tickets for the waste generated from a turnaround? Previous years information is helpful.

C. Waste Characterization

- Sampling Options: 1) We ask each department to collect waste generated over several days to a central area; or 2) The company asks the hauler to direct the main waste bins to a sort location.
- What sampling option could be accommodated for this study - 1, 2, or both?
- Sorting Options
- Can a waste characterization study take place on the company site between (state the dates)? Yes or No
- If no - Are there any other sites (i.e., waste transfer station, company warehouse, etc.) at which a waste characterization of your facility's waste could occur, that you know of?
- Would this location have access to a front-end loader? Is it sheltered from the elements?
- What is your relationship with the hauler, and would they divert the waste bins to a common location for sorting?
- If yes - Is there an indoor location to sort the waste or would this be outside?
- Could staff bring department waste materials to the central sorting location?
- Will movement of waste require any approvals? If so, by whom?
- Would sorters have ability to deposit material into recycling or garbage bins after?
- What safety training would be required (specific PPE)?
- When could sorters arrive on site and how long could they stay?
- Administration
- What sign-in steps are required for site visits?
- Who would be the contact person for a site visit?

D. Procurement

Item	Plastics material/composition if known	Weight of plastic item/container if known	Quantity Ordered Per Year	Total Stock	Approximate Percentage of stock disposed each year
Example: *Hard Hats*	*HDPE shell of hat, plastic film wrapper*	*.5 kg (whole item)*	*2,000*	*15,000*	*10%*

E. Plastic Feedstock

Item	Current Source	Plastics material/composition if known	Quantity Ordered Per Year	Quantity Used Per Year	Use
Example: *PET resin*	*Merlin Plastics*	*virgin PET*	*200 tonnes*	*180 tonnes*	*Fuel for ethene cracker*

F. Additional Information

A.2.0 Waste Audit Categories

A - 1: Detailed Waste Audit Categories

Classification	Material Type / Category	Description (examples)	Industrial	Administrative
Recyclable Plastics	PET (#1) - rigid containers & jars - clear, colored & black	Heinz ketchup, kraft miracle whip, Hellman's mayonnaise, cooking oil, dish soap, honey, Listerine	■	
	PET (#1) - thermoform - clear, colored & black	Clamshells, sealable cake trays, microwave dinner trays, blister packs, egg cartons	■	
	HDPE (#2) rigid bottles/jugs - Natural	Clear cleaner/spray containers, washer fluid	■	■
	HDPE (#2) rigid bottles/jugs - Color/pigmented	Margarine tubs, laundry detergent, bleach	■	
	HDPE (#2) pails, buckets & drums	Items greater than 5 liters	■	
	PVC (#3) rigid packaging		■	
	PP (#5) pails, buckets & drums	Items greater than 5 liters	■	
	PS (#6) -expanded foam	PS (#6) - expand foam- white, colored & black	■	
	PS (#6) - rigid	Berry containers, muffin containers, clamshell take-out containers, utensils/cutlery, CD cases		■
	HDPE (#2) & LDPE (#4) - film packaging	Product packaging film	■	■
	Grocery / retail carry out bags			■
	PP (#5) flexible/woven		■	
	Mixed rigid containers (#3-#7)	Squeezable bottles, container items		■
Recyclable Paper	Paper cups	Paper cups		■
	Mixed recyclable paper & cardboard	Office paper, cracker boxes, envelopes.	■	■
Other Divertibles	Pallets	Plastic pallets	■	
	Crates/gaylords	Plastic	■	
	Other drums, bulk totes	Plastic	■	
	Pipes	Plastic (PPO Pipes)	■	
	Spools	Plastic	■	
	E-Waste	Meter, cables, computer part, light bulbs, speaker, batteries, printer cartridge	■	■
	Scrap - ferrous		■	

Classification	Material Type / Category	Description (examples)	Industrial	Administrative
	Scrap - non-ferrous		■	
	Wood pallets	Off cuts	■	
	Other wood	Wood offcuts, 2x4 cut offs	■	
Metal Containers	Metal Containers	Food cans		■
Glass Containers	Glass Containers	Food jars (non-refundable containers), isopropyl alcohol		■
Compostable Material	Organics	Food waste and food paper		■
	Compostable Plastics	Compostable plastics		■
Beverage Containers	Beverage Containers	Refundable beverage containers, 8.13 full water bottles		■
Other Waste	Strapping	Plastic strapping, black PE	■	
	Other rigid plastic packaging	foam	■	
	Durable goods	Hard hats, signs, zip ties, foam rollers, pens, spill tarp, piece of airhorn, safety glasses, storage totes, eye droppers, pipettes	■	■
	PE Flexible foam packaging	Flexible flat foam	■	■
	Garbage bags	Liners used to collect waste	■	■
	Shrink wrap/pallet wrap		■	
	Laminated & other film	Chip bag wrappers, plastic foil covers		■
	PPE gloves		■	
	Single Use Plastics	Plastic utensils, straws, stir sticks		■
	Construction/renovation	Insulation, tubes, fines.		
	Industrial hazardous waste	Unknown liquid and solvents, lab par	■	■
	Rubber	Matt, gaskets.	■	
	Textiles & leather	Work gloves, textiles, rags, mop heads	■	
	Coffee pods		■	■
	Other materials	Grease, mosquito traps, fines, mixed materials, latex, rubber gloves, tape, sweepings, air filters, aerosol cans, lab towels, wipes, absorbent pads, caulking tube, tie down, cords, wipes, tin foil, steel, nuts, dryer sheet, masks, wax paper, ear plugs, rope, dust, printer ink dust	■	■