2024 Time & Motion Study
Final Report

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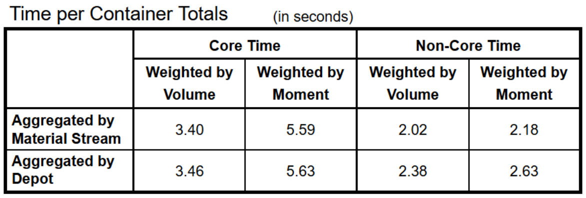
Executive Summary

In June 2024, MNP selected RIVR Solutions (RIVR) to perform a time and motion study to determine labour time per container and space requirements to accommodate handling the volume of container returns at bottle depots in Alberta, Canada.

MNP and RIVR arrived at a sample size of 33 out of a 221 depots with a 90% Confidence Level and 24% Margin of Error. Depots were randomly selected within the size and community type groupings provided by the client. RIVR acquired video data from 33 depots involving 12 road trips and nearly 8,000 minutes of video. A coding methodology was established that was flexible enough to accommodate process variation from depot to depot while capturing the entirety of labour in four activity groups: Primary Sort, Secondary Count, Storage, and Van Loading. Calculating Total Core Time involved adding each category's average time per container.

Non-Core Time was captured using the same technique as Core Time, dividing the time by the number of bottles within the scope of the core activity performed. This technique allowed RIVR to measure “actual non-core data independent of the amount of core time performed.”

All data was compiled and weighted by two different variables: the 2023 Annual Volume and the number of Observations or Moments within the 2024 study. This approach was taken because even though 2023 Volume numbers are relevant to the cash contribution of each material stream and depot, they are an entirely separate variable from the details of this (2024) study. Weighting by Moment reflects the actual Total Time observed in the study, and is RIVR’s recommended method to more accurately reflect the cross-section of Alberta Depots.



Time per Container Totals (in seconds)

	Core Time		Non-Core Time	
	Weighted by Volume	**Weighted by Moment**	**Weighted by Volume**	**Weighted by Moment**
Aggregated by Material Stream	3.40	5.59	2.02	2.18
Aggregated by Depot	3.46	5.63	2.38	2.63

The Total Time per Container values in the 2024 study are higher than those in the 2018 study. Total Time weighted by annual volume is 5.42 seconds/ container (Core and Non-Core summed and aggregated by material stream) compared to 3.33 seconds per container in 2018 by volume. This study's results match the 2018 study when only direct handling was applied to the calculation. Non-Core Time in this study is nearly proportional to the Core Time in the 2018 study. RIVR’s method of acquiring non-core data differed from the 2018 study. RIVR associated non-core activities within the scope of core activity rather than making non-core time a function of core time in the previous study. However, RIVR ultimately recommends that Non-Core Time should be excluded from the final number for assessment.

The aggregated data was segregated into community type and depot size. The biggest realization in this data was that both Core and Non-Core time was reasonably consistent across most depots, regardless of depot volume.

A comparative analysis was conducted between depots with automation and depots without automation of similar size and community type. The results illustrated that integrating automation into primary sort activity was not always beneficial in reducing the Time per Container numbers, but automation applied to secondary operations reduced labour time.

1. Introduction

1.1. Background

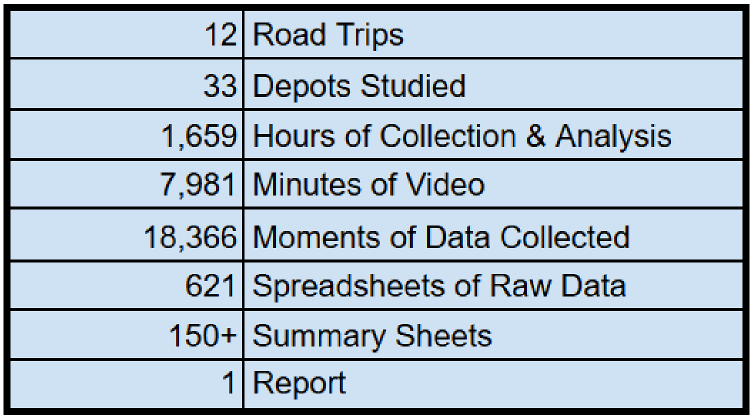
The Beverage Container Management Board (BCMB) is mandated to regulate the beverage container system for the Alberta Ministry of Environment and Protected Areas. The BCMB is the Delegated Administrative Organization (DAO) that works closely with the Alberta Beverage Container Recycling Corporation (ABCRC), a collection system agent for non-refillable containers, and the Alberta Bottle Depot Association (ABDA) who represents the Alberta Bottle Depots. Beverage containers are part of a sustained circular economy in Alberta, and consumers are fully refunded their returns at a bottle depot. The BCMB is responsible for setting the handling commission rates paid to depots for the handling of containers. The BCMB retains MNP for cost analysis for the beverage container returns and to provide recommended handling commissions. MNP selected RIVR Solutions (RIVR) to conduct a time and motion study to determine labour hours and space allocations required for handling each beverage container.

1.2. Objective

This study aims to determine labour and space allocations for handling beverage container categories or streams as they are often referred to. Containers are received, counted, and sorted and undergo a consolidation process, storage (staging) and shipping. The results of this study will aid in determining the handling commission defensibly and fairly based on the actual relative labour requirements for each container type. The acquisition of data from the sampled depots, subsequent analyses, aggregation of data and draft generation of a report occurred from June 17 to November 25, 2024.

1.3. Study by the numbers

MNP agreed to a sample size of 33 depots based on the recommended sample size assessment performed (see Section 2 below). The rationale for increasing the sample size from 21 depots was establishing an improved Margin of Error and Confidence Level. Sampling 33 depots translated to the following numbers:



12	Road Trips
33	Depots Studied
1,659	Hours of Collection & Analysis
7,981	Minutes of Video
18,366	Moments of Data Collected
621	Spreadsheets of Raw Data
150+	Summary Sheets
1	Report

Figure 1 - Study by the Numbers

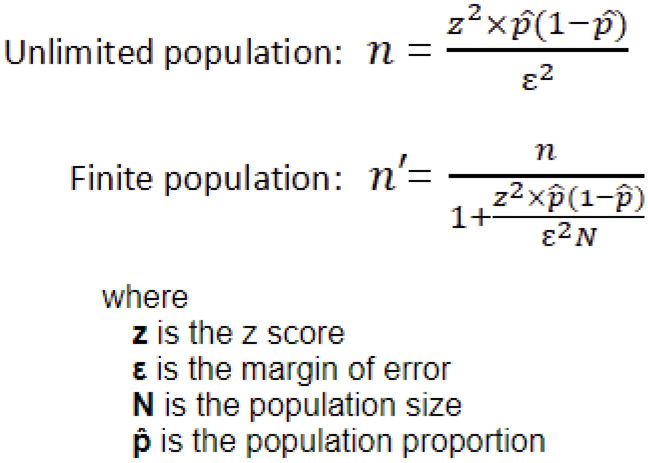
1.4. <u>Not in scope</u>

A review of depot efficiencies is not in scope. Variations in productivity effectiveness are accounted for in the data samples and aggregated.

2. Determination of Sample Size

2.1. Following a review of the ProSolve Time & Motion Study Report from 2018, most results had standard deviations of approximately 30% of the average core time. This wide distribution indicates that there wasn't enough data to obtain a normal distribution. The report did not indicate how a 10% sample size or 21 depots were justified.

2.2. RIVR utilized a standard sample size calculation based on a 90% confidence interval and a 15% Margin of Error. The calculation is as follows:



Unlimited population: $n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$

Finite population: $n' = \frac{n}{1+\frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$

where
  z is the z score
  ε is the margin of error
  N is the population size
  p̂ is the population proportion

2.2.1. For this study, the following variables were applied to the formula:
  2.2.1.1. Z-score = 1.66 (interpolation based on 90% Confidence Interval)
  2.2.1.2. Margin of Error = 15%
  2.2.1.3. Population Size is data and category dependent
  2.2.1.4. Population Proportion = % of Population for each category (50% for Total or undetermined)

2.3. The requirements of the study mandated that the same proportion of depots based on depot size and community type be reflective of the depots in the sample. Therefore, the 2023 annual volume data was sorted by volume and community type, and the following chart was developed:

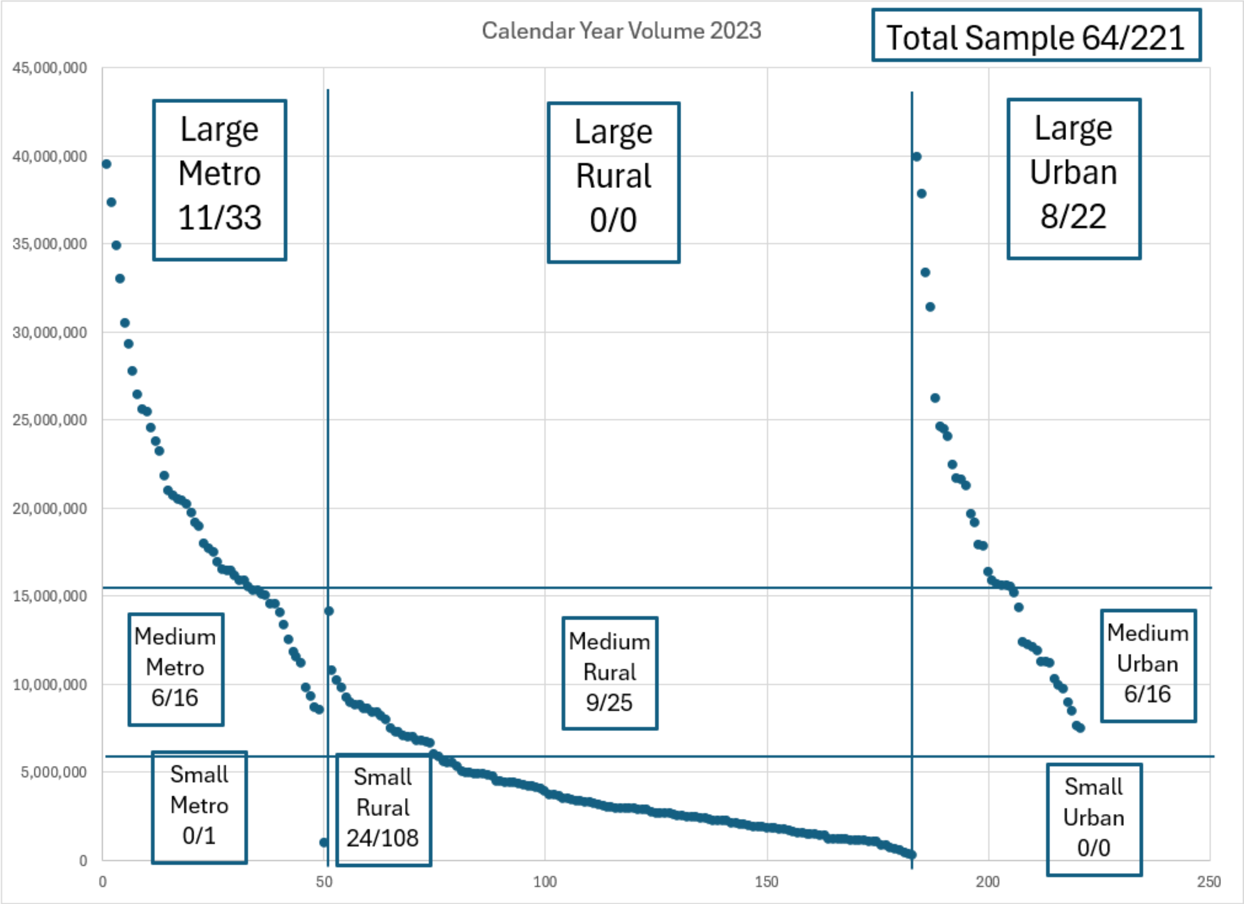


Figure 2: Depots Divided by Category

2.4. Figure 2 illustrates three trend curves divided by community type: Metro, Rural, and Urban. Size is then divided up by the given definitions:

2.4.1. Small is <6M
2.4.2. Medium 6M to 15.5M
2.4.3. Large is >15.5M

2.5. Each box in Figure 2 indicates the size and community type, as well as the sample size as a function of the population in that category. The study would require data from at least **64** out of **221** depots to achieve a sample size of statistical significance broken into these categories.

2.6. Similarly, the data was divided into size only and community type only. After applying those parameters, the sample sizes resulted in **52** and **57** depots, respectively.

2.7. Final Sample Size Determination:

- 2.7.1. Given the timeline and budget outlined in the Request for Proposal, a sample size of 33 depots was agreed upon.
- 2.7.2. Utilizing the 2023 Volume and Community Type data, the Sample Size of **33** was distributed at the same population proportions determined by the analysis in Figure 2. For the depots to be sampled in each category, the Margin of Error can be determined by solving for the Margin of Error using the formula in Section 2.2, but solving for the Margin of Error instead of Sample Size. The sample sizes and margins of error directly from the formula are:
  - 2.7.2.1. Large Metro: 5 Depots at 26.06% Error
  - 2.7.2.2. Large Rural: 0 Depots
  - 2.7.2.3. Large Urban: 3 Depots at 28.39% Error
  - 2.7.2.4. Med. Metro: 2 Depots at 30.17% Error
  - 2.7.2.5. Med. Rural: 5 Depots at 23.16% Error
  - 2.7.2.6. Med. Urban: 2 Depots at 30.17% Error
  - 2.7.2.7. Small Metro: 0 Depots
  - 2.7.2.8. Small Rural: 16 Depots at 19.90% Error
  - 2.7.2.9. Small Urban: 0 Depots

- 2.7.3. Utilizing the direct proportions of the total population, there are margins of error ranging from 19.9% to 30.2%. Redistributing the sample sizes between categories, the margins of error can be normalized to around 24%. See below:
  - 2.7.3.1. Large Metro: 6 Depots at 23.73% Error
  - 2.7.3.2. Large Rural: 0 Depots
  - 2.7.3.3. Large Urban: 4 Depots at 24.53% Error
  - 2.7.3.4. Med. Metro: 3 Depots at 24.57% Error
  - 2.7.3.5. Med. Rural: 5 Depots at 23.16% Error
  - 2.7.3.6. Med. Urban: 3 Depots at 24.57% Error
  - 2.7.3.7. Small Metro: 0 Depots
  - 2.7.3.8. Small Rural: 12 Depots at 23.21% Error
  - 2.7.3.9. Small Urban: 0 Depots

- 2.7.4. Despite the 9% difference in the Margin of Error, sampling 12 more depots greatly improved the statistical significance of each core time of the above population groups.

3. Depot Selection

3.1. Utilizing a list of all 221 depots, the list was sorted by depot size and community type to reflect the 9 categories listed in Section 2.7.3 above.

3.2. Depots were then identified to have either BCMB or ABDA board members on them or were studied in the 2018 Time and Motion Study. These depots were excluded from selection for this study.

3.3. Within the bounds of each category, a random number was generated utilizing the random function in an Excel Spreadsheet. Each category was sorted from low to high based on the random number generated.

3.4. Depots were assigned random numbers, beginning with the smallest up to the number of depots identified in Section 2.7.3, omitting the excluded depots. The number assigned became the Sample Identification number for this study

3.5. This methodology was helpful because if there was an issue with any of the depots selected, the next depot on the list in that category could be used and remain randomly assigned.

3.6. The 33 depots selected were then placed on a map and scheduled for study based on their location, where 2 to 3 depots could be studied per week.

3.7. After two weeks of data collection, a week was reserved for analysis before travelling to the next set of depots.

4. Data Collection Methodology

4.1. Every depot had slightly different processes. However, each depot had four fundamental functions or categories of activity:

  4.1.1. Primary Sort
  4.1.2. Secondary Count
  4.1.3. Storage
  4.1.4. Van Loading

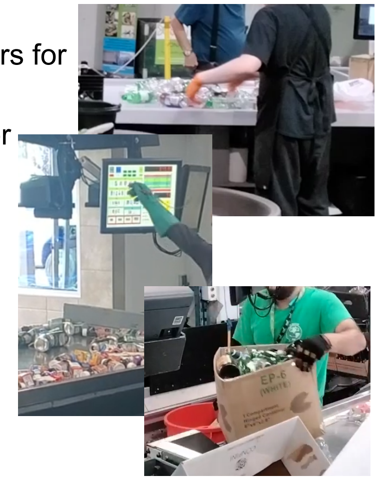
4.2. Within the Primary Sort and Secondary Count functions, bottles were directly or indirectly handled to transport them to the following function. Indirect handling is carrying a tote of bottles to the next location. Time per container was calculated based on the time spent carrying the tote divided by the number of containers in the tote. Recording quantities were also included in indirect time.

4.3. For each material stream studied, coding was established to properly assign time for the study. For example, a code such as **PSM07DC,** is interpreted as:

  4.3.1. **PS** = Primary Sort (SC=Secondary Count, ST=Storage, VL=Van Loading).
  4.3.2. **M** = Manual handling (A=Automation when interacting with Automation).
  4.3.3. **07** = the Material Stream ID number for Gable Top 0-1 (other codes are consistent with material stream ID Numbers provided by MNP.
  4.3.4. **DC** = Direct Core (IC=Indirect Core, NC=Non-Core)

4.4. Non-Core time was not assigned by material stream because activities such as sweeping, talking, or cleaning were done independent of a material stream.

4.5. Primary Sort:



4.5.1. **Direct Primary Sort** is the time spent directly counting containers for the purpose of paying the customer.
4.5.2. **Indirect Primary Sort** is any activity related to Direct Primary for the purpose of attending to a customer. It may include:
4.5.2.1. Entering quantities into a computer
4.5.2.2. Moving material to another location
4.5.2.3. Positioning bins for collection
4.5.3. Primary Sort Time is calculated by:
4.5.3.1. **Direct Time** = motion time / # of Containers counted
4.5.3.2. **Indirect Time** = motion time / # of Containers moved or entered

4.6. Secondary Count:

4.6.1. **Direct Secondary** is time spent counting containers for the purpose of filling a Megabag.
4.6.2. **Indirect Secondary** is any activity of moving material for the purpose of filling a Megabag. It may include:
4.6.2.1. Entering quantities onto a tracking sheet
4.6.2.2. Dumping material into the Megabag
4.6.2.3. Walking to and from the Megabag
4.6.3. Secondary Sort is calculated by:
4.6.3.1. **Direct Time** = motion time / # of Containers counted
4.6.3.2. **Indirect Time** = motion time / # of Containers moved or entered

4.7. Storage:

4.7.1. **Storage** involves the processing of:
4.7.1.1. Removing the full Megabag
4.7.1.2. Closing the Megabag
4.7.1.3. Moving the Megabag to the Storage Area
4.7.1.4. Tagging the Megabag
4.7.1.5. Placing the Megabag on a pallet or positioning for Storage
4.7.1.6. Replacing the Megabag with an empty bag
4.7.2. All time in Storage is considered Indirect and is calculated by:
4.7.2.1. **Indirect Time** = motion time / # of Containers moved within the Megabag

4.8. Van Loading:

4.8.1. **Van Loading** involves the process of removing empty pallets and empty bags from the van and loading full Megabags onto the van. Including:

4.8.1.1. Interacting with the driver

4.8.1.2. Unloading empties

4.8.1.3. Loading the van

4.8.1.4. Preparing and stowing equipment to assist in loading.

4.8.2. All time in Van Loading is considered Indirect. Time for unloading and preparation was given a motion per container quantity based on the total manifest quantity & added to the material stream time. The calculation is:

4.8.2.1. **Indirect Time** = motion time / # of Containers moved in a Megabag + Unloading Empty pallets & Megabags + Preparation & Stowing

4.9. Non-Core:

4.9.1. **Non-Core Time** was accounted for utilizing real data and estimating the relative scope of the activity to the containers involved in the non-core time.

4.9.1.1. For instance, if an employee had to interrupt their counting to go to the bathroom, the time between stopping and starting their counting was divided by the quantity of bottles counted for that customer.

4.9.2. Non-core time was not counted when there were no customers to attend to. This typically skewed the data because cleaning or organizing occurred at a much slower pace and was consumed by conversation. Also, Non-Core time without a customer did not interrupt the core processes.

4.10. Utilizing “Actual” Data:

4.10.1. Using the rubric or methodology described above has eliminated the need to make assumptions, utilize artificial data, or reference Maynards Operational Sequence Techniques (MOST) standards. All data from the study is associated with container volume at a given depot.

4.10.2. However, as the study progressed, a weakness was found in accounting for activity that crossed material streams. The two main areas were:

4.10.2.1. Paying the Customer

4.10.2.2. Opening bags of mixed material

4.10.3. These indirect core activities could not be associated with a particular material stream.

4.10.3.1. The weakness was mitigated by assigning the core time to a particular material stream (either the last or the largest) and dividing it by the approximate quantity of the bag or entire load from a customer.

4.10.4. This methodology is designed to capture the entirety of labour captured at each depot and is flexible enough to apply time codes to each activity despite process variations from depot to depot.

4.10.5. This method is additive as Direct and Indirect time is added together to achieve an average Primary or Secondary Core Time.

4.10.6. Primary Sort and Secondary Count are then added to Storage and Van Loading to determine a Total Core Time.

4.10.7. Total Core Time is then added to the Total Non-Core Time to achieve the Total Time per Container.

5. Analysis

5.1. Weighting

5.1.1. Related to using “Actual” data, there is also a desire to ensure data is analyzed utilizing relevant data within the study.

5.1.2. Historically, this same time and motion study has been analyzed using the previous year's annual volumes. There is a good reason to use annual volumes: the volume of containers translates to labour time for each material stream and is impacted by what material stream has the most influence. Material streams and depots that ship the most volume should influence the time per container data since they represent the most financial value proportionately.

5.1.3. However, there are two issues as it relates to the study itself:

5.1.3.1. First, annual volume is fundamentally unrelated to the study. It is determined completely independent of the data collected in the study. This study tracked the number of observations or moments of data observed in each activity category.

5.1.3.2. Second, weighting the data by volume is grossly biased toward larger depots and minimizes the effect of smaller, more rural depots. The larger depots are weighted more than ten-fold over the smaller depots. Thus, one does not have a representative picture of what is happening in the province, as rural depots comprise over half of the depots in Alberta.

5.1.4. Therefore, this study will provide data weighted by annual volume and number of moments by material stream or depot.

5.1.4.1. **Weighting by Volume** utilizes annual 2023 data by material stream and depot. The data will be aggregated and listed by material stream and depot, thus using the 2023 volume for each material stream in each depot.

5.1.4.2. **Weighting by Moments** directly relates to the number of observations made for each material stream. The weighting looks at the number of moments in each activity category. Weighting by moments lessens the impact of the larger and faster material streams proportionately, thus raising the overall time per container.

5.1.4.3. The data will be presented in four tables:
- 5.1.4.3.1. Weighted by Volume aggregated by Material Stream
- 5.1.4.3.2. Weighted by Moments aggregated by Material Stream
- 5.1.4.3.3. Weighted by Volume aggregated by Depot
- 5.1.4.3.4. Weighted by Moments aggregated by Depot

5.1.5. As discussed in Section 5.1.3 above, the traditional weighting method by annual volume applies the most influence to the material streams with the highest volume to the final Time per Container number. Because the volume of the larger material streams is exponentially larger than that of the smaller material streams, the impact of the smaller material streams is negligible.

5.1.5.1. For example, when comparing Aluminum to Tetra Brick Over One Litre, Aluminum has 1800 times more containers annually than Tetra Brick 1L+.

5.1.5.2. In a similar light, Aluminum is over 400 times that of Bi-Metal Zero to One Litre

5.1.6. Similarly, the volume of Aluminum is influenced by the Time per Container of the largest depots, which provides multiple times more volume than the smaller, more rural depots, making the rural depots fundamentally negligible in this study. Thus, only the larger depots which have a smaller Time per Container value are represented in the Weighted by Volume Numbers.

5.1.6.1. For example, Depot 05 has 115 times more influence than Depot 23.

5.1.6.2. Depot 05 has almost 8 times more influence than Depot 15 in the same size class.

5.1.7. With this said, the same results could be obtained using annual volume by choosing only the largest depots and measuring the largest material streams. If evaluating by volume is valued over moments, then focusing on medium and small depots will not be required in future studies.

5.1.8. RIVR began the sample size assessment as prescribed in the Request for Proposal (RFP). The sample size calculation was driven by the RFP, intending that each population group, as identified in Section 2.7 above, obtained statistically significant data for each population group. This would imply that the Time per Container number should represent all of the material streams observed and reflect all depots of every size and community type. Weighting by Moments is the recommended methodology to best represent the Time per Container as a representation of Alberta Depots.

5.1.8.1. When weighted by Moments, the larger material streams have approximately 300 times more influence than smaller material streams but this is still better than 1800 times using annual volume numbers. This emphasizes the value of evaluating by moments compared to the prior year's volume.

5.1.9. From a depot standpoint, all depots collectively have less than 1000 summed moments. Depot 05 is only 3.5 times more influential than Depot 23 compared to the 115 times mentioned above in the volume comparison in Section 5.1.6. Just another example of providing a better representation of small and rural depots.

5.2. Seasonality

5.2.1. RIVR recognizes that volume shifts significantly monthly depending on the season. Based on a project for the ABCRC, RIVR knows that Aluminum volumes can be reduced by at least 40% between June and October, the same time frame for this study.

5.2.2. However, when the team visited a depot, daily volumes were never a consideration, as the volume could vary from day to day or week to week, regardless of seasonality. One owner indicated that Tuesdays are busier than Thursdays because some people receive social assistance payments on Wednesdays and don't necessarily need the money on Thursdays.

5.2.3. Therefore, regardless of daily volumes, the Depot Team would stay at any one depot long enough to maximize the number of material streams they can identify and attempt to collect statistically significant data for each material stream. When volumes were lower, the team would stay longer, and when there was steady volume at a depot, they didn't have to stay as long. Daily volumes had little impact on the quantity of data collected and were more dependent on how much data could be collected in a day.

5.2.4. That being said, as reflected in the tables below, smaller depots have larger times per container, as the sense of urgency to serve the customers is less when there aren't people waiting to be served.

5.2.5. Seasonality would be more relevant if weighting by volume was done with monthly volume numbers. If monthly numbers were used, a correction factor would have been applied to reflect a June equivalent, so September data would be more accurate compared to June data. However, by using annual volumes, seasonality is removed from the equation because annual volumes include all of the seasons.

5.3. Aggregation

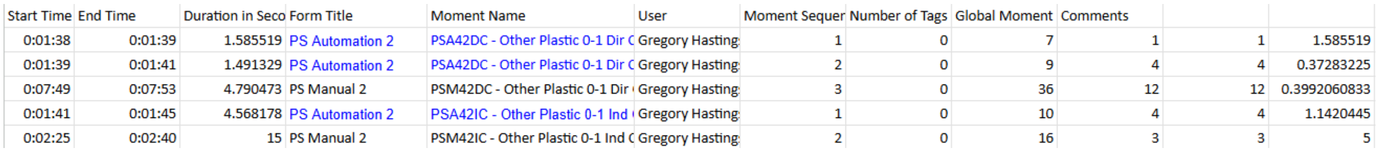
5.3.1. Data is collected by taking videos of each of the four categories described in Section 4.1.

5.3.2. Those videos are downloaded using a video coding software called Vosaic. Vosaic is an online video solution that was initially developed to perform research in academic settings. However, in working with the General Manager, Vosaic provided the ability to provide reports with fractions of seconds down to multiple decimal points.

5.3.3. The software was customizable to define the categories as described in Section 4.3. The codes in each category became buttons in the software, so when a worker picks up a material stream, a button is pushed, and the code is applied to the video for the duration of the activity. When the activity is complete, the button is turned off to end the 'Moment'.

5.3.4. The analyzer would then assign a number to that moment based on the number of containers handled, either directly or indirectly within that moment timeframe.

5.3.5. When a video is fully analyzed and coded, the analyzer downloads a spreadsheet with the Moments listed with time stamps, as seen in Figure 3 below.



Start Time	End Time	Duration in Seco	Form Title	Moment Name	User	Moment Sequer	Number of Tags	Global Moment	Comments		
0:01:38	0:01:39	1.585519	PS Automation 2	PSA42DC - Other Plastic 0-1 Dir C	Gregory Hasting	1	0	7	1	1	1.585519
0:01:39	0:01:41	1.491329	PS Automation 2	PSA42DC - Other Plastic 0-1 Dir C	Gregory Hasting	2	0	9	4	4	0.37283225
0:07:49	0:07:53	4.790473	PS Manual 2	PSM42DC - Other Plastic 0-1 Dir	Gregory Hasting	3	0	36	12	12	0.3992060833
0:01:41	0:01:45	4.568178	PS Automation 2	PSA42IC - Other Plastic 0-1 Ind	Gregory Hasting	1	0	10	4	4	1.1420445
0:02:25	0:02:40	15	PS Manual 2	PSM42IC - Other Plastic 0-1 Ind C	Gregory Hasting	2	0	16	3	3	5

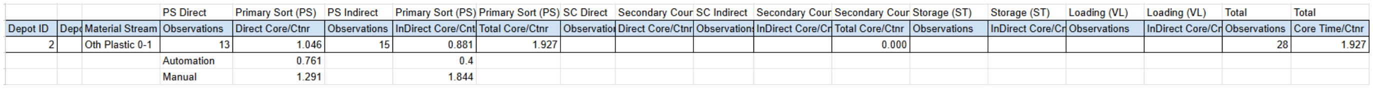
Figure 3: Data Output from Vosaic

5.3.6. The single video spreadsheet would then be sorted and divided into separate spreadsheets collecting data for individual material streams. Figure 3 shows a single video's Other Plastic 0-1 data.

5.3.7. The data output lists each moment's time stamp, the Moment's calculated duration, and the code applied under the Moment Name. It also gives unique tags to the Moment with Sequence numbers, Global numbers, and comments on the Moment. This is where the container quantity would be recorded. The Comment field is a text field, and additional comments were made occasionally to identify the type of activity that was performed. The value in the comment field is translated to a number field, and a Time per Container value is calculated for each Moment.

5.3.8. The moments for all of the videos for each material stream are then compiled and sorted by Moment Name so that the data can be separated into groups of Direct/Indirect, activity categories, and Manual/Automation Moments.

5.3.9. The average of each group of moments is calculated, and the number of Observations or Moments and the average value of that Code are listed at the top of each sheet, as seen in Figure 4.



			PS Direct	Primary Sort (PS)	PS Indirect	Primary Sort (PS)	Primary Sort (PS)	SC Direct	Secondary Cour	SC Indirect	Secondary Cour	Secondary Cour	Storage (ST)	Storage (ST)	Loading (VL)	Loading (VL)	Total	Total
Depot ID	Depo	Material Stream	Observations	Direct Core/Ctnr	Observations	InDirect Core/Cnt	Total Core/Ctnr	Observatio	Direct Core/Ctnr	Observations	InDirect Core/Cr	Total Core/Ctnr	Observations	InDirect Core/Cr	Observations	InDirect Core/Cr	Observations	Core Time/Ctnr
2		Oth Plastic 0-1	13	1.046	15	0.881	1.927					0.000					28	1.927
			Automation	0.761		0.4												
			Manual	1.291		1.844												

Figure 4: Average Time per Container for a Material Stream in a Depot

5.3.10. At this point, each of these lines is dropped into Summary Spreadsheets, first grouping common material streams across all depots and then all material streams for a particular depot.

5.3.11. Non-Core was only aggregated by Depot as material streams are not associated with Non-Core Time.

5.3.12. The summary sheets are weighted by volume and moments, as described above, and summarized on a single sheet, as seen in the figures shown in Section 6.

6. Total Time per Container Results:

6.1. Overview:

6.1.1. The end values for Total Time per Container are listed in Figure 5 below.

Time per Container Totals (in seconds)

	Core Time		Non-Core Time	
	Weighted by Volume	Weighted by Moment	Weighted by Volume	Weighted by Moment
Aggregated by Material Stream	3.40	5.59	2.02	2.18
Aggregated by Depot	3.46	5.63	2.38	2.63

Figure 5: Total Time per Container values

6.1.2. These numbers are higher than the data collected in the 2018 study. Higher values may be accounted for based on the following reasons:

6.1.2.1. **Methodology:** RIVR's intent was to capture ALL of the labour over the course of a day in each depot, whether it was directly handled or indirectly handled. These numbers are additive and not averaged into each other, so the totals may be more than the **2.16** sec/containers listed in the 2018 study.

6.1.2.1.1. To test this theory, if only the direct times are added together for Primary and Secondary, and then added the Storage and Loading times aggregated by material stream and volume the Total Core time would be **2.14** sec/container which is only two hundredths of a second from the 2018 study core time.

6.1.2.2. **Moment Duration:** RIVR attempted to measure ALL of the labour which means the moments were typically end to end including walking back from a Megabag or secondary sorting location ready to count the next material stream. It is not clear from the 2018 study how much labour activity was captured during their analysis.

6.1.2.3. **Non-Core:** The 2018 Study used a percentage of non-core time as a function of the total Core Time. They determined that Non-Core time was 35.2% of the Core time across depots, and that number was applied to all material streams. Observations were made, but Non-Core time was never independently determined. The Non-Core Time was determined to be **1.17** seconds per container as a percentage of Core Time.

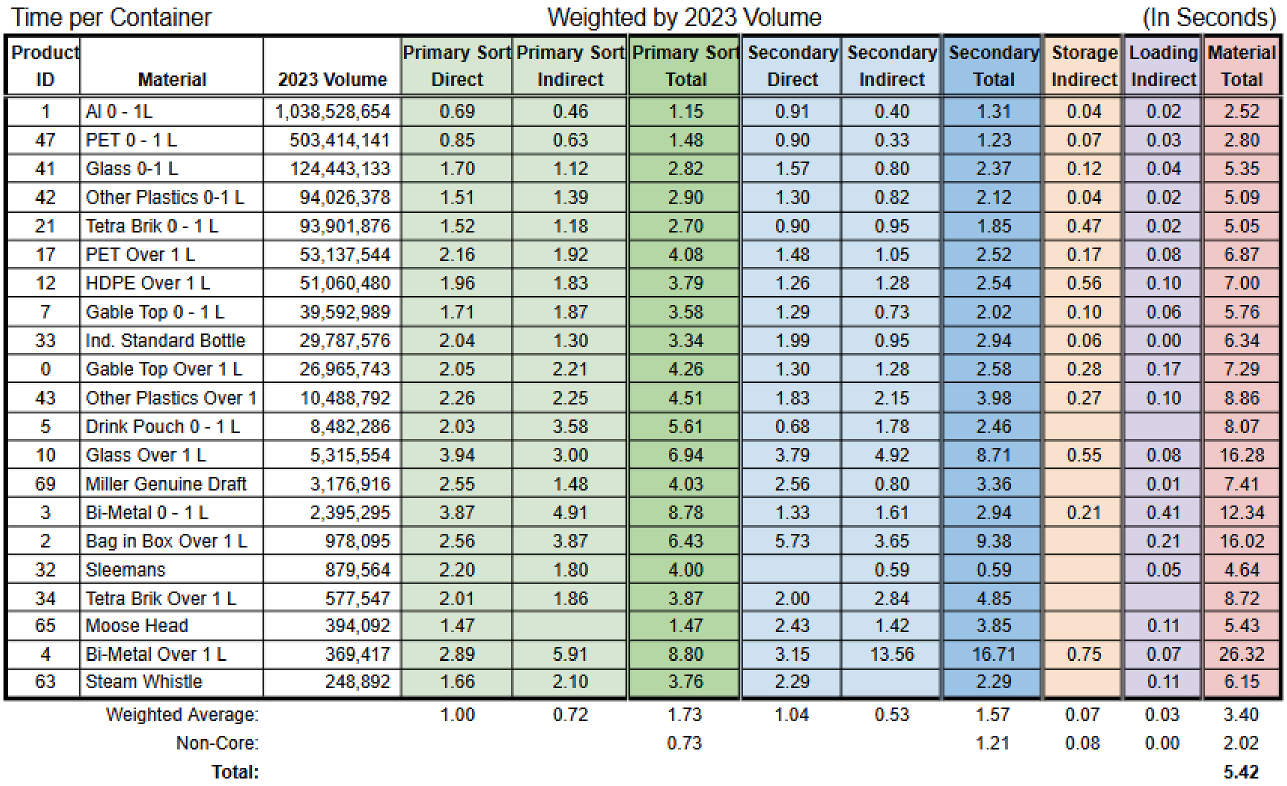
6.1.2.3.1. In this study, Non-Core time was measured and divided by the number of bottles within the scope of that activity. See Section 4.9 for an example.

6.1.2.3.2. RIVR established its methodology to measure "actual" data. Non-Core Time was summed for Primary, Secondary, Storage and Loading categories and determined to be **2.18** seconds per container independent of Core Time. Further commentary on the use of non-core time within this study can be found in Section 7.3.5 below.

6.2. Aggregated by Material Stream:

6.2.1. Figure 6 breaks down the data for each activity category listed by Material Stream.

6.2.2. Non-Core Time is summarized at the bottom since Non-Core Time was measured independent of Material Streams.

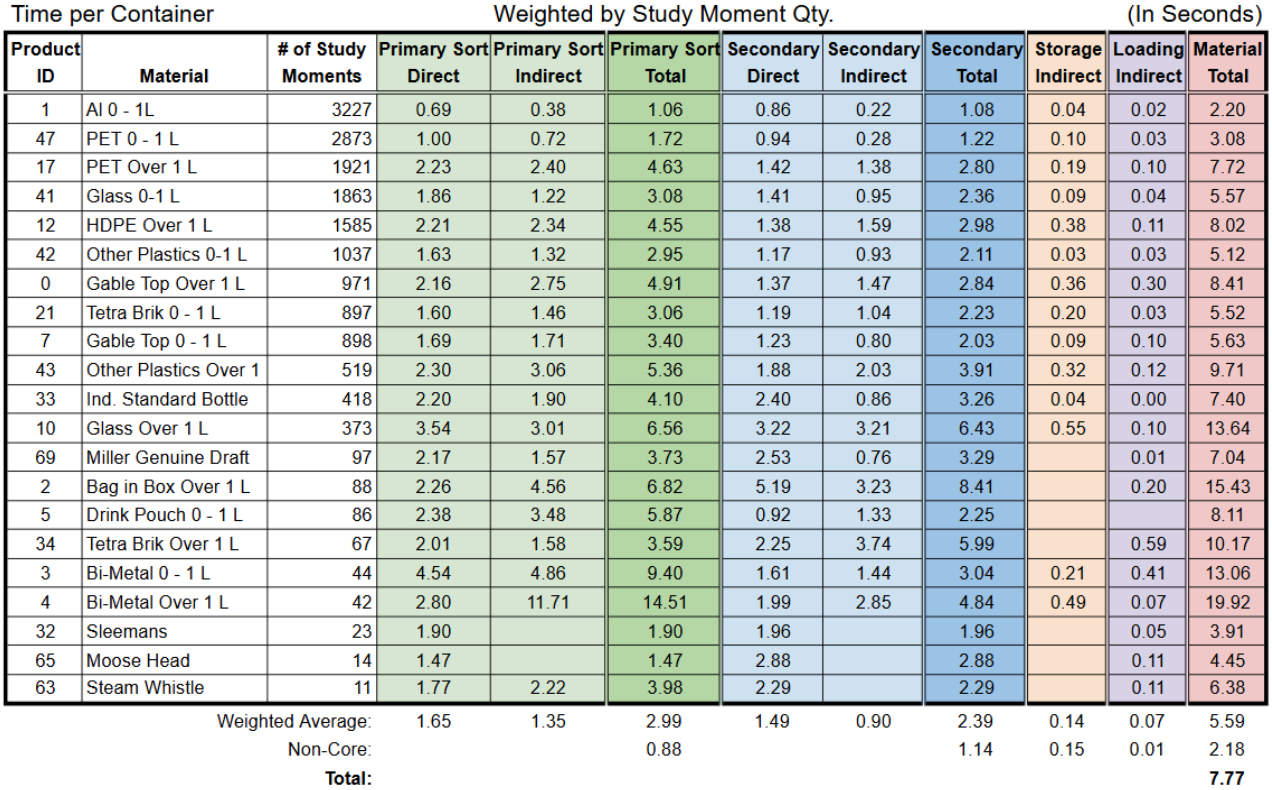


Time per Container — Weighted by 2023 Volume — (In Seconds)

Product ID	Material	2023 Volume	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Material Total
1	Al 0 - 1L	1,038,528,654	0.69	0.46	1.15	0.91	0.40	1.31	0.04	0.02	2.52
47	PET 0 - 1 L	503,414,141	0.85	0.63	1.48	0.90	0.33	1.23	0.07	0.03	2.80
41	Glass 0-1 L	124,443,133	1.70	1.12	2.82	1.57	0.80	2.37	0.12	0.04	5.35
42	Other Plastics 0-1 L	94,026,378	1.51	1.39	2.90	1.30	0.82	2.12	0.04	0.02	5.09
21	Tetra Brik 0 - 1 L	93,901,876	1.52	1.18	2.70	0.90	0.95	1.85	0.47	0.02	5.05
17	PET Over 1 L	53,137,544	2.16	1.92	4.08	1.48	1.05	2.52	0.17	0.08	6.87
12	HDPE Over 1 L	51,060,480	1.96	1.83	3.79	1.26	1.28	2.54	0.56	0.10	7.00
7	Gable Top 0 - 1 L	39,592,989	1.71	1.87	3.58	1.29	0.73	2.02	0.10	0.06	5.76
33	Ind. Standard Bottle	29,787,576	2.04	1.30	3.34	1.99	0.95	2.94	0.06	0.00	6.34
0	Gable Top Over 1 L	26,965,743	2.05	2.21	4.26	1.30	1.28	2.58	0.28	0.17	7.29
43	Other Plastics Over 1	10,488,792	2.26	2.25	4.51	1.83	2.15	3.98	0.27	0.10	8.86
5	Drink Pouch 0 - 1 L	8,482,286	2.03	3.58	5.61	0.68	1.78	2.46			8.07
10	Glass Over 1 L	5,315,554	3.94	3.00	6.94	3.79	4.92	8.71	0.55	0.08	16.28
69	Miller Genuine Draft	3,176,916	2.55	1.48	4.03	2.56	0.80	3.36		0.01	7.41
3	Bi-Metal 0 - 1 L	2,395,295	3.87	4.91	8.78	1.33	1.61	2.94	0.21	0.41	12.34
2	Bag in Box Over 1 L	978,095	2.56	3.87	6.43	5.73	3.65	9.38		0.21	16.02
32	Sleemans	879,564	2.20	1.80	4.00		0.59	0.59		0.05	4.64
34	Tetra Brik Over 1 L	577,547	2.01	1.86	3.87	2.00	2.84	4.85			8.72
65	Moose Head	394,092	1.47		1.47	2.43	1.42	3.85		0.11	5.43
4	Bi-Metal Over 1 L	369,417	2.89	5.91	8.80	3.15	13.56	16.71	0.75	0.07	26.32
63	Steam Whistle	248,892	1.66	2.10	3.76	2.29		2.29		0.11	6.15
	Weighted Average:		1.00	0.72	1.73	1.04	0.53	1.57	0.07	0.03	3.40
	Non-Core:				0.73			1.21	0.08	0.00	2.02
	Total:										**5.42**

Figure 6: Time per Container Weighted by Volume, Listed by Material Stream

6.2.3. The same data Weighted by Moments:



Time per Container Weighted by Study Moment Qty. (In Seconds)

Product ID	Material	# of Study Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Material Total
1	Al 0 - 1L	3227	0.69	0.38	1.06	0.86	0.22	1.08	0.04	0.02	2.20
47	PET 0 - 1 L	2873	1.00	0.72	1.72	0.94	0.28	1.22	0.10	0.03	3.08
17	PET Over 1 L	1921	2.23	2.40	4.63	1.42	1.38	2.80	0.19	0.10	7.72
41	Glass 0-1 L	1863	1.86	1.22	3.08	1.41	0.95	2.36	0.09	0.04	5.57
12	HDPE Over 1 L	1585	2.21	2.34	4.55	1.38	1.59	2.98	0.38	0.11	8.02
42	Other Plastics 0-1 L	1037	1.63	1.32	2.95	1.17	0.93	2.11	0.03	0.03	5.12
0	Gable Top Over 1 L	971	2.16	2.75	4.91	1.37	1.47	2.84	0.36	0.30	8.41
21	Tetra Brik 0 - 1 L	897	1.60	1.46	3.06	1.19	1.04	2.23	0.20	0.03	5.52
7	Gable Top 0 - 1 L	898	1.69	1.71	3.40	1.23	0.80	2.03	0.09	0.10	5.63
43	Other Plastics Over 1	519	2.30	3.06	5.36	1.88	2.03	3.91	0.32	0.12	9.71
33	Ind. Standard Bottle	418	2.20	1.90	4.10	2.40	0.86	3.26	0.04	0.00	7.40
10	Glass Over 1 L	373	3.54	3.01	6.56	3.22	3.21	6.43	0.55	0.10	13.64
69	Miller Genuine Draft	97	2.17	1.57	3.73	2.53	0.76	3.29		0.01	7.04
2	Bag in Box Over 1 L	88	2.26	4.56	6.82	5.19	3.23	8.41		0.20	15.43
5	Drink Pouch 0 - 1 L	86	2.38	3.48	5.87	0.92	1.33	2.25			8.11
34	Tetra Brik Over 1 L	67	2.01	1.58	3.59	2.25	3.74	5.99		0.59	10.17
3	Bi-Metal 0 - 1 L	44	4.54	4.86	9.40	1.61	1.44	3.04	0.21	0.41	13.06
4	Bi-Metal Over 1 L	42	2.80	11.71	14.51	1.99	2.85	4.84	0.49	0.07	19.92
32	Sleemans	23	1.90		1.90	1.96		1.96		0.05	3.91
65	Moose Head	14	1.47		1.47	2.88		2.88		0.11	4.45
63	Steam Whistle	11	1.77	2.22	3.98	2.29		2.29		0.11	6.38
		Weighted Average:	1.65	1.35	2.99	1.49	0.90	2.39	0.14	0.07	5.59
		Non-Core:			0.88			1.14	0.15	0.01	2.18
		Total:									**7.77**

Figure 7: Time per Container Weighted by Moments, Listed by Material Stream

6.2.4. No data in a table cell indicates that observations were not made for that material stream for that particular activity.

6.2.5. Material streams not shown on the table were not observed during the study, such as, Liquor and Wine Ceramics, Plastic One-Way Kegs, or Small Sleeve in a Box.

6.2.6. Figures 6 and 7 reveal some obvious trends:

6.2.6.1. In direct handling, containers one litre or less have smaller times because they typically handle four containers at a time. Containers above one litre are typically handled one or two at a time

6.2.6.2. For indirect handling, lower volume streams are typically higher because they move a smaller amount of materials in one load.

6.2.6.3. This holds true for direct handling as well. When counting large volumes of material, one can count a large amount of material without interruption. Therefore, larger volumes see less time per container.

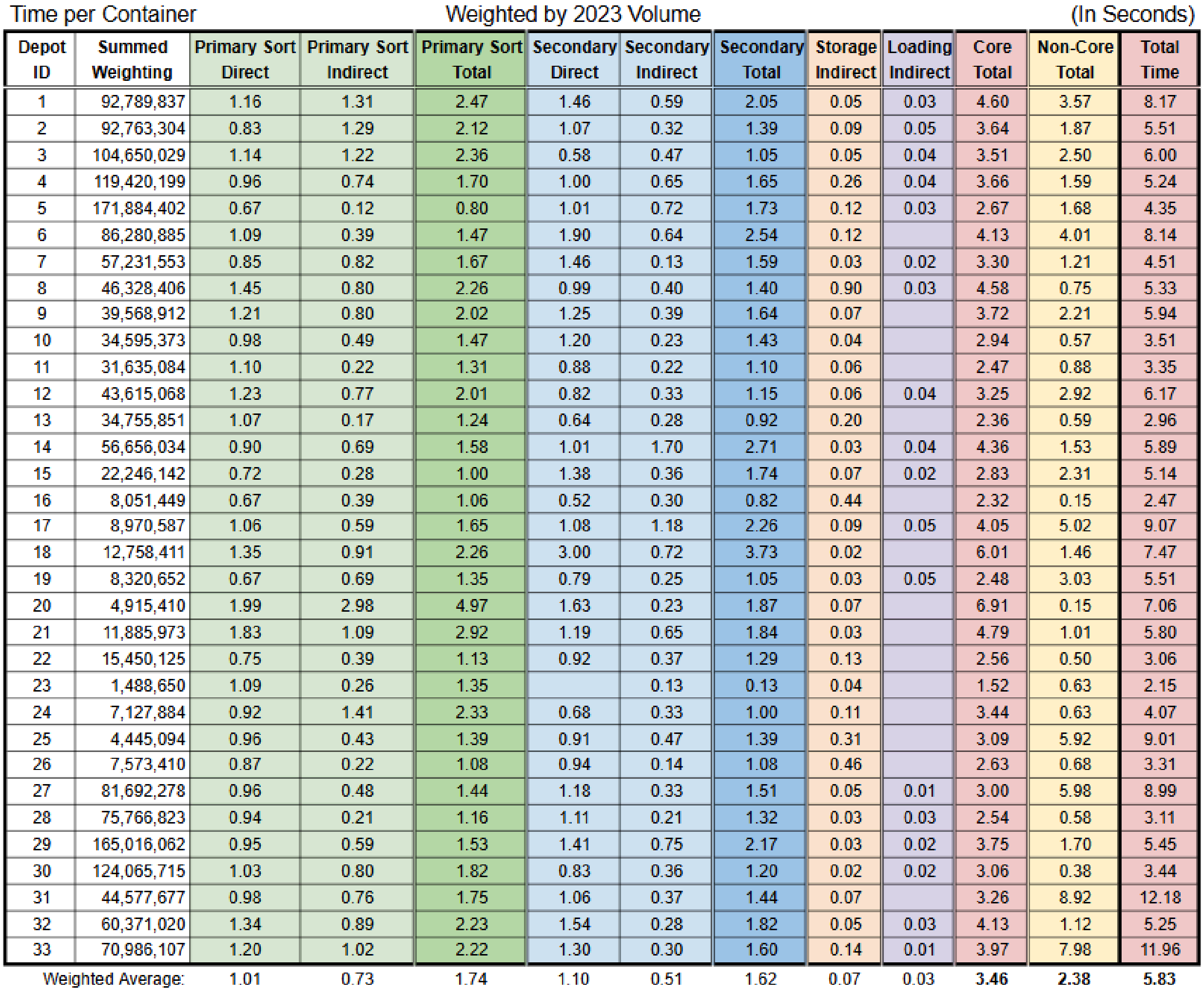
6.2.6.4. In some depots, Primary Indirect and Secondary Direct activity was eliminated by counting customer volumes into a bin and then carrying that bin directly to the Megabag, thus eliminating intermediate steps.

6.2.6.5. Storage and loading numbers are higher for larger materials because there are smaller volumes per Megabag.

6.3. Aggregated by Depot

6.3.1. Figure 6 may be sufficient for the client to examine Total Time by material stream. However, to examine trends by Depot Size and Community Type, the data must also be aggregated and weighted by Depot.

6.3.2. Non-Core Time is summarized by Depot along with Total Core Time in Figure 8.



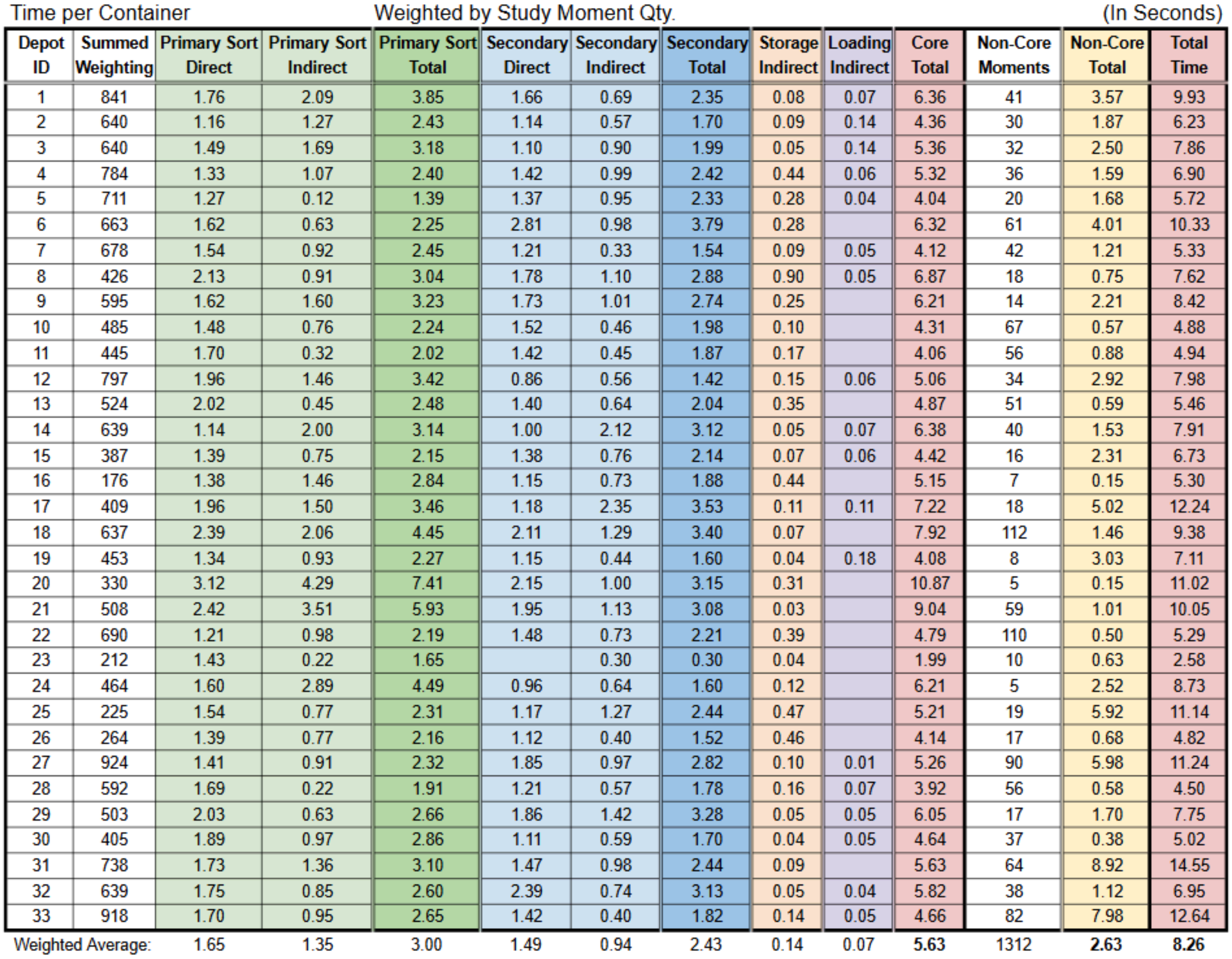
Time per Container Weighted by 2023 Volume (In Seconds)

Depot ID	Summed Weighting	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Total	Total Time
1	92,789,837	1.16	1.31	2.47	1.46	0.59	2.05	0.05	0.03	4.60	3.57	8.17
2	92,763,304	0.83	1.29	2.12	1.07	0.32	1.39	0.09	0.05	3.64	1.87	5.51
3	104,650,029	1.14	1.22	2.36	0.58	0.47	1.05	0.05	0.04	3.51	2.50	6.00
4	119,420,199	0.96	0.74	1.70	1.00	0.65	1.65	0.26	0.04	3.66	1.59	5.24
5	171,884,402	0.67	0.12	0.80	1.01	0.72	1.73	0.12	0.03	2.67	1.68	4.35
6	86,280,885	1.09	0.39	1.47	1.90	0.64	2.54	0.12		4.13	4.01	8.14
7	57,231,553	0.85	0.82	1.67	1.46	0.13	1.59	0.03	0.02	3.30	1.21	4.51
8	46,328,406	1.45	0.80	2.26	0.99	0.40	1.40	0.90	0.03	4.58	0.75	5.33
9	39,568,912	1.21	0.80	2.02	1.25	0.39	1.64	0.07		3.72	2.21	5.94
10	34,595,373	0.98	0.49	1.47	1.20	0.23	1.43	0.04		2.94	0.57	3.51
11	31,635,084	1.10	0.22	1.31	0.88	0.22	1.10	0.06		2.47	0.88	3.35
12	43,615,068	1.23	0.77	2.01	0.82	0.33	1.15	0.06	0.04	3.25	2.92	6.17
13	34,755,851	1.07	0.17	1.24	0.64	0.28	0.92	0.20		2.36	0.59	2.96
14	56,656,034	0.90	0.69	1.58	1.01	1.70	2.71	0.03	0.04	4.36	1.53	5.89
15	22,246,142	0.72	0.28	1.00	1.38	0.36	1.74	0.07	0.02	2.83	2.31	5.14
16	8,051,449	0.67	0.39	1.06	0.52	0.30	0.82	0.44		2.32	0.15	2.47
17	8,970,587	1.06	0.59	1.65	1.08	1.18	2.26	0.09	0.05	4.05	5.02	9.07
18	12,758,411	1.35	0.91	2.26	3.00	0.72	3.73	0.02		6.01	1.46	7.47
19	8,320,652	0.67	0.69	1.35	0.79	0.25	1.05	0.03	0.05	2.48	3.03	5.51
20	4,915,410	1.99	2.98	4.97	1.63	0.23	1.87	0.07		6.91	0.15	7.06
21	11,885,973	1.83	1.09	2.92	1.19	0.65	1.84	0.03		4.79	1.01	5.80
22	15,450,125	0.75	0.39	1.13	0.92	0.37	1.29	0.13		2.56	0.50	3.06
23	1,488,650	1.09	0.26	1.35		0.13	0.13	0.04		1.52	0.63	2.15
24	7,127,884	0.92	1.41	2.33	0.68	0.33	1.00	0.11		3.44	0.63	4.07
25	4,445,094	0.96	0.43	1.39	0.91	0.47	1.39	0.31		3.09	5.92	9.01
26	7,573,410	0.87	0.22	1.08	0.94	0.14	1.08	0.46		2.63	0.68	3.31
27	81,692,278	0.96	0.48	1.44	1.18	0.33	1.51	0.05	0.01	3.00	5.98	8.99
28	75,766,823	0.94	0.21	1.16	1.11	0.21	1.32	0.03	0.03	2.54	0.58	3.11
29	165,016,062	0.95	0.59	1.53	1.41	0.75	2.17	0.03	0.02	3.75	1.70	5.45
30	124,065,715	1.03	0.80	1.82	0.83	0.36	1.20	0.02	0.02	3.06	0.38	3.44
31	44,577,677	0.98	0.76	1.75	1.06	0.37	1.44	0.07		3.26	8.92	12.18
32	60,371,020	1.34	0.89	2.23	1.54	0.28	1.82	0.05	0.03	4.13	1.12	5.25
33	70,986,107	1.20	1.02	2.22	1.30	0.30	1.60	0.14	0.01	3.97	7.98	11.96
	Weighted Average:	1.01	0.73	1.74	1.10	0.51	1.62	0.07	0.03	**3.46**	**2.38**	**5.83**

Figure 8: Time per Container Weighted by Volume, Listed by Depot

6.3.2.1. The Summed Weighting values in Figure 8, is a result of utilizing 2023 Volume by material stream for each depot, to provide a weighted average by depot for each activity category. Those summed values then contributed the weighting of each depot to provide the final result. There is no direct relation to the actual volume of the depot or its material streams, but the values are a comparative representation of that depot's influence on the weighted average for Total Core Time in each activity category.

6.3.3. The same data weighted by Moments:



Time per Container Weighted by Study Moment Qty. (In Seconds)

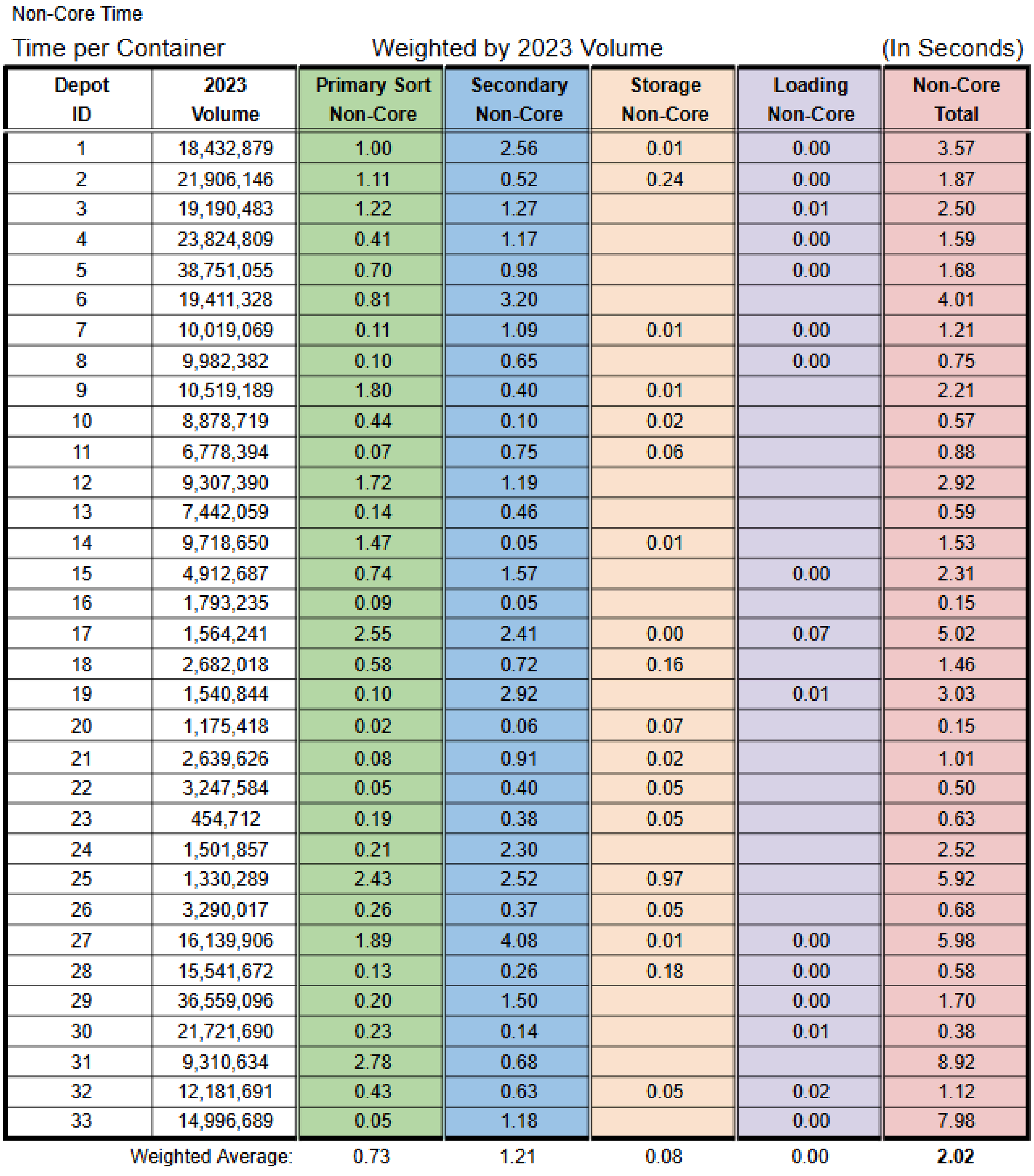
Depot ID	Summed Weighting	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Moments	Non-Core Total	Total Time
1	841	1.76	2.09	3.85	1.66	0.69	2.35	0.08	0.07	6.36	41	3.57	9.93
2	640	1.16	1.27	2.43	1.14	0.57	1.70	0.09	0.14	4.36	30	1.87	6.23
3	640	1.49	1.69	3.18	1.10	0.90	1.99	0.05	0.14	5.36	32	2.50	7.86
4	784	1.33	1.07	2.40	1.42	0.99	2.42	0.44	0.06	5.32	36	1.59	6.90
5	711	1.27	0.12	1.39	1.37	0.95	2.33	0.28	0.04	4.04	20	1.68	5.72
6	663	1.62	0.63	2.25	2.81	0.98	3.79	0.28		6.32	61	4.01	10.33
7	678	1.54	0.92	2.45	1.21	0.33	1.54	0.09	0.05	4.12	42	1.21	5.33
8	426	2.13	0.91	3.04	1.78	1.10	2.88	0.90	0.05	6.87	18	0.75	7.62
9	595	1.62	1.60	3.23	1.73	1.01	2.74	0.25		6.21	14	2.21	8.42
10	485	1.48	0.76	2.24	1.52	0.46	1.98	0.10		4.31	67	0.57	4.88
11	445	1.70	0.32	2.02	1.42	0.45	1.87	0.17		4.06	56	0.88	4.94
12	797	1.96	1.46	3.42	0.86	0.56	1.42	0.15	0.06	5.06	34	2.92	7.98
13	524	2.02	0.45	2.48	1.40	0.64	2.04	0.35		4.87	51	0.59	5.46
14	639	1.14	2.00	3.14	1.00	2.12	3.12	0.05	0.07	6.38	40	1.53	7.91
15	387	1.39	0.75	2.15	1.38	0.76	2.14	0.07	0.06	4.42	16	2.31	6.73
16	176	1.38	1.46	2.84	1.15	0.73	1.88	0.44		5.15	7	0.15	5.30
17	409	1.96	1.50	3.46	1.18	2.35	3.53	0.11	0.11	7.22	18	5.02	12.24
18	637	2.39	2.06	4.45	2.11	1.29	3.40	0.07		7.92	112	1.46	9.38
19	453	1.34	0.93	2.27	1.15	0.44	1.60	0.04	0.18	4.08	8	3.03	7.11
20	330	3.12	4.29	7.41	2.15	1.00	3.15	0.31		10.87	5	0.15	11.02
21	508	2.42	3.51	5.93	1.95	1.13	3.08	0.03		9.04	59	1.01	10.05
22	690	1.21	0.98	2.19	1.48	0.73	2.21	0.39		4.79	110	0.50	5.29
23	212	1.43	0.22	1.65		0.30	0.30	0.04		1.99	10	0.63	2.58
24	464	1.60	2.89	4.49	0.96	0.64	1.60	0.12		6.21	5	2.52	8.73
25	225	1.54	0.77	2.31	1.17	1.27	2.44	0.47		5.21	19	5.92	11.14
26	264	1.39	0.77	2.16	1.12	0.40	1.52	0.46		4.14	17	0.68	4.82
27	924	1.41	0.91	2.32	1.85	0.97	2.82	0.10	0.01	5.26	90	5.98	11.24
28	592	1.69	0.22	1.91	1.21	0.57	1.78	0.16	0.07	3.92	56	0.58	4.50
29	503	2.03	0.63	2.66	1.86	1.42	3.28	0.05	0.05	6.05	17	1.70	7.75
30	405	1.89	0.97	2.86	1.11	0.59	1.70	0.04	0.05	4.64	37	0.38	5.02
31	738	1.73	1.36	3.10	1.47	0.98	2.44	0.09		5.63	64	8.92	14.55
32	639	1.75	0.85	2.60	2.39	0.74	3.13	0.05	0.04	5.82	38	1.12	6.95
33	918	1.70	0.95	2.65	1.42	0.40	1.82	0.14	0.05	4.66	82	7.98	12.64
Weighted Average:		1.65	1.35	3.00	1.49	0.94	2.43	0.14	0.07	**5.63**	1312	**2.63**	**8.26**

Figure 9: Time per Container Weighted by Moment, Listed by Depot

6.3.4. Aggregating data by depot shows the key difference between weighting by volume and weighting by moment. In Figure 9, all depots had under 1,000 summed observations, Compared to the 100-fold difference between large and small depots in Figure 8.

7. Non-Core Time

7.1. An independent measurement of non-core time allows analysis by examining its impact on each activity category.



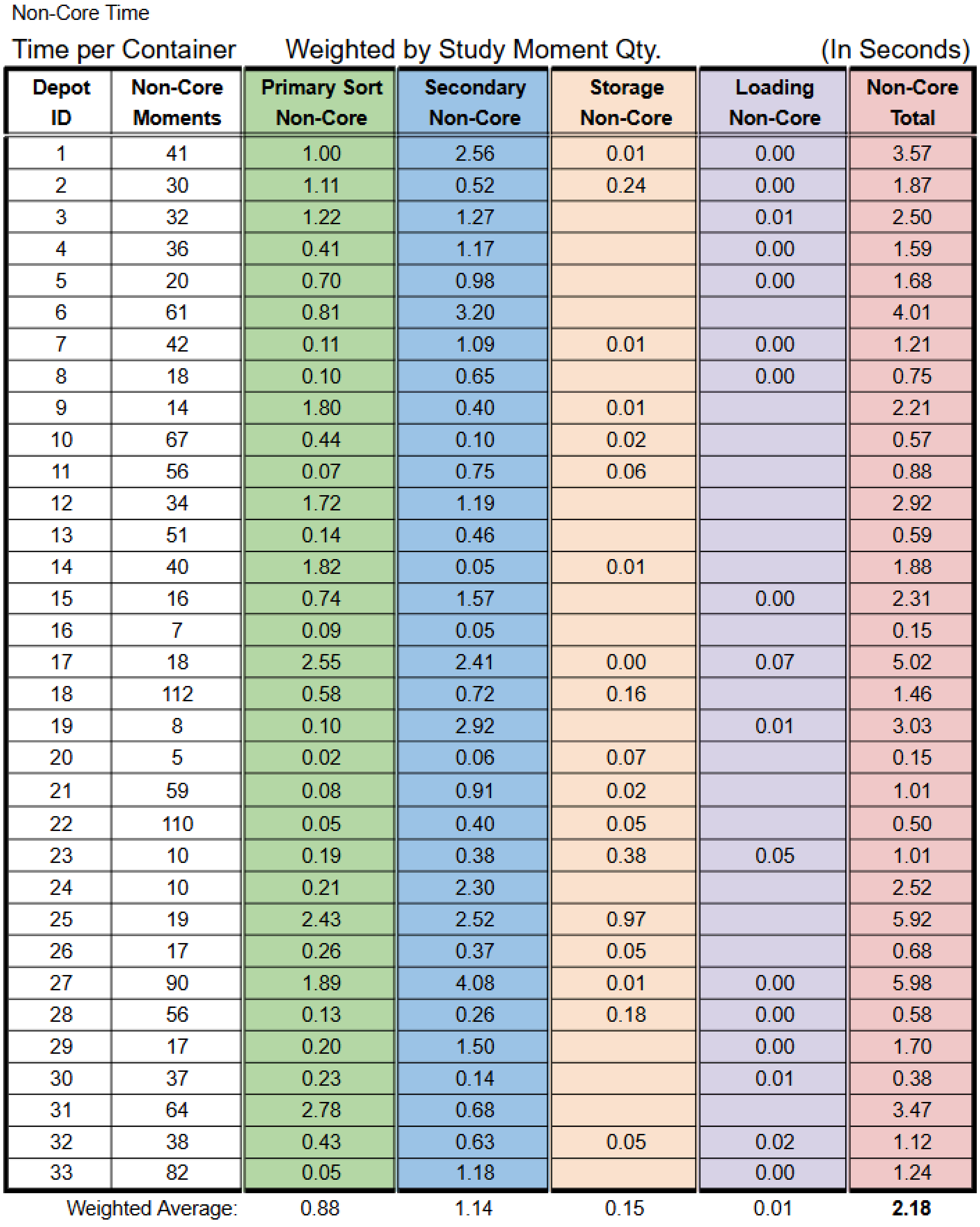
Non-Core Time

Time per Container Weighted by 2023 Volume (In Seconds)

Depot ID	2023 Volume	Primary Sort Non-Core	Secondary Non-Core	Storage Non-Core	Loading Non-Core	Non-Core Total
1	18,432,879	1.00	2.56	0.01	0.00	3.57
2	21,906,146	1.11	0.52	0.24	0.00	1.87
3	19,190,483	1.22	1.27		0.01	2.50
4	23,824,809	0.41	1.17		0.00	1.59
5	38,751,055	0.70	0.98		0.00	1.68
6	19,411,328	0.81	3.20			4.01
7	10,019,069	0.11	1.09	0.01	0.00	1.21
8	9,982,382	0.10	0.65		0.00	0.75
9	10,519,189	1.80	0.40	0.01		2.21
10	8,878,719	0.44	0.10	0.02		0.57
11	6,778,394	0.07	0.75	0.06		0.88
12	9,307,390	1.72	1.19			2.92
13	7,442,059	0.14	0.46			0.59
14	9,718,650	1.47	0.05	0.01		1.53
15	4,912,687	0.74	1.57		0.00	2.31
16	1,793,235	0.09	0.05			0.15
17	1,564,241	2.55	2.41	0.00	0.07	5.02
18	2,682,018	0.58	0.72	0.16		1.46
19	1,540,844	0.10	2.92		0.01	3.03
20	1,175,418	0.02	0.06	0.07		0.15
21	2,639,626	0.08	0.91	0.02		1.01
22	3,247,584	0.05	0.40	0.05		0.50
23	454,712	0.19	0.38	0.05		0.63
24	1,501,857	0.21	2.30			2.52
25	1,330,289	2.43	2.52	0.97		5.92
26	3,290,017	0.26	0.37	0.05		0.68
27	16,139,906	1.89	4.08	0.01	0.00	5.98
28	15,541,672	0.13	0.26	0.18	0.00	0.58
29	36,559,096	0.20	1.50		0.00	1.70
30	21,721,690	0.23	0.14		0.01	0.38
31	9,310,634	2.78	0.68			8.92
32	12,181,691	0.43	0.63	0.05	0.02	1.12
33	14,996,689	0.05	1.18		0.00	7.98
	Weighted Average:	0.73	1.21	0.08	0.00	**2.02**

Figure 10: Non-Core Time Weighted by Volume

7.2. The same data as above but weighted by Moments.



Non-Core Time

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	Non-Core Moments	Primary Sort Non-Core	Secondary Non-Core	Storage Non-Core	Loading Non-Core	Non-Core Total
1	41	1.00	2.56	0.01	0.00	3.57
2	30	1.11	0.52	0.24	0.00	1.87
3	32	1.22	1.27		0.01	2.50
4	36	0.41	1.17		0.00	1.59
5	20	0.70	0.98		0.00	1.68
6	61	0.81	3.20			4.01
7	42	0.11	1.09	0.01	0.00	1.21
8	18	0.10	0.65		0.00	0.75
9	14	1.80	0.40	0.01		2.21
10	67	0.44	0.10	0.02		0.57
11	56	0.07	0.75	0.06		0.88
12	34	1.72	1.19			2.92
13	51	0.14	0.46			0.59
14	40	1.82	0.05	0.01		1.88
15	16	0.74	1.57		0.00	2.31
16	7	0.09	0.05			0.15
17	18	2.55	2.41	0.00	0.07	5.02
18	112	0.58	0.72	0.16		1.46
19	8	0.10	2.92		0.01	3.03
20	5	0.02	0.06	0.07		0.15
21	59	0.08	0.91	0.02		1.01
22	110	0.05	0.40	0.05		0.50
23	10	0.19	0.38	0.38	0.05	1.01
24	10	0.21	2.30			2.52
25	19	2.43	2.52	0.97		5.92
26	17	0.26	0.37	0.05		0.68
27	90	1.89	4.08	0.01	0.00	5.98
28	56	0.13	0.26	0.18	0.00	0.58
29	17	0.20	1.50		0.00	1.70
30	37	0.23	0.14		0.01	0.38
31	64	2.78	0.68			3.47
32	38	0.43	0.63	0.05	0.02	1.12
33	82	0.05	1.18		0.00	1.24
Weighted Average:		0.88	1.14	0.15	0.01	**2.18**

Figure 11: Non-Core Time Weighted by Moments

7.3. Analysis

7.3.1. Despite the weighting, the total non-core times are similar within a 16 hundredths difference.

7.3.2. Cells without data indicate that non-core time was not observed.

7.3.3. Secondary Non-Core contained the largest numbers for time per container. In observing the depots with the larger numbers, the following activity was observed:

- 7.3.3.1. Talking
- 7.3.3.2. Not having something to write with
- 7.3.3.3. Crushing Boxes
- 7.3.3.4. Waiting for Primary to fill a bin
- 7.3.3.5. Cleaning and organizing after a customer
- 7.3.3.6. Lack of urgency
- 7.3.3.7. Forgot the number to add to the bin

7.3.4. Primary Sort also had a significant portion of the total number. Some of the activities observed for Primary activity were:

- 7.3.4.1. Talking
- 7.3.4.2. Identifying qualifying material
- 7.3.4.3. Walking to get delivered material
- 7.3.4.4. Unsure of what to do next
- 7.3.4.5. Sorting out garbage
- 7.3.4.6. Emptying liquid out of containers
- 7.3.4.7. Cleaning workstation
- 7.3.4.8. Chatting with customers
- 7.3.4.9. Waiting for customer

7.3.5. Understanding that Non-Core Time isn't necessarily associated with a single material stream makes one wonder about the value of non-core time in the Total Time per Container number.

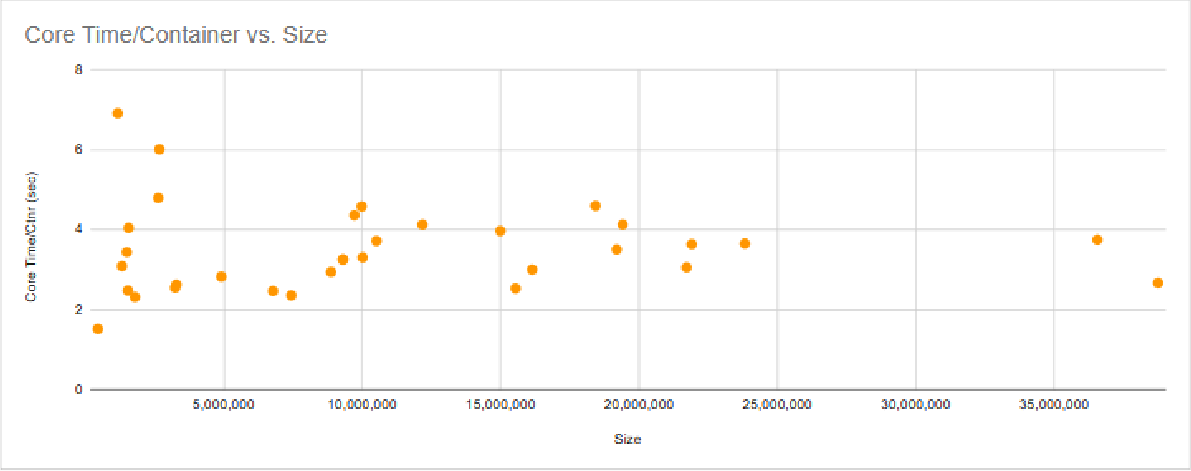
- 7.3.5.1. Excluding Non-Core time provides an actual handling time per container value from beginning to end without confounding the overall value.
- 7.3.5.2. Clean depots add Non-Core time in their process of cleaning their station between customers. In this case, depots with good processes can have more non-core time in their total numbers and add value.
- 7.3.5.3. In most capacity planning activities, it is customary to add a 10-20 percent buffer to account for human factors that reduce the efficiency and, thus, the work centre's capacity. This methodology may be a better representation of labour applied to a material stream than adding measured Non-Core Time.

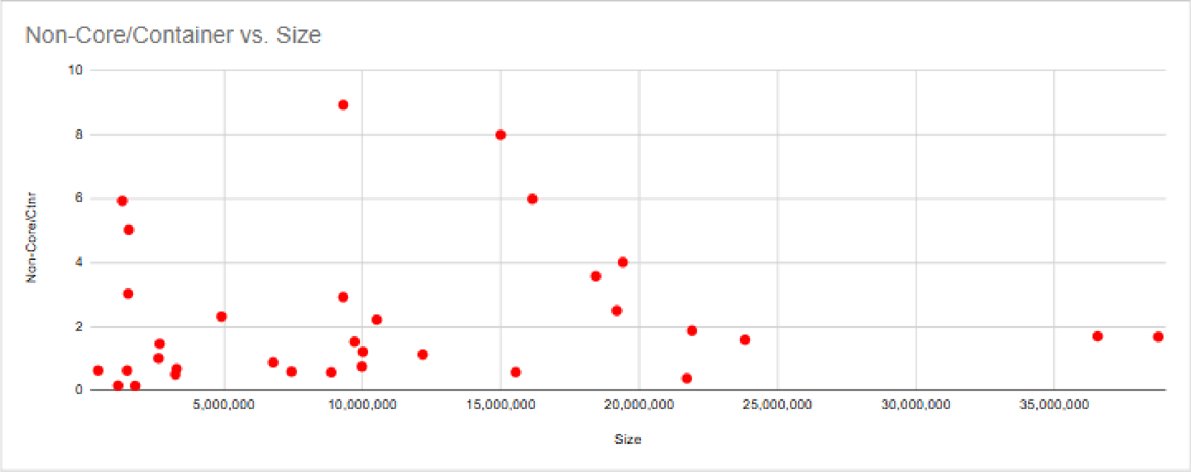
7.3.6. Understanding how this data is used to allocate costs by material stream, RIVR recommends only using Total Core Time by material stream to apply labour to each material stream. In the past, Non-Core time was added to the final number; however, it was always a proportion of Core Time, never derived from Non-Core Time in that material stream.

7.3.7. Understanding the impact of Non-Core time on depot inefficiency has value in terms of quantifying non-value added labour. However, utilizing core time and adding a 20% inefficiency human factor may be an approach to establishing a productivity goal for depots. Recognizing the human influence on container throughput efficiency is an important aspect of depot operations.

8. Scatter Plots

8.1. Figure 13 Shows Core Time, Non-Core Time and Total Time versus Volume:





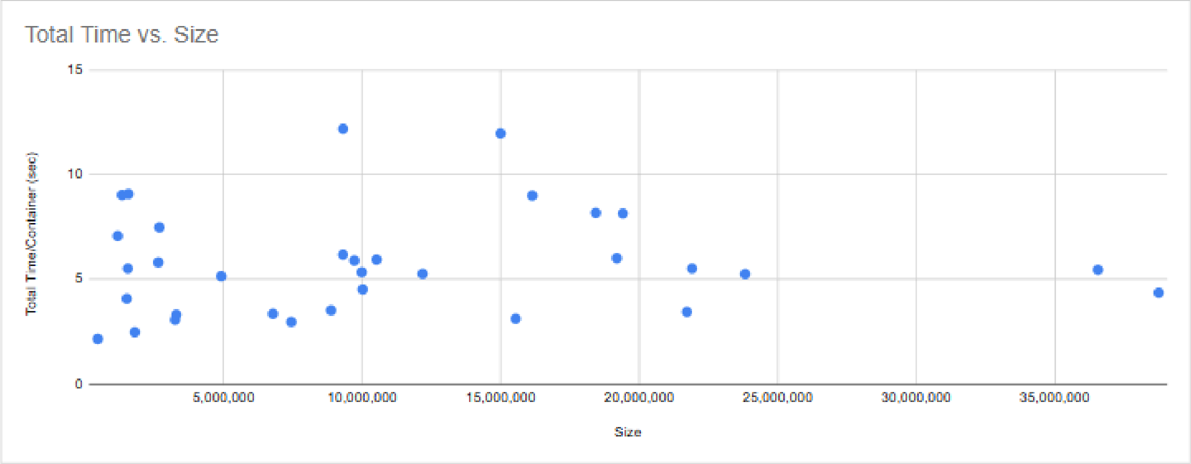


Figure 12: Core, Non-Core, and Total Time by Volume

8.1.1. Figure 12 reveals interesting trends:

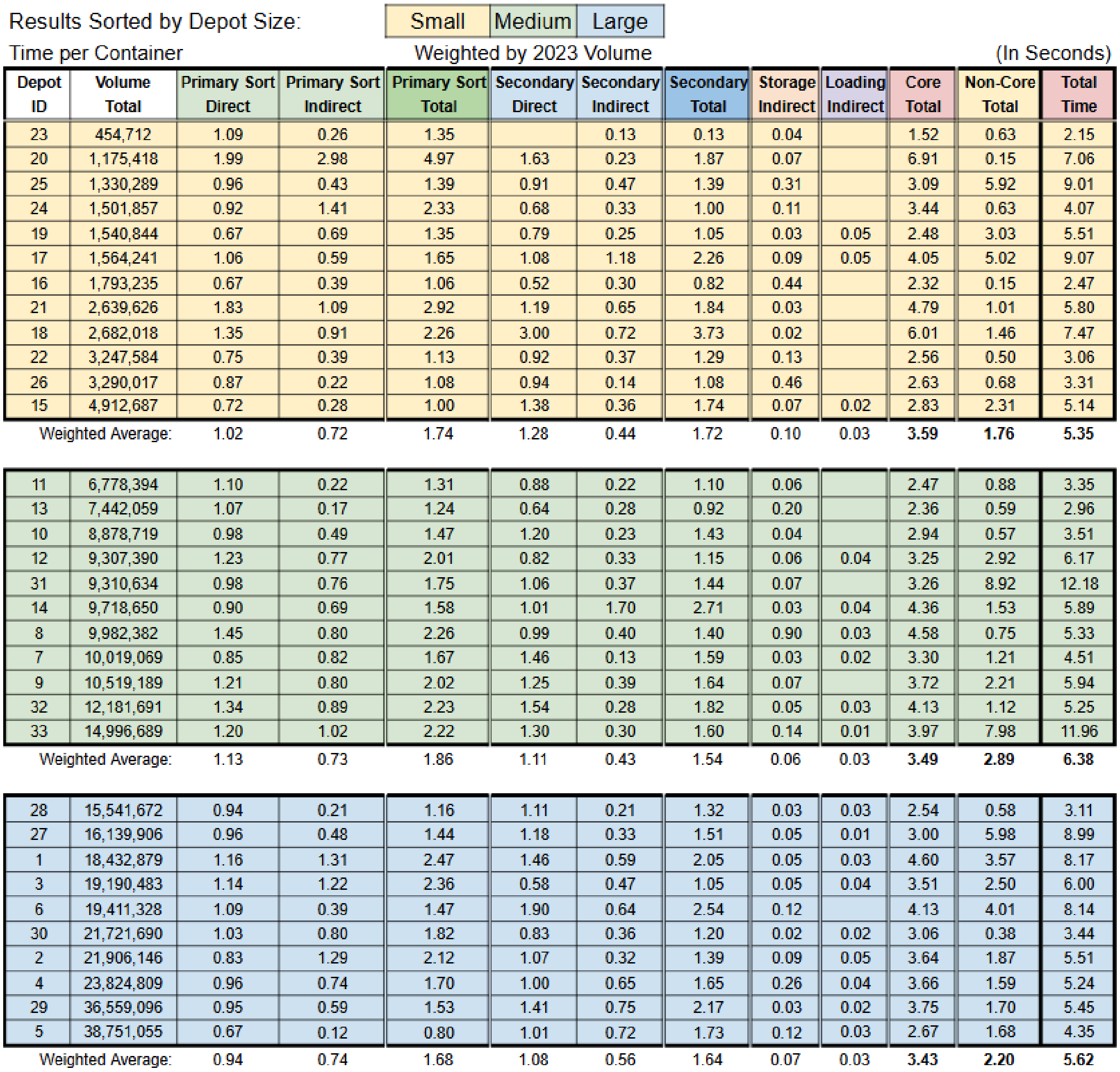
- 8.1.1.1. Most depots have a Total Core Time between 2 and 4.25 seconds per container, regardless of depot volume.
- 8.1.1.2. The outliers fall in the small depots where variations in process exist.
  - 8.1.1.2.1. The depot with the worst core time was greatly affected by handling glass. Workers would take one or two bottles at a time and walk them to the back of the room.
  - 8.1.1.2.2. This was also the case for the second largest core time only they were carrying HDPE and PET Over a Litre to the back of the room.
- 8.1.1.3. Most depots have a Total Non-Core Time between 0 and 2 seconds.
- 8.1.1.4. Outliers in Non-Core Time occur in smaller and larger depots, between 15 and 20 Million in volume.
  - 8.1.1.4.1. The largest non-core time occurred in a depot with too many employees for the volume. Another depot had several handling points between counting for the customer and going to the Megabag.
- 8.1.1.5. The Total time chart shows how important it is to separate Core and Non-Core data. Total time is clouded by either core or non-core time without any discernible trends. However, there is some consistency around five (5) seconds of total handling time, lending to statistical significance.

9. Time per Container by Depot Size

9.1. Figure 13 shows results weighted by Volume and grouped by Depot Size.

9.2. The client defines the size based on volume:

- 9.2.1. Small = <6M containers per year
- 9.2.2. Medium = 6M to 15.5M containers per year
- 9.2.3. Large = >15.5M containers per year



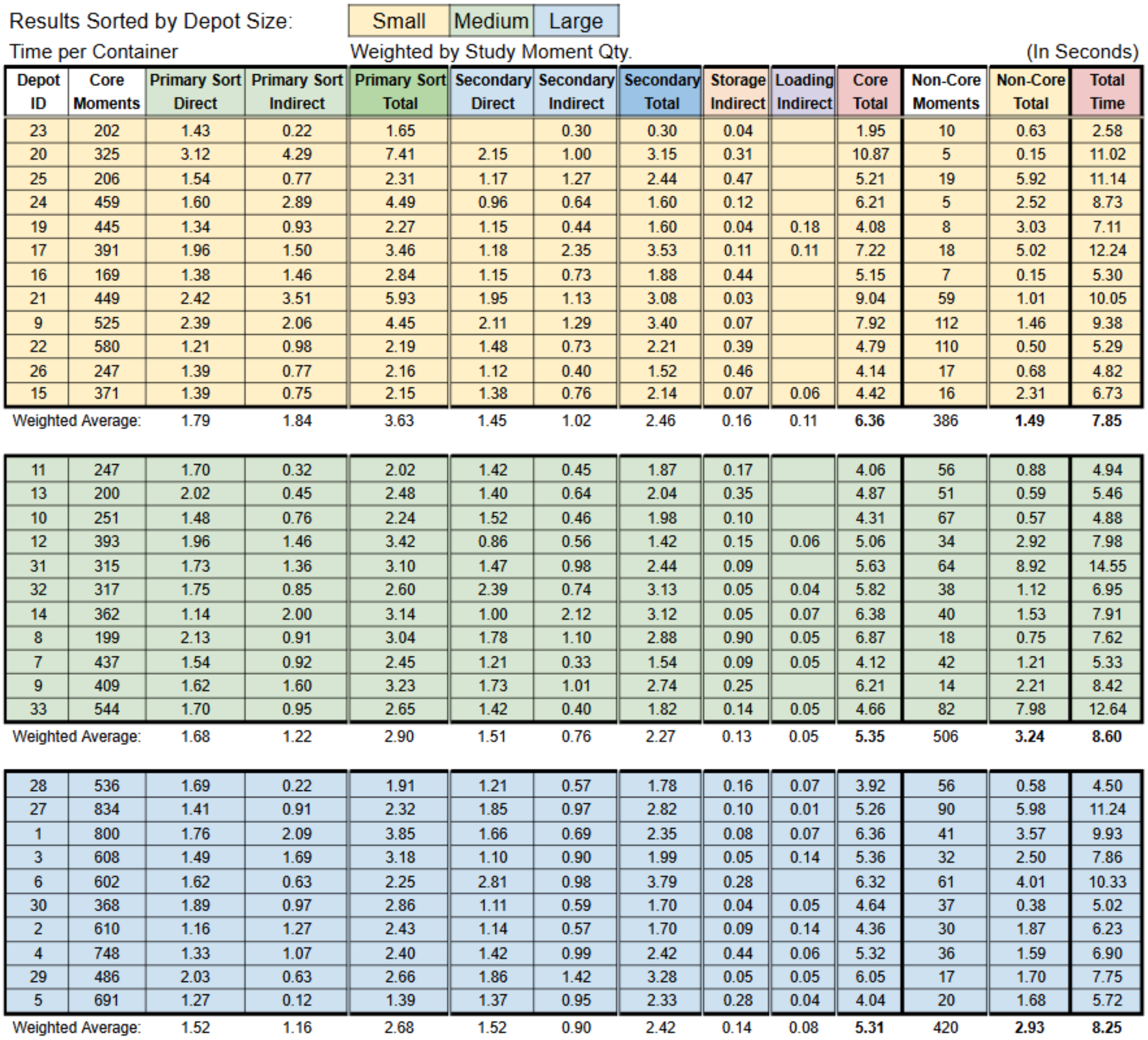
Results Sorted by Depot Size: Small | Medium | Large

Time per Container | Weighted by 2023 Volume | (In Seconds)

Depot ID	Volume Total	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Total	Total Time
23	454,712	1.09	0.26	1.35		0.13	0.13	0.04		1.52	0.63	2.15
20	1,175,418	1.99	2.98	4.97	1.63	0.23	1.87	0.07		6.91	0.15	7.06
25	1,330,289	0.96	0.43	1.39	0.91	0.47	1.39	0.31		3.09	5.92	9.01
24	1,501,857	0.92	1.41	2.33	0.68	0.33	1.00	0.11		3.44	0.63	4.07
19	1,540,844	0.67	0.69	1.35	0.79	0.25	1.05	0.03	0.05	2.48	3.03	5.51
17	1,564,241	1.06	0.59	1.65	1.08	1.18	2.26	0.09	0.05	4.05	5.02	9.07
16	1,793,235	0.67	0.39	1.06	0.52	0.30	0.82	0.44		2.32	0.15	2.47
21	2,639,626	1.83	1.09	2.92	1.19	0.65	1.84	0.03		4.79	1.01	5.80
18	2,682,018	1.35	0.91	2.26	3.00	0.72	3.73	0.02		6.01	1.46	7.47
22	3,247,584	0.75	0.39	1.13	0.92	0.37	1.29	0.13		2.56	0.50	3.06
26	3,290,017	0.87	0.22	1.08	0.94	0.14	1.08	0.46		2.63	0.68	3.31
15	4,912,687	0.72	0.28	1.00	1.38	0.36	1.74	0.07	0.02	2.83	2.31	5.14
Weighted Average:		1.02	0.72	1.74	1.28	0.44	1.72	0.10	0.03	**3.59**	**1.76**	**5.35**
11	6,778,394	1.10	0.22	1.31	0.88	0.22	1.10	0.06		2.47	0.88	3.35
13	7,442,059	1.07	0.17	1.24	0.64	0.28	0.92	0.20		2.36	0.59	2.96
10	8,878,719	0.98	0.49	1.47	1.20	0.23	1.43	0.04		2.94	0.57	3.51
12	9,307,390	1.23	0.77	2.01	0.82	0.33	1.15	0.06	0.04	3.25	2.92	6.17
31	9,310,634	0.98	0.76	1.75	1.06	0.37	1.44	0.07		3.26	8.92	12.18
14	9,718,650	0.90	0.69	1.58	1.01	1.70	2.71	0.03	0.04	4.36	1.53	5.89
8	9,982,382	1.45	0.80	2.26	0.99	0.40	1.40	0.90	0.03	4.58	0.75	5.33
7	10,019,069	0.85	0.82	1.67	1.46	0.13	1.59	0.03	0.02	3.30	1.21	4.51
9	10,519,189	1.21	0.80	2.02	1.25	0.39	1.64	0.07		3.72	2.21	5.94
32	12,181,691	1.34	0.89	2.23	1.54	0.28	1.82	0.05	0.03	4.13	1.12	5.25
33	14,996,689	1.20	1.02	2.22	1.30	0.30	1.60	0.14	0.01	3.97	7.98	11.96
Weighted Average:		1.13	0.73	1.86	1.11	0.43	1.54	0.06	0.03	**3.49**	**2.89**	**6.38**
28	15,541,672	0.94	0.21	1.16	1.11	0.21	1.32	0.03	0.03	2.54	0.58	3.11
27	16,139,906	0.96	0.48	1.44	1.18	0.33	1.51	0.05	0.01	3.00	5.98	8.99
1	18,432,879	1.16	1.31	2.47	1.46	0.59	2.05	0.05	0.03	4.60	3.57	8.17
3	19,190,483	1.14	1.22	2.36	0.58	0.47	1.05	0.05	0.04	3.51	2.50	6.00
6	19,411,328	1.09	0.39	1.47	1.90	0.64	2.54	0.12		4.13	4.01	8.14
30	21,721,690	1.03	0.80	1.82	0.83	0.36	1.20	0.02	0.02	3.06	0.38	3.44
2	21,906,146	0.83	1.29	2.12	1.07	0.32	1.39	0.09	0.05	3.64	1.87	5.51
4	23,824,809	0.96	0.74	1.70	1.00	0.65	1.65	0.26	0.04	3.66	1.59	5.24
29	36,559,096	0.95	0.59	1.53	1.41	0.75	2.17	0.03	0.02	3.75	1.70	5.45
5	38,751,055	0.67	0.12	0.80	1.01	0.72	1.73	0.12	0.03	2.67	1.68	4.35
Weighted Average:		0.94	0.74	1.68	1.08	0.56	1.64	0.07	0.03	**3.43**	**2.20**	**5.62**

Figure 13: Depots Grouped by Size and Weighted by Volume

9.3. The same data weighted by Moments:



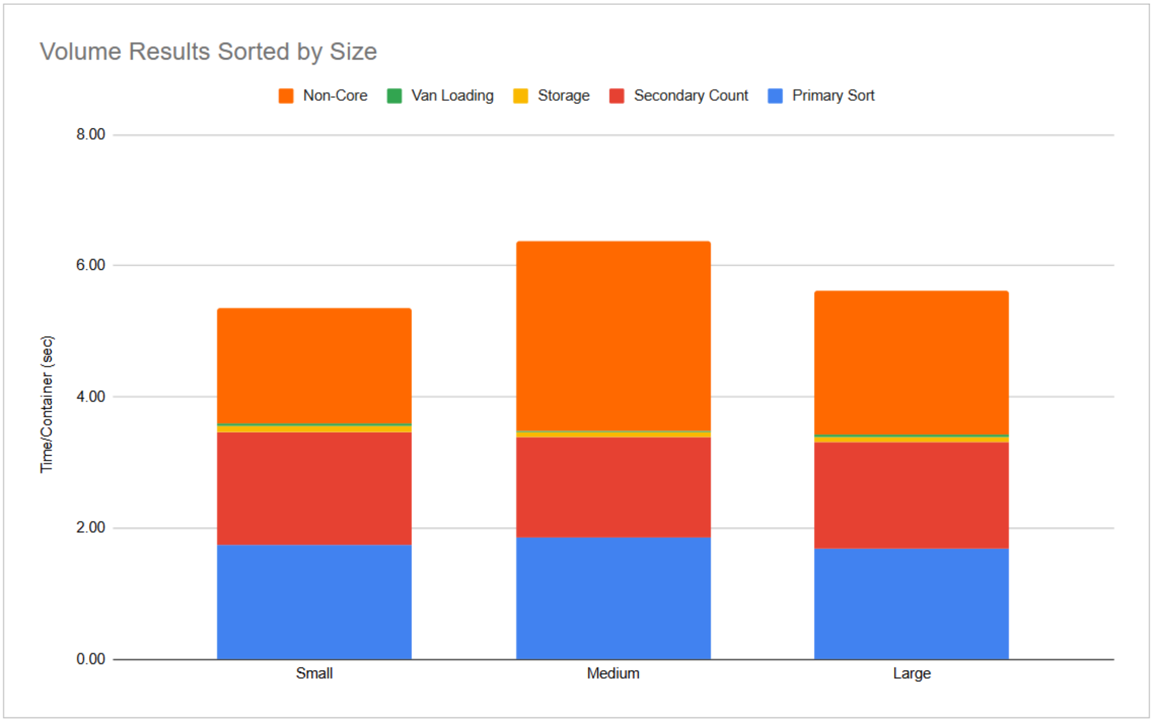
Results Sorted by Depot Size: Small Medium Large

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	Core Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Moments	Non-Core Total	Total Time
23	202	1.43	0.22	1.65		0.30	0.30	0.04		1.95	10	0.63	2.58
20	325	3.12	4.29	7.41	2.15	1.00	3.15	0.31		10.87	5	0.15	11.02
25	206	1.54	0.77	2.31	1.17	1.27	2.44	0.47		5.21	19	5.92	11.14
24	459	1.60	2.89	4.49	0.96	0.64	1.60	0.12		6.21	5	2.52	8.73
19	445	1.34	0.93	2.27	1.15	0.44	1.60	0.04	0.18	4.08	8	3.03	7.11
17	391	1.96	1.50	3.46	1.18	2.35	3.53	0.11	0.11	7.22	18	5.02	12.24
16	169	1.38	1.46	2.84	1.15	0.73	1.88	0.44		5.15	7	0.15	5.30
21	449	2.42	3.51	5.93	1.95	1.13	3.08	0.03		9.04	59	1.01	10.05
9	525	2.39	2.06	4.45	2.11	1.29	3.40	0.07		7.92	112	1.46	9.38
22	580	1.21	0.98	2.19	1.48	0.73	2.21	0.39		4.79	110	0.50	5.29
26	247	1.39	0.77	2.16	1.12	0.40	1.52	0.46		4.14	17	0.68	4.82
15	371	1.39	0.75	2.15	1.38	0.76	2.14	0.07	0.06	4.42	16	2.31	6.73
Weighted Average:		1.79	1.84	3.63	1.45	1.02	2.46	0.16	0.11	**6.36**	386	**1.49**	**7.85**
11	247	1.70	0.32	2.02	1.42	0.45	1.87	0.17		4.06	56	0.88	4.94
13	200	2.02	0.45	2.48	1.40	0.64	2.04	0.35		4.87	51	0.59	5.46
10	251	1.48	0.76	2.24	1.52	0.46	1.98	0.10		4.31	67	0.57	4.88
12	393	1.96	1.46	3.42	0.86	0.56	1.42	0.15	0.06	5.06	34	2.92	7.98
31	315	1.73	1.36	3.10	1.47	0.98	2.44	0.09		5.63	64	8.92	14.55
32	317	1.75	0.85	2.60	2.39	0.74	3.13	0.05	0.04	5.82	38	1.12	6.95
14	362	1.14	2.00	3.14	1.00	2.12	3.12	0.05	0.07	6.38	40	1.53	7.91
8	199	2.13	0.91	3.04	1.78	1.10	2.88	0.90	0.05	6.87	18	0.75	7.62
7	437	1.54	0.92	2.45	1.21	0.33	1.54	0.09	0.05	4.12	42	1.21	5.33
9	409	1.62	1.60	3.23	1.73	1.01	2.74	0.25		6.21	14	2.21	8.42
33	544	1.70	0.95	2.65	1.42	0.40	1.82	0.14	0.05	4.66	82	7.98	12.64
Weighted Average:		1.68	1.22	2.90	1.51	0.76	2.27	0.13	0.05	**5.35**	506	**3.24**	**8.60**
28	536	1.69	0.22	1.91	1.21	0.57	1.78	0.16	0.07	3.92	56	0.58	4.50
27	834	1.41	0.91	2.32	1.85	0.97	2.82	0.10	0.01	5.26	90	5.98	11.24
1	800	1.76	2.09	3.85	1.66	0.69	2.35	0.08	0.07	6.36	41	3.57	9.93
3	608	1.49	1.69	3.18	1.10	0.90	1.99	0.05	0.14	5.36	32	2.50	7.86
6	602	1.62	0.63	2.25	2.81	0.98	3.79	0.28		6.32	61	4.01	10.33
30	368	1.89	0.97	2.86	1.11	0.59	1.70	0.04	0.05	4.64	37	0.38	5.02
2	610	1.16	1.27	2.43	1.14	0.57	1.70	0.09	0.14	4.36	30	1.87	6.23
4	748	1.33	1.07	2.40	1.42	0.99	2.42	0.44	0.06	5.32	36	1.59	6.90
29	486	2.03	0.63	2.66	1.86	1.42	3.28	0.05	0.05	6.05	17	1.70	7.75
5	691	1.27	0.12	1.39	1.37	0.95	2.33	0.28	0.04	4.04	20	1.68	5.72
Weighted Average:		1.52	1.16	2.68	1.52	0.90	2.42	0.14	0.08	**5.31**	420	**2.93**	**8.25**

Figure 14: Depots Grouped by Size and Weighted by Moments

9.4. Total numbers can be arranged with a stacked bar chart:

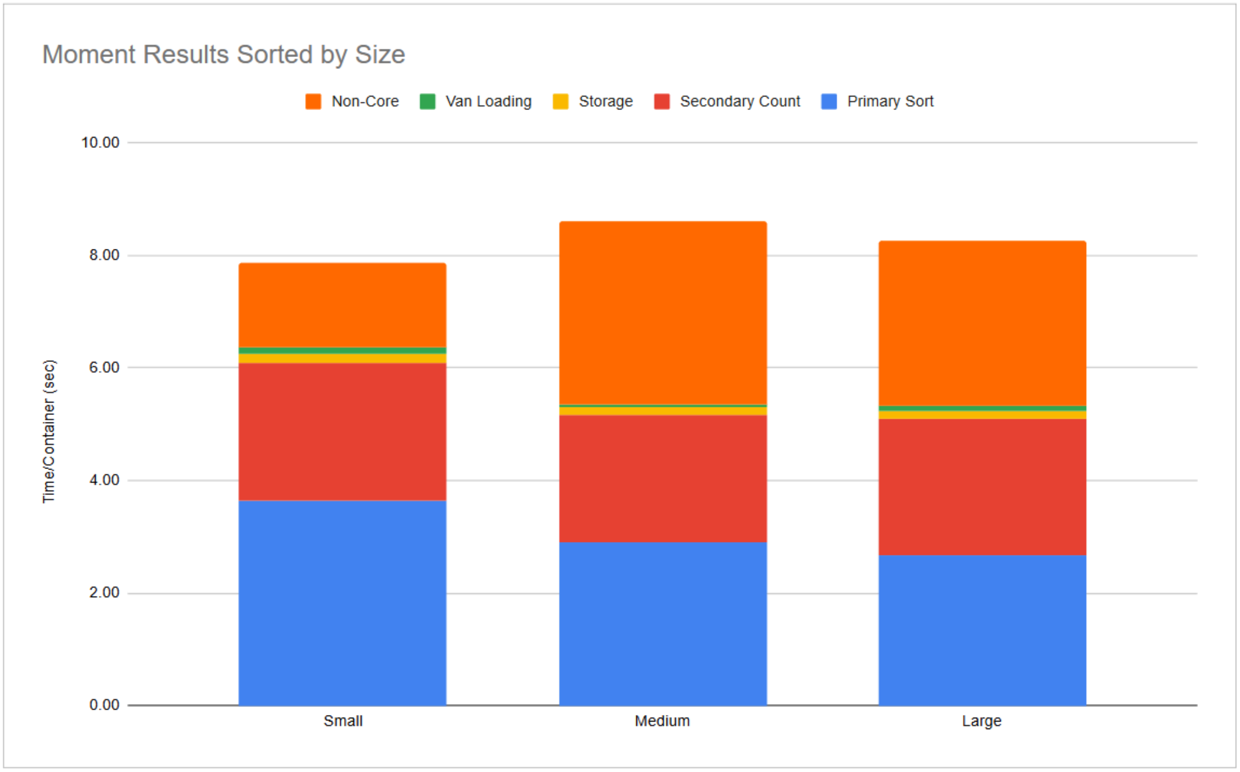


	Small	Medium	Large
Primary Sort	1.74	1.86	1.68
Secondary Count	1.72	1.54	1.64
Storage	0.10	0.06	0.07
Van Loading	0.03	0.03	0.03
Non-Core	1.76	2.89	2.20

Figure 15: Time per Container by Depot Size, Weighted by Volume

9.4.1. When weighted by Volume, Primary Sort is nearly the same as in all three groups; small depots have slightly more Secondary Time, and Medium Depots have significantly more Non-Core Time.

9.5. The same data weighted by moments:



	Small	Medium	Large
Primary Sort	3.63	2.90	2.68
Secondary Count	2.46	2.27	2.42
Storage	0.16	0.13	0.14
Van Loading	0.11	0.05	0.08
Non-Core	1.49	3.24	2.93

Figure 16: Time per Container by Depot Size, Weighted by Moments

9.5.1. Weighting by Moments shifts the data, with Small Depots having longer Primary Sort Times, Medium Depots having slightly less Secondary time, and Small Depots having considerably less Non-Core Time.

9.6. Interestingly, by changing the weighting, Medium Depots stand out in the Volume data as being statistically different, while Small Depots stand out as different in the Moment data.

10. Time per Container by Community Type

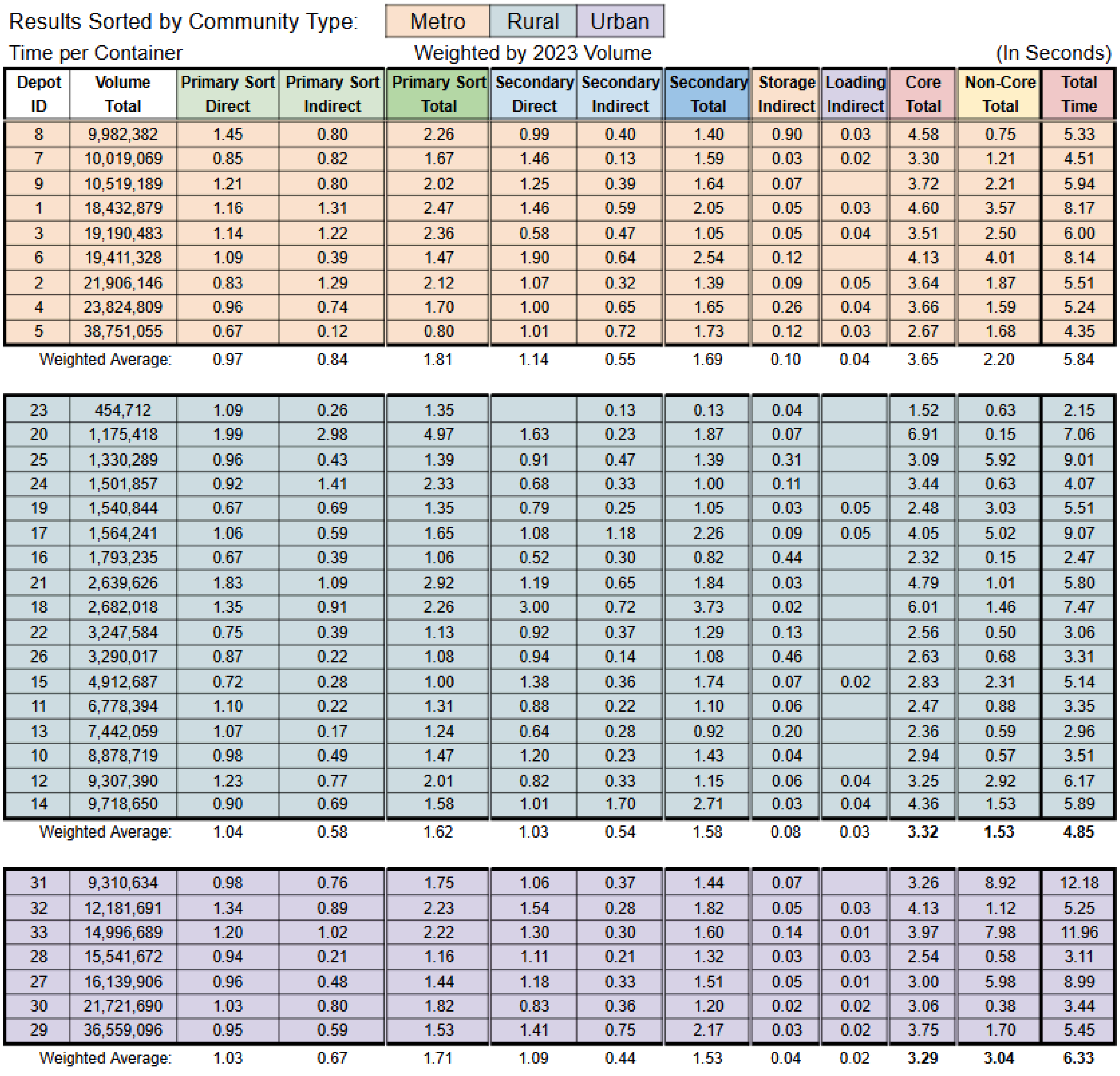
10.1. Figure 17 shows results weighted by Volume and grouped by Community Type.

10.2. Community Types are provided by the client and are defined as:

10.2.1. Metro Depots are in and around Alberta's two main population centres, Calgary and Edmonton.

10.2.2. Rural Depots are located in smaller Rural communities around the province.

10.2.3. Urban Depots are larger communities around Alberta, such as Grande Prairie, Fort MacMurray, Red Deer, and Lethbridge.



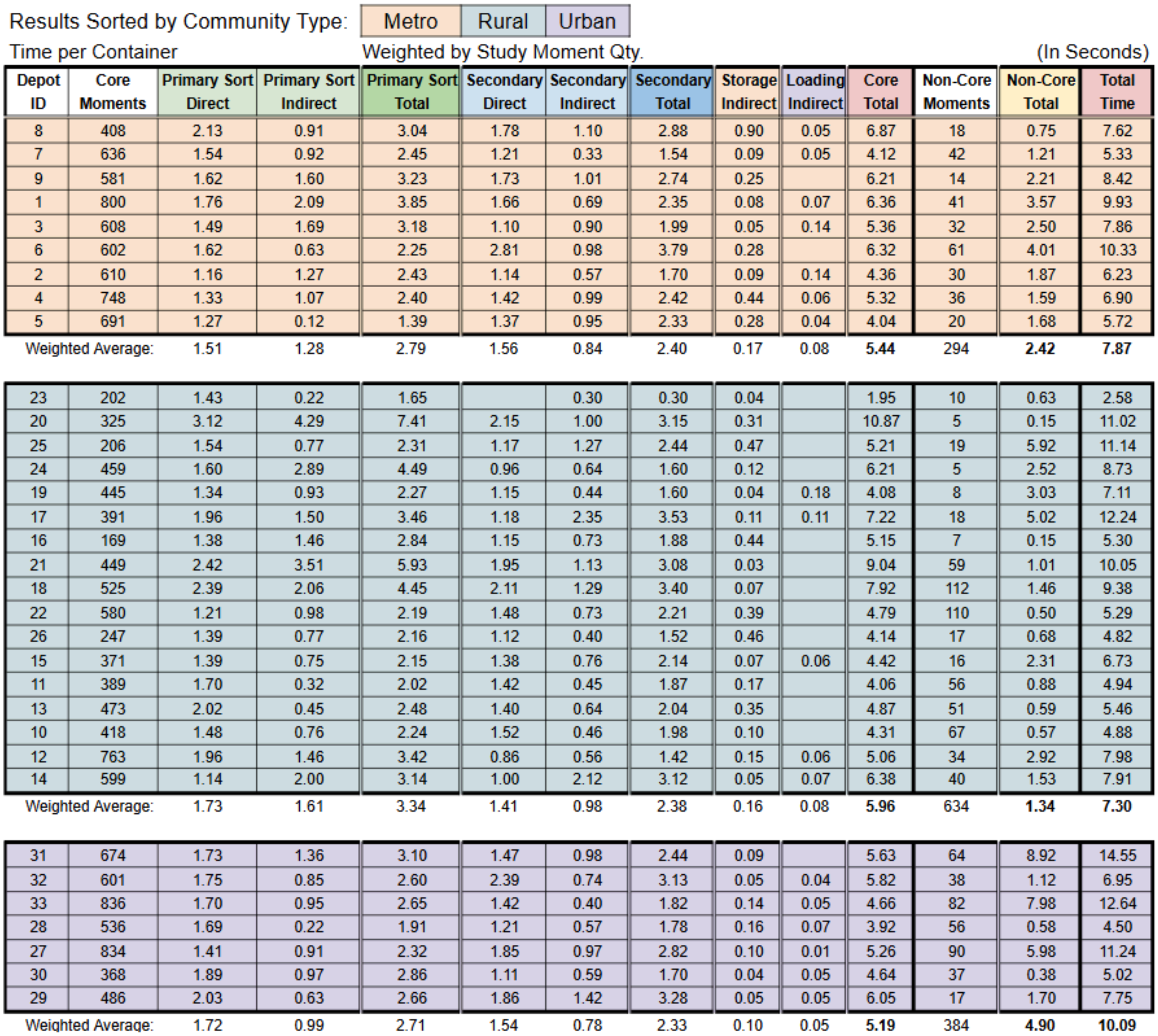
Results Sorted by Community Type: Metro | Rural | Urban

Time per Container — Weighted by 2023 Volume — (In Seconds)

Depot ID	Volume Total	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Total	Total Time
8	9,982,382	1.45	0.80	2.26	0.99	0.40	1.40	0.90	0.03	4.58	0.75	5.33
7	10,019,069	0.85	0.82	1.67	1.46	0.13	1.59	0.03	0.02	3.30	1.21	4.51
9	10,519,189	1.21	0.80	2.02	1.25	0.39	1.64	0.07		3.72	2.21	5.94
1	18,432,879	1.16	1.31	2.47	1.46	0.59	2.05	0.05	0.03	4.60	3.57	8.17
3	19,190,483	1.14	1.22	2.36	0.58	0.47	1.05	0.05	0.04	3.51	2.50	6.00
6	19,411,328	1.09	0.39	1.47	1.90	0.64	2.54	0.12		4.13	4.01	8.14
2	21,906,146	0.83	1.29	2.12	1.07	0.32	1.39	0.09	0.05	3.64	1.87	5.51
4	23,824,809	0.96	0.74	1.70	1.00	0.65	1.65	0.26	0.04	3.66	1.59	5.24
5	38,751,055	0.67	0.12	0.80	1.01	0.72	1.73	0.12	0.03	2.67	1.68	4.35
Weighted Average:		0.97	0.84	1.81	1.14	0.55	1.69	0.10	0.04	3.65	2.20	5.84
23	454,712	1.09	0.26	1.35		0.13	0.13	0.04		1.52	0.63	2.15
20	1,175,418	1.99	2.98	4.97	1.63	0.23	1.87	0.07		6.91	0.15	7.06
25	1,330,289	0.96	0.43	1.39	0.91	0.47	1.39	0.31		3.09	5.92	9.01
24	1,501,857	0.92	1.41	2.33	0.68	0.33	1.00	0.11		3.44	0.63	4.07
19	1,540,844	0.67	0.69	1.35	0.79	0.25	1.05	0.03	0.05	2.48	3.03	5.51
17	1,564,241	1.06	0.59	1.65	1.08	1.18	2.26	0.09	0.05	4.05	5.02	9.07
16	1,793,235	0.67	0.39	1.06	0.52	0.30	0.82	0.44		2.32	0.15	2.47
21	2,639,626	1.83	1.09	2.92	1.19	0.65	1.84	0.03		4.79	1.01	5.80
18	2,682,018	1.35	0.91	2.26	3.00	0.72	3.73	0.02		6.01	1.46	7.47
22	3,247,584	0.75	0.39	1.13	0.92	0.37	1.29	0.13		2.56	0.50	3.06
26	3,290,017	0.87	0.22	1.08	0.94	0.14	1.08	0.46		2.63	0.68	3.31
15	4,912,687	0.72	0.28	1.00	1.38	0.36	1.74	0.07	0.02	2.83	2.31	5.14
11	6,778,394	1.10	0.22	1.31	0.88	0.22	1.10	0.06		2.47	0.88	3.35
13	7,442,059	1.07	0.17	1.24	0.64	0.28	0.92	0.20		2.36	0.59	2.96
10	8,878,719	0.98	0.49	1.47	1.20	0.23	1.43	0.04		2.94	0.57	3.51
12	9,307,390	1.23	0.77	2.01	0.82	0.33	1.15	0.06	0.04	3.25	2.92	6.17
14	9,718,650	0.90	0.69	1.58	1.01	1.70	2.71	0.03	0.04	4.36	1.53	5.89
Weighted Average:		1.04	0.58	1.62	1.03	0.54	1.58	0.08	0.03	**3.32**	**1.53**	**4.85**
31	9,310,634	0.98	0.76	1.75	1.06	0.37	1.44	0.07		3.26	8.92	12.18
32	12,181,691	1.34	0.89	2.23	1.54	0.28	1.82	0.05	0.03	4.13	1.12	5.25
33	14,996,689	1.20	1.02	2.22	1.30	0.30	1.60	0.14	0.01	3.97	7.98	11.96
28	15,541,672	0.94	0.21	1.16	1.11	0.21	1.32	0.03	0.03	2.54	0.58	3.11
27	16,139,906	0.96	0.48	1.44	1.18	0.33	1.51	0.05	0.01	3.00	5.98	8.99
30	21,721,690	1.03	0.80	1.82	0.83	0.36	1.20	0.02	0.02	3.06	0.38	3.44
29	36,559,096	0.95	0.59	1.53	1.41	0.75	2.17	0.03	0.02	3.75	1.70	5.45
Weighted Average:		1.03	0.67	1.71	1.09	0.44	1.53	0.04	0.02	**3.29**	**3.04**	**6.33**

Figure 17: Time per Container weighted by Volume, Grouped by Community Type

10.3. The same data weighted by Moments:



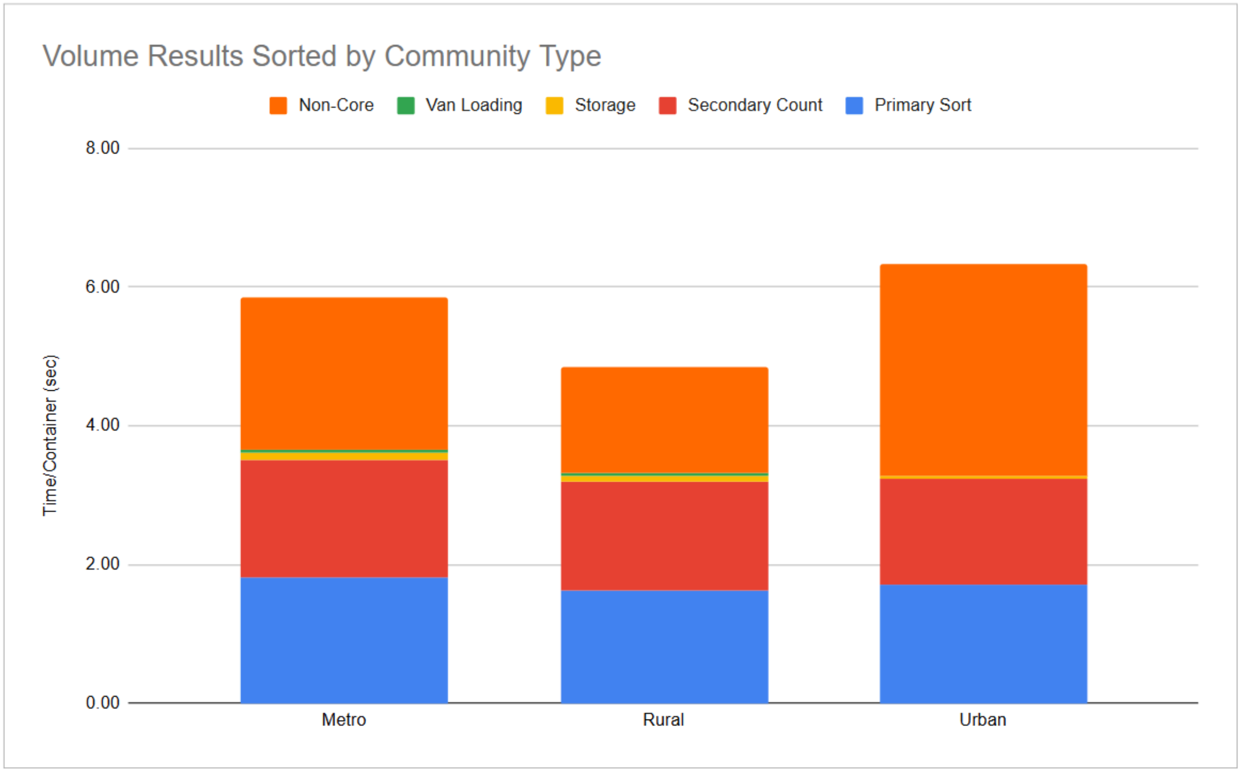
Results Sorted by Community Type: Metro | Rural | Urban

Time per Container — Weighted by Study Moment Qty. — (In Seconds)

Depot ID	Core Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Secondary Direct	Secondary Indirect	Secondary Total	Storage Indirect	Loading Indirect	Core Total	Non-Core Moments	Non-Core Total	Total Time
8	408	2.13	0.91	3.04	1.78	1.10	2.88	0.90	0.05	6.87	18	0.75	7.62
7	636	1.54	0.92	2.45	1.21	0.33	1.54	0.09	0.05	4.12	42	1.21	5.33
9	581	1.62	1.60	3.23	1.73	1.01	2.74	0.25		6.21	14	2.21	8.42
1	800	1.76	2.09	3.85	1.66	0.69	2.35	0.08	0.07	6.36	41	3.57	9.93
3	608	1.49	1.69	3.18	1.10	0.90	1.99	0.05	0.14	5.36	32	2.50	7.86
6	602	1.62	0.63	2.25	2.81	0.98	3.79	0.28		6.32	61	4.01	10.33
2	610	1.16	1.27	2.43	1.14	0.57	1.70	0.09	0.14	4.36	30	1.87	6.23
4	748	1.33	1.07	2.40	1.42	0.99	2.42	0.44	0.06	5.32	36	1.59	6.90
5	691	1.27	0.12	1.39	1.37	0.95	2.33	0.28	0.04	4.04	20	1.68	5.72
Weighted Average:		1.51	1.28	2.79	1.56	0.84	2.40	0.17	0.08	**5.44**	294	**2.42**	**7.87**
23	202	1.43	0.22	1.65		0.30	0.30	0.04		1.95	10	0.63	2.58
20	325	3.12	4.29	7.41	2.15	1.00	3.15	0.31		10.87	5	0.15	11.02
25	206	1.54	0.77	2.31	1.17	1.27	2.44	0.47		5.21	19	5.92	11.14
24	459	1.60	2.89	4.49	0.96	0.64	1.60	0.12		6.21	5	2.52	8.73
19	445	1.34	0.93	2.27	1.15	0.44	1.60	0.04	0.18	4.08	8	3.03	7.11
17	391	1.96	1.50	3.46	1.18	2.35	3.53	0.11	0.11	7.22	18	5.02	12.24
16	169	1.38	1.46	2.84	1.15	0.73	1.88	0.44		5.15	7	0.15	5.30
21	449	2.42	3.51	5.93	1.95	1.13	3.08	0.03		9.04	59	1.01	10.05
18	525	2.39	2.06	4.45	2.11	1.29	3.40	0.07		7.92	112	1.46	9.38
22	580	1.21	0.98	2.19	1.48	0.73	2.21	0.39		4.79	110	0.50	5.29
26	247	1.39	0.77	2.16	1.12	0.40	1.52	0.46		4.14	17	0.68	4.82
15	371	1.39	0.75	2.15	1.38	0.76	2.14	0.07	0.06	4.42	16	2.31	6.73
11	389	1.70	0.32	2.02	1.42	0.45	1.87	0.17		4.06	56	0.88	4.94
13	473	2.02	0.45	2.48	1.40	0.64	2.04	0.35		4.87	51	0.59	5.46
10	418	1.48	0.76	2.24	1.52	0.46	1.98	0.10		4.31	67	0.57	4.88
12	763	1.96	1.46	3.42	0.86	0.56	1.42	0.15	0.06	5.06	34	2.92	7.98
14	599	1.14	2.00	3.14	1.00	2.12	3.12	0.05	0.07	6.38	40	1.53	7.91
Weighted Average:		1.73	1.61	3.34	1.41	0.98	2.38	0.16	0.08	**5.96**	634	**1.34**	**7.30**
31	674	1.73	1.36	3.10	1.47	0.98	2.44	0.09		5.63	64	8.92	14.55
32	601	1.75	0.85	2.60	2.39	0.74	3.13	0.05	0.04	5.82	38	1.12	6.95
33	836	1.70	0.95	2.65	1.42	0.40	1.82	0.14	0.05	4.66	82	7.98	12.64
28	536	1.69	0.22	1.91	1.21	0.57	1.78	0.16	0.07	3.92	56	0.58	4.50
27	834	1.41	0.91	2.32	1.85	0.97	2.82	0.10	0.01	5.26	90	5.98	11.24
30	368	1.89	0.97	2.86	1.11	0.59	1.70	0.04	0.05	4.64	37	0.38	5.02
29	486	2.03	0.63	2.66	1.86	1.42	3.28	0.05	0.05	6.05	17	1.70	7.75
Weighted Average:		1.72	0.99	2.71	1.54	0.78	2.33	0.10	0.05	**5.19**	384	**4.90**	**10.09**

Figure 18: Time per Container Weighted by Volume, Grouped by Community Type

10.4. Total numbers arranged on a stacked bar chart:



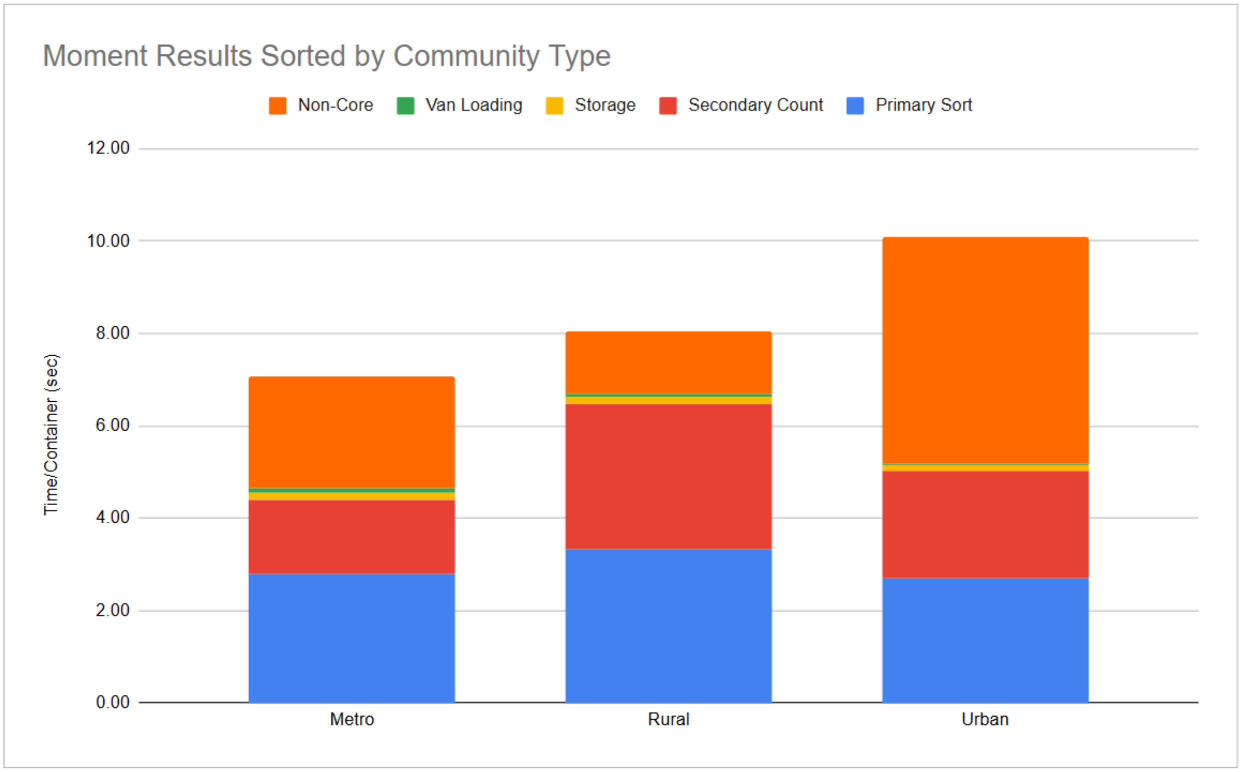
	Metro	Rural	Urban
Primary Sort	1.81	1.62	1.71
Secondary Count	1.69	1.58	1.53
Storage	0.10	0.08	0.04
Van Loading	0.04	0.03	0.02
Non-Core	2.20	1.53	3.04

Figure 19: Time per Container by Community Type, Weighted by Volume

10.4.1. This chart shows minimal contrast in Primary Sort and Secondary Count, though Metro Depots are slightly higher in both activity categories.

10.4.2. Non-core time has the most variation in community types, with Urban Depots having the most non-core time and Rural having the least.

10.5. The same data weighted by Moments:



	Metro	Rural	Urban
Primary Sort	2.79	3.34	2.71
Secondary Count	1.60	3.12	2.33
Storage	0.17	0.16	0.10
Van Loading	0.08	0.08	0.05
Non-Core	2.42	1.34	4.90

Figure 20: Time per Container by Community, Weighted by Moments

10.6. Weighting by Moments shifts the trends, with Rural Depots having the most Primary Sort and Secondary Count time, though having the least Non-Core Time, nearly 3.6 seconds per container less than Urban Depots.

11. Effects of Automation

11.1. Observations with Automation

11.1.1. As automation becomes more influential within the total depot population, it is difficult not to compare manual and automated processes. Automation is used in **10** of the **33** depots studied in either primary or secondary operations.

11.1.2. These observations don't always translate into the numbers illustrated below, but there were some obvious learnings to note through visiting depots and watching the subsequent videos:

11.1.2.1. Automation only operates to the degree that it is maintained. Non-Core time was generated because workers had to attend to the machine in order to keep it loaded or to ensure containers weren't missed in the counter.

11.1.2.2. Automation interrupts the manual process. When integrating automation into manual counting, there is a clear stoppage in the manual process, as the material must be taken to the counter and returned with a number.

11.1.2.3. Even though less time is spent per container, automation still involves a lot of manual counting.

11.1.2.3.1. Automation is designed for specific material streams, so all non-automated streams are manually counted before automation is engaged.

11.1.2.3.2. Any automated material streams still get picked through to weed out any crushed or unreadable containers to prevent them from going through the automation thus affecting the time per container for automation.

11.1.2.4. Non-Core time is created by using automation.

11.1.2.4.1. When using automation, the worker will either stand by the machine, assist the machine in moving material, or talk to customers while the automation is running.

11.1.2.4.2. Automation does not always negatively impact Non-Core time because the time is divided by a higher number of containers running through the automation.

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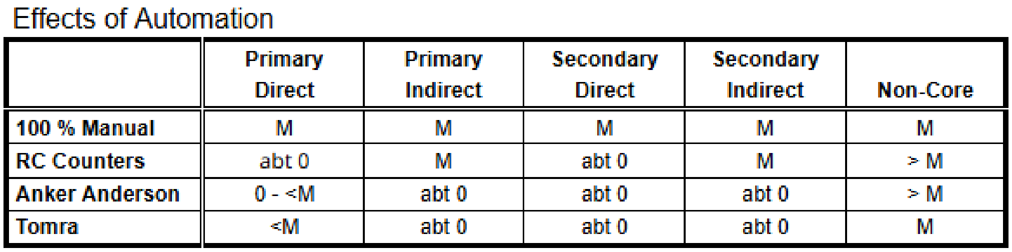
11.2. Types of Automation and Comparison to Manual Operation

11.2.1. Three models of automation were used within the 10 depots sampled with automation. For this reason, RIVR performed a comparative analysis utilizing manual depots of similar size and community type as the 'control.' Data involving automation is then compared to the 'Control' or manual equivalent depots.

11.2.2. It is important to remember that this is a study of labour time per container, so labour should effectively disappear, be reduced or negated when automation is applied. It is not so much of what is seen in the numbers but what is not seen.

11.2.3. Using manual depots as the control, a hypothesis can be developed to reflect the impact of automation on the data of this study:



Effects of Automation

	Primary Direct	Primary Indirect	Secondary Direct	Secondary Indirect	Non-Core
100 % Manual	M	M	M	M	M
RC Counters	abt 0	M	abt 0	M	> M
Anker Anderson	0 - <M	abt 0	abt 0	abt 0	> M
Tomra	<M	abt 0	abt 0	abt 0	M

Figure 21: Hypothetical Effects of Automation on each Activity Category

11.2.4. The data below may or may not reflect the hypothesized effects on the data, but it is worth stepping through the hypothetical effects to study automation's impact on the data.

11.2.5. Three models of automation were used in the sampled depots:

11.2.5.1. **RC Counters**: Typically a stand alone unit that counts containers under 1 Litre.

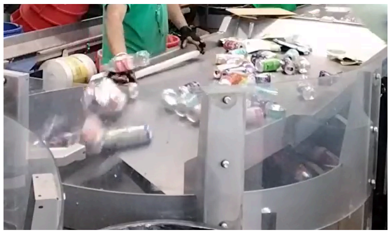
11.2.5.1.1. RC Counters can be used in Primary and Secondary operations to count for the purpose of paying the customer or to count material into the Megabags. In both cases, direct handling goes to zero, but indirect handling still exists because the worker still has to get the material to the counter. Non-core time typically exists around the counter as workers tend to either wait or assist the machine in keeping the equipment running.

11.2.5.2. **Anker Andersen**: Typically designed as an integrated unit for Primary and Secondary operations, this unit utilizes a singulator table where non-automated material streams are picked through when the machine is stopped, and then the machine is turned on and the table singulates and orients the material on the conveyor for counting.

11.2.5.2.1. Anker Andersen machines eliminate the need to count automated material directly, but material must still be manually counted if it can't be read by the machine. When the machine is integrated with secondary sorting into the megabags, both direct and indirect secondary labour is nearly eliminated.

11.2.5.3. **Tomra**: Similar to Anker Andersen, it is also an integrated system equipped with a singulator under a stainless steel workstation where a worker counts all of the non-automated material, and then pushes the remaining material into a moving singulator to be counted by the machine. Anker Andersen has a similar version of this automation interface.

11.2.5.3.1. Tomra equipment is very similar to the singluator table of Anker Andersen, though there is still direct labour in pushing the automated material into the singulator. Like Anker Andersen, the secondary automation nearly eliminates the need for worker interaction.



11.3. Categories of Automation

11.3.1. Based on the automation descriptions above, there is a crossover between Anker Andersen and Tomra equipment. However, there can be distinctions between the processes they implement from depot to depot. Automation will be compared to manual operation under these four categories:

11.3.1.1. **Count Only:** Material is fed into a machine to either count for the customer or count into a Megabag.

11.3.1.2. **Push Automation:** This method involves picking out non-automated material streams and then directly pushing the automated material streams into a singulator to be counted (both Anker Andersen and Tomra).

11.3.1.3. **Singulator Table**: Similar to Push, the worker manually counts the non-automated materials streams while the material sits on the Singulator Table. Once sorted, the table turns into a singulator and moves the material to the counter.

11.3.1.4. **Secondary Automation**: Most depots using Tomra or Anker Andersen machines have automation that either manually or automatically collects material streams, counts, and sorts the containers into Megabags. When this automation is combined with primary automation, there is no secondary labour.

11.4. Automation Analysis

11.4.1. In this study, the data weighted by Moments is most directly applicable to this analysis as automated depots are compared to manual depots of similar size and volume.

11.4.2. Only Aluminum data was used in this comparative analysis because it is the largest and most common material stream automated across the sampled depots.

11.4.3. The tables below utilize a crude “heat map” or color configuration below each table:

11.4.3.1. Blue indicates the ‘control’ values. Shades of blue with automated depots indicate they are similar to the control.

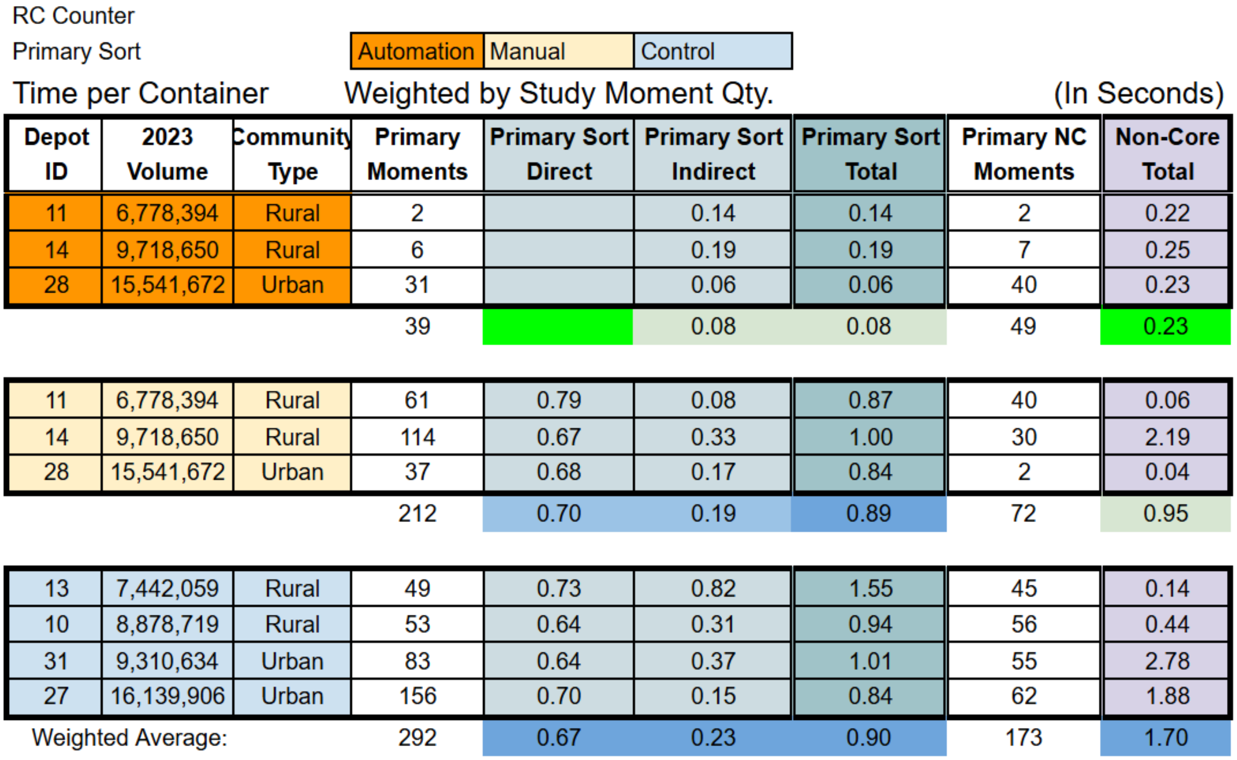
11.4.3.2. Bright Green indicates no or minimal labour through using automation. Other shades of green indicate lower times than the control.

11.4.3.3. Bright Red indicates much longer times than the control. Shades of red indicate moderate increases in time.

11.4.4. Though the control has no automation involved, automated depots also affect the manual labour around the automation. Therefore, manual data is also listed for the automated depots.

11.5. Automation Comparison Results

11.5.1. Primary Count Only:



RC Counter
Primary Sort

Automation | Manual | Control

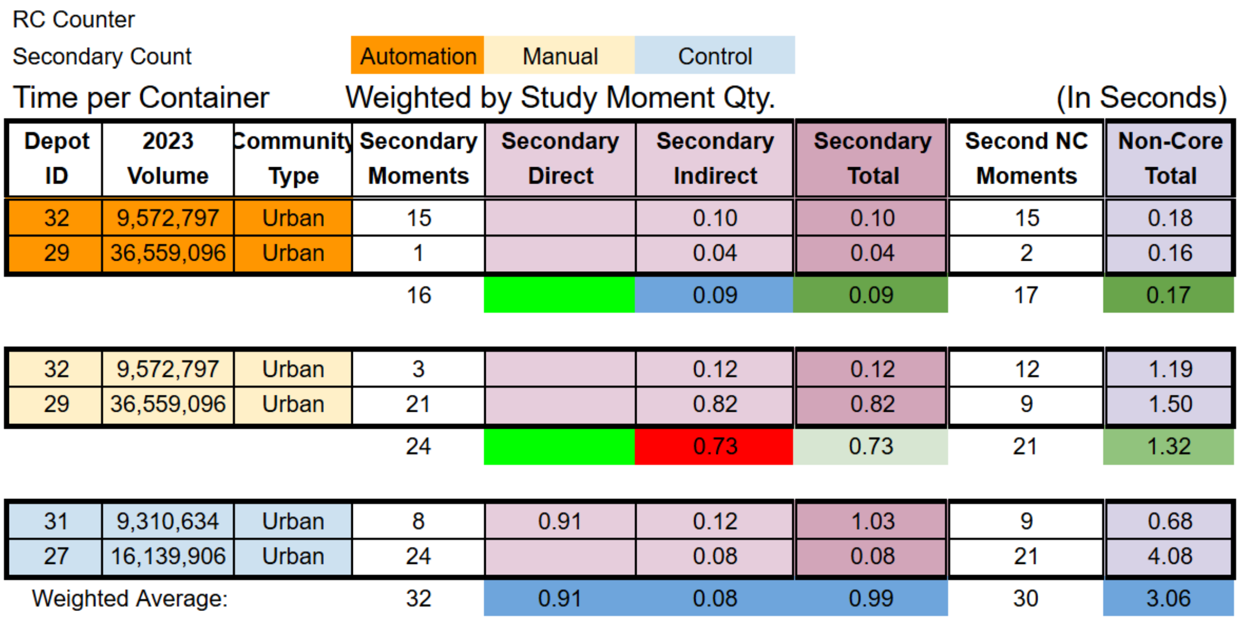
Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	2023 Volume	Community Type	Primary Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Primary NC Moments	Non-Core Total
11	6,778,394	Rural	2		0.14	0.14	2	0.22
14	9,718,650	Rural	6		0.19	0.19	7	0.25
28	15,541,672	Urban	31		0.06	0.06	40	0.23
			39		0.08	0.08	49	0.23
11	6,778,394	Rural	61	0.79	0.08	0.87	40	0.06
14	9,718,650	Rural	114	0.67	0.33	1.00	30	2.19
28	15,541,672	Urban	37	0.68	0.17	0.84	2	0.04
			212	0.70	0.19	0.89	72	0.95
13	7,442,059	Rural	49	0.73	0.82	1.55	45	0.14
10	8,878,719	Rural	53	0.64	0.31	0.94	56	0.44
31	9,310,634	Urban	83	0.64	0.37	1.01	55	2.78
27	16,139,906	Urban	156	0.70	0.15	0.84	62	1.88
Weighted Average:			292	0.67	0.23	0.90	173	1.70

Figure 22: Automation Comparison - Primary Count Only

11.5.1.1. Using primary counters eliminates the need for physical counting for the customer. The process adds indirect time and non-core times. However, the times are spread over more containers, so the Time per Container is the same or better over the control.

11.5.2. Secondary Count Only:



RC Counter

Secondary Count

Automation | Manual | Control

Time per Container — Weighted by Study Moment Qty. — (In Seconds)

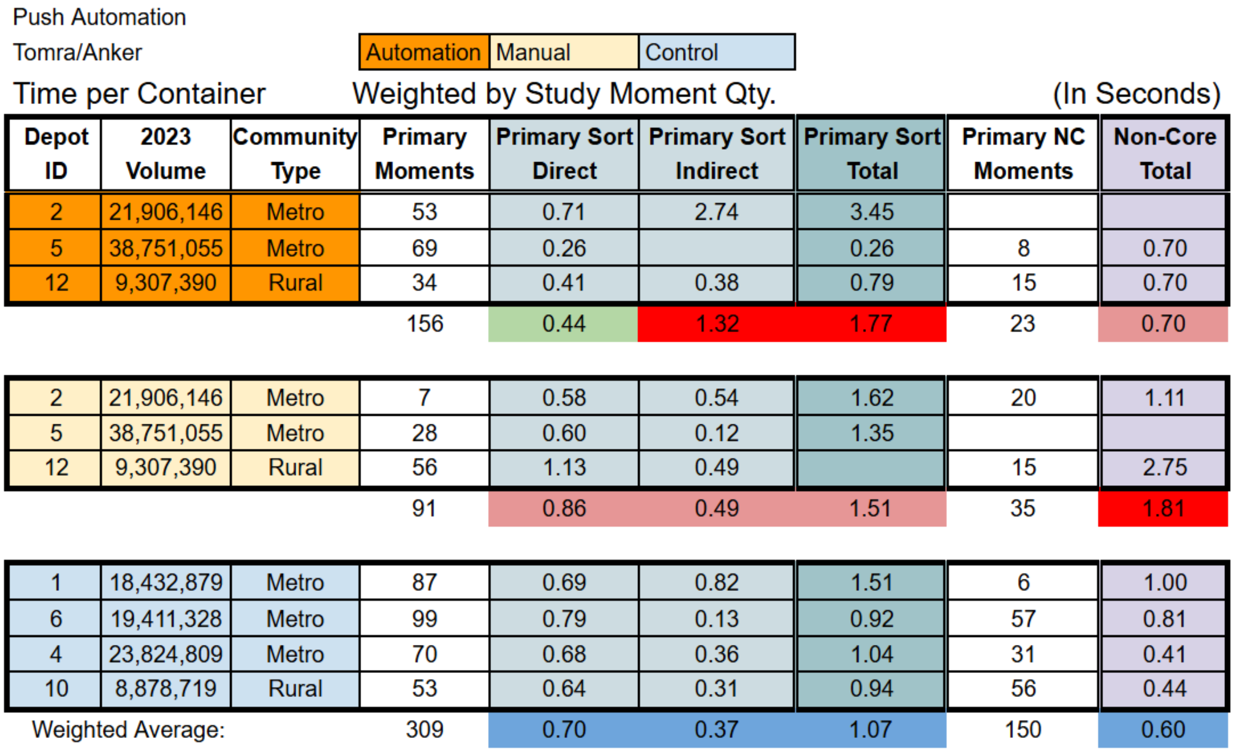
Depot ID	2023 Volume	Community Type	Secondary Moments	Secondary Direct	Secondary Indirect	Secondary Total	Second NC Moments	Non-Core Total
32	9,572,797	Urban	15		0.10	0.10	15	0.18
29	36,559,096	Urban	1		0.04	0.04	2	0.16
			16		0.09	0.09	17	0.17
32	9,572,797	Urban	3		0.12	0.12	12	1.19
29	36,559,096	Urban	21		0.82	0.82	9	1.50
			24		0.73	0.73	21	1.32
31	9,310,634	Urban	8	0.91	0.12	1.03	9	0.68
27	16,139,906	Urban	24		0.08	0.08	21	4.08
Weighted Average:			32	0.91	0.08	0.99	30	3.06

Figure 23: Automation Comparison - Secondary Only

11.5.2.1. Using counters for secondary operations eliminates physical counting. It also improves non-core time.

11.5.2.2. However, having secondary counters negatively affects Secondary Indirect time for non-automated material. This is possibly because Megabags for non-automated material are placed around the automation, creating longer travel distances and increasing walking time.

11.5.3. Push Automation



Push Automation
Tomra/Anker

Automation	Manual	Control

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	2023 Volume	Community Type	Primary Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Primary NC Moments	Non-Core Total
2	21,906,146	Metro	53	0.71	2.74	3.45		
5	38,751,055	Metro	69	0.26		0.26	8	0.70
12	9,307,390	Rural	34	0.41	0.38	0.79	15	0.70
			156	0.44	1.32	1.77	23	0.70
2	21,906,146	Metro	7	0.58	0.54	1.62	20	1.11
5	38,751,055	Metro	28	0.60	0.12	1.35		
12	9,307,390	Rural	56	1.13	0.49		15	2.75
			91	0.86	0.49	1.51	35	1.81
1	18,432,879	Metro	87	0.69	0.82	1.51	6	1.00
6	19,411,328	Metro	99	0.79	0.13	0.92	57	0.81
4	23,824,809	Metro	70	0.68	0.36	1.04	31	0.41
10	8,878,719	Rural	53	0.64	0.31	0.94	56	0.44
Weighted Average:			309	0.70	0.37	1.07	150	0.60

Figure 24: Automation Comparison - Push Automation

11.5.3.1. Push Automation enables workers to push a large amount of product through the system at one time; however, it does not eliminate the need for direct handling of the material.

11.5.3.2. Push Automation negatively impacts indirect and core times for both automated and manual material. This is most likely caused by how the workspace is set up for automation, not manual counting.

11.5.3.3. Workers tend to wait for the machine to complete its counting before obtaining a final count.

11.5.4. Singulator Table

Singulator Table
Anker Andersen

Automation | Manual | Control

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	2023 Volume	Community Type	Primary Moments	Primary Sort Direct	Primary Sort Indirect	Primary Sort Total	Primary NC Moments	Non-Core Total
3	19,190,483	Metro	24	1.71	0.61	2.33	13	0.81
			24	1.71	0.61	2.33	13	0.81
3	19,190,483	Metro	67	0.92	1.29	2.21	13	1.62
			67	0.92	1.29	2.21	13	1.62
1	18,432,879	Metro	87	0.69	0.82	1.51	6	1.00
6	19,411,328	Metro	99	0.79	0.13	0.92	57	0.81
4	23,824,809	Metro	70	0.68	0.36	1.04	31	0.41
Weighted Average:			256	0.72	0.38	1.10	94	0.69

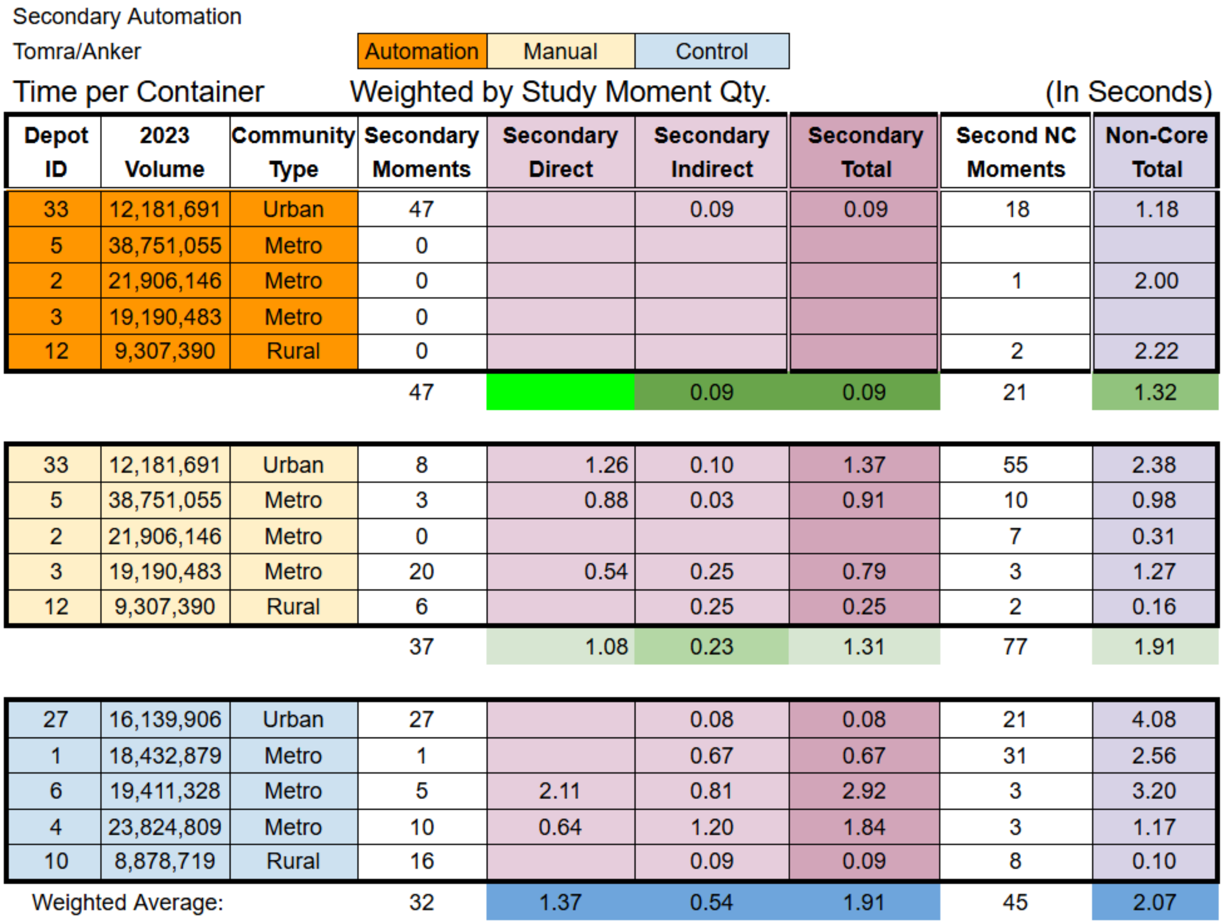
Figure 25: Automation Comparison - Singulator Table

11.5.4.1. The Singulator Table is fundamentally a manual workstation until it gets turned on. However, it doesn't eliminate the need for direct counting because the worker picks out automated material that is crushed or unreadable by the machine. Picking unreadable automated material is typically small, so it is not as fast as moving four containers simultaneously. Typically, the worker will enter the count immediately after finding the material, thus adding indirect time.

11.5.4.2. When the machine is turned on, there is essentially nothing for the worker to do, hence non-core time is added while the machine is running.

11.5.4.3. In a manual workstation, typically, the customer opens the bags of material onto the table. In this configuration, the worker must open the bags, adding indirect and non-core time.

11.5.5. Secondary Automation



Secondary Automation

Tomra/Anker

Automation	Manual	Control

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	2023 Volume	Community Type	Secondary Moments	Secondary Direct	Secondary Indirect	Secondary Total	Second NC Moments	Non-Core Total
33	12,181,691	Urban	47		0.09	0.09	18	1.18
5	38,751,055	Metro	0					
2	21,906,146	Metro	0				1	2.00
3	19,190,483	Metro	0					
12	9,307,390	Rural	0				2	2.22
			47		0.09	0.09	21	1.32
33	12,181,691	Urban	8	1.26	0.10	1.37	55	2.38
5	38,751,055	Metro	3	0.88	0.03	0.91	10	0.98
2	21,906,146	Metro	0				7	0.31
3	19,190,483	Metro	20	0.54	0.25	0.79	3	1.27
12	9,307,390	Rural	6		0.25	0.25	2	0.16
			37	1.08	0.23	1.31	77	1.91
27	16,139,906	Urban	27		0.08	0.08	21	4.08
1	18,432,879	Metro	1		0.67	0.67	31	2.56
6	19,411,328	Metro	5	2.11	0.81	2.92	3	3.20
4	23,824,809	Metro	10	0.64	1.20	1.84	3	1.17
10	8,878,719	Rural	16		0.09	0.09	8	0.10
Weighted Average:			32	1.37	0.54	1.91	45	2.07

Figure 26: Automation Comparison - Secondary Automation

11.5.5.1. Secondary Automation greatly improves Time per Container secondary time. It eliminates the need for direct counting, and only needing to attend to the Megabags when they start to get full. e.g. unclogging the sorter.

11.5.5.2. Non-automated handling is also improved. Possibly having a smaller number of material streams to manage.

11.5.5.3. Non-Core time is also improved for both automated and non-automated material streams.

11.5.6. Forklifts in Storage

Storage
Forklift — Forklift | Manual | Control

Time per Container Weighted by Study Moment Qty. (In Seconds)

Depot ID	2023 Volume	Community Type	Storage Moments	Storage Indirect	Storage NC Moments	Non-Core Total
8	9,982,382	Metro				
5	38,751,055	Metro				
9	10,519,189	Metro				
1	18,432,879	Metro	2	0.01	2	0.01
29	36,559,096	Urban	4	0.01		
12	9,307,390	Rural	1	0.04		
			7	0.02	2	0.01
8	9,982,382	Metro				
5	38,751,055	Metro	2	0.08		
9	10,519,189	Metro	1	0.05	1	0.01
1	18,432,879	Metro	2	0.10	1	0.01
29	36,559,096	Urban	3	0.15		
12	9,307,390	Rural	1	0.08		
			9	0.46	2	0.01
27	16,139,906	Urban	4	0.02	3	0.01
7	10,019,069	Metro	3	0.02	2	0.01
6	19,411,328	Metro	2	0.06		
4	23,824,809	Metro	1	0.05		
33	12,181,691	Urban				
10	8,878,719	Rural	2	0.03	2	0.01
Weighted Average:			12	0.03	7	0.01

Figure 27: Forklift Utilization in Storage

11.5.6.1. Some depots use forklifts to store Megabags for loading. There is no impact on Time per Container against the Control.

11.5.6.2. However, when people are on the ground interacting with the forklift, they are less productive.

11.5.7. Forklift vs Manual Loading

11.5.7.1. Generally, forklifts are not used if the depot ships less than three million containers per year.

11.5.7.1.1. One small depot uses a forklift because their storage is in a mezzanine.

11.5.7.2. Depots that load a van manually (with a pallet jack) spend **0.15** seconds per container.

11.5.7.3. Depots that load a van with a forklift spend **0.065** seconds per container.

11.5.8. Automation Summary

11.5.8.1. As mentioned approximately ⅓ of the depots studied have some degree of automation. However, automation has positive and negative effects on Time per Container and general depot efficiency.

11.5.8.2. Using automation to handle and count containers into Megabags is an overall benefit. Automated material streams are put on a conveyor, placed into a singluator and then counted and sorted into its respective Megabag. This generally eliminates the labour for carrying a bin with a known quantity to the Megabag and recording the quantity until the bag is full. Some non-core time is created when the Megabag is full, but for the quantity of containers they are managing the time per container impact is relatively small.

11.5.8.3. The challenge for depots and where waste or non-core time is introduced is in the integration of automation with Primary Sort activities. In some cases, automation was introduced, but the way containers are handled hasn't changed.

11.5.8.3.1. For instance, one depot will handle aluminum cans four at a time just as if they were counting into a garbage can, but not count them. After they finish counting the rest of the load from the customer, they will then take the garbage cans and wheel them into another room and dump them into the counter. Instead of doing core activities, the worker will stand on a ladder and assist the cans into chutes to ensure an accurate count. They will then read the count, and return to their work station in the first room and enter the quantity to pay the customer. Almost the entire time to relocate the cans to the back room was considered non-core time, and the time handling the cans into the garbage can was considered direct manual time. The worker may have avoided counting a large quantity of cans utilizing the counter, but their behavior never changed, and thus adding non-core time as opposed to counting the cans manually in the first place.

11.5.8.4. The automated primary workstations require manual sorting for non-automated material streams. However, manual stations were set up with convenient locations for material bins, where the automated stations contain machinery in those locations, so manual handling and counting is not as efficient. As a result, the Time per Container value goes up for manual handling in these cases, and productivity suffers.

11.5.8.5. Manual Time per Container increases for automated material streams because the worker will pick through the load for crushed or unreadable automated containers.

Therefore, not only does it take longer to sort, but those motions are divided by a smaller number compared to the manual handling of four containers at a time over a longer, more consistent period of time.

11.5.8.6. Automation creates wait time. Once all of the manual sorting and handling is done, the worker will push the button to count, wait for the machinery to do its work, and then turn off the automation to obtain the count and pay the customer. If there were a way that the worker could perform core work while the machine was working, there would be less wait time or non-core time while the machines are doing work for them.

11.5.8.7. With this in mind, both behavior and practice needs to change when integrating with Primary Sort activities to realize the benefits of automation.

12. Depot Area Evaluation

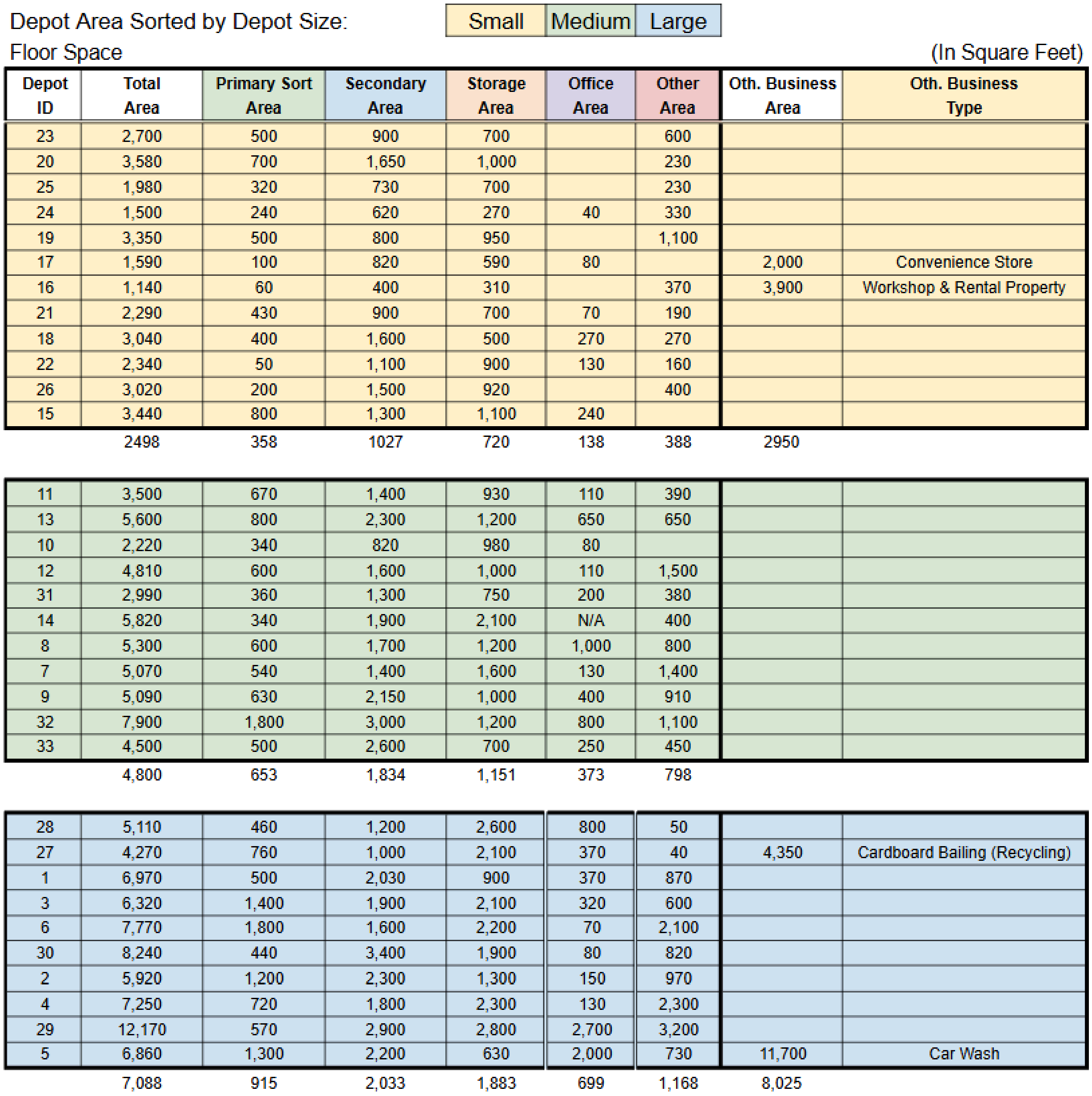
12.1. The depot team measured the area of each of the sampled depots to the nearest 10 square feet.

12.2. The area of each activity category was estimated when drawing the floor plan for each depot.

12.3. In addition, the team also measured any other business attached to the depot that generated a separate revenue stream for the depot owner.

12.4. Floor Plans of each of the depots will be provided to the client in a separate file.

12.5. The Depot Area broken down by activity category is illustrated in Figure 28 below.



Depot Area Sorted by Depot Size: Small | Medium | Large

Floor Space (In Square Feet)

Depot ID	Total Area	Primary Sort Area	Secondary Area	Storage Area	Office Area	Other Area	Oth. Business Area	Oth. Business Type
23	2,700	500	900	700		600		
20	3,580	700	1,650	1,000		230		
25	1,980	320	730	700		230		
24	1,500	240	620	270	40	330		
19	3,350	500	800	950		1,100		
17	1,590	100	820	590	80		2,000	Convenience Store
16	1,140	60	400	310		370	3,900	Workshop & Rental Property
21	2,290	430	900	700	70	190		
18	3,040	400	1,600	500	270	270		
22	2,340	50	1,100	900	130	160		
26	3,020	200	1,500	920		400		
15	3,440	800	1,300	1,100	240			
	2498	358	1027	720	138	388	2950	
11	3,500	670	1,400	930	110	390		
13	5,600	800	2,300	1,200	650	650		
10	2,220	340	820	980	80			
12	4,810	600	1,600	1,000	110	1,500		
31	2,990	360	1,300	750	200	380		
14	5,820	340	1,900	2,100	N/A	400		
8	5,300	600	1,700	1,200	1,000	800		
7	5,070	540	1,400	1,600	130	1,400		
9	5,090	630	2,150	1,000	400	910		
32	7,900	1,800	3,000	1,200	800	1,100		
33	4,500	500	2,600	700	250	450		
	4,800	653	1,834	1,151	373	798		
28	5,110	460	1,200	2,600	800	50		
27	4,270	760	1,000	2,100	370	40	4,350	Cardboard Bailing (Recycling)
1	6,970	500	2,030	900	370	870		
3	6,320	1,400	1,900	2,100	320	600		
6	7,770	1,800	1,600	2,200	70	2,100		
30	8,240	440	3,400	1,900	80	820		
2	5,920	1,200	2,300	1,300	150	970		
4	7,250	720	1,800	2,300	130	2,300		
29	12,170	570	2,900	2,800	2,700	3,200		
5	6,860	1,300	2,200	630	2,000	730	11,700	Car Wash
	7,088	915	2,033	1,883	699	1,168	8,025	

Figure 28: Depot Area by Depot Size

12.5.1. Depots handling larger amounts of containers require more square footage. Small Depots average **2,500** square feet as Large Depots utilize approximately **7,000** square feet on average.

12.5.2. Secondary Counting requires the most floor space, whereas Primary Sort uses the least space across depot sizes.

12.5.3. Two other businesses in each of the Small and Large categories typically have larger footprints than the depot itself.

12.5.4. Medium depots are typically stand alone businesses.

12.5.5. This data can be shown in a stacked bar chart (not including Other Businesses):

Size	Primary Sort Area	Secondary Sort Area	Storage Area	Office Area	Other Area
Small	358	1,027	720	138	388
Medium	653	1,834	1,151	373	798
Large	915	2,033	1,883	699	1,168

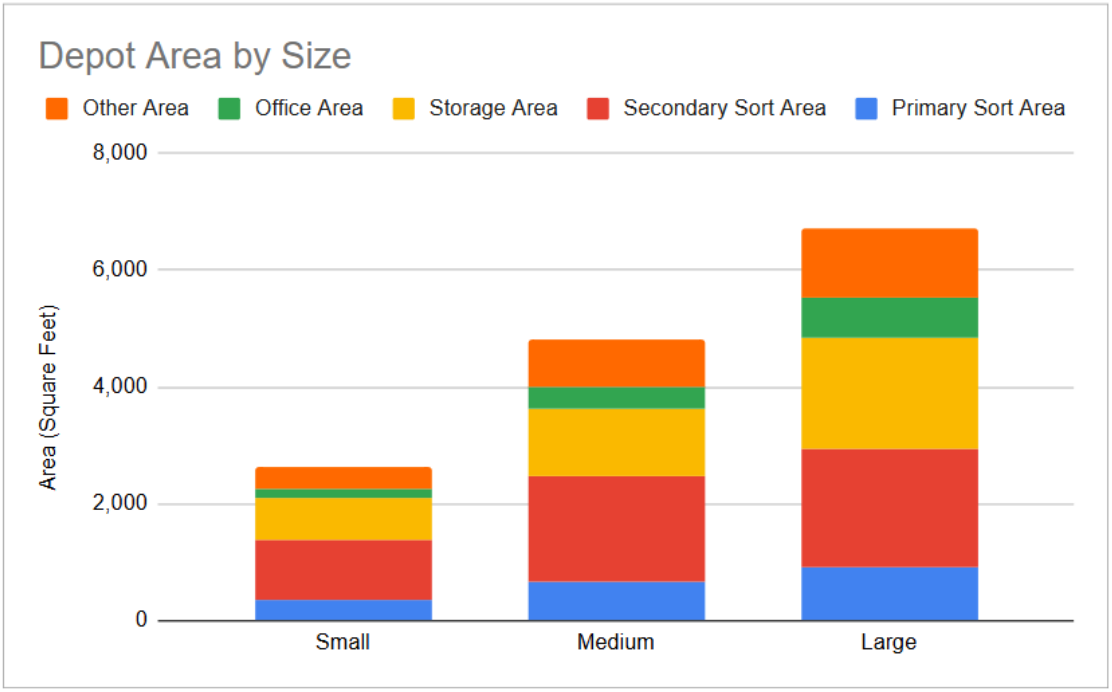


Figure 29: Depot Area by Size - Stacked Bar Chart

12.5.6. Space can be predicted based on Annual Volume using a trend line:

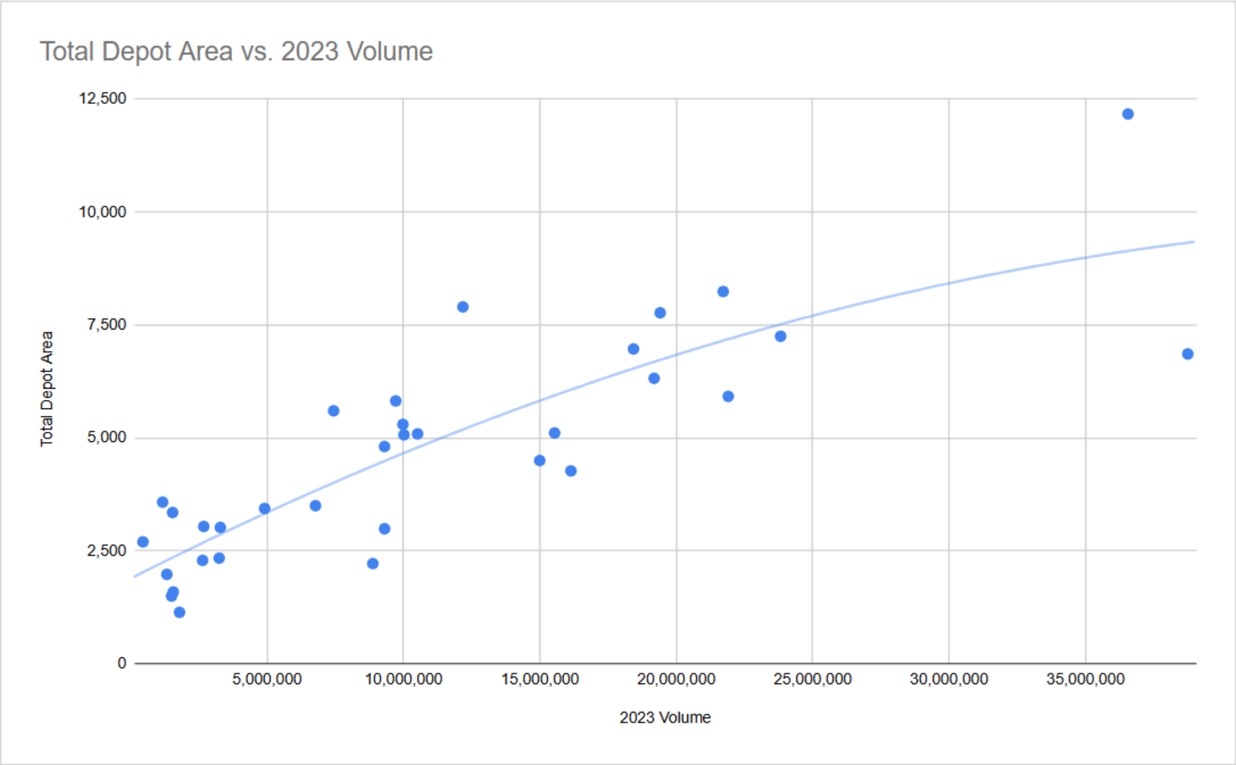
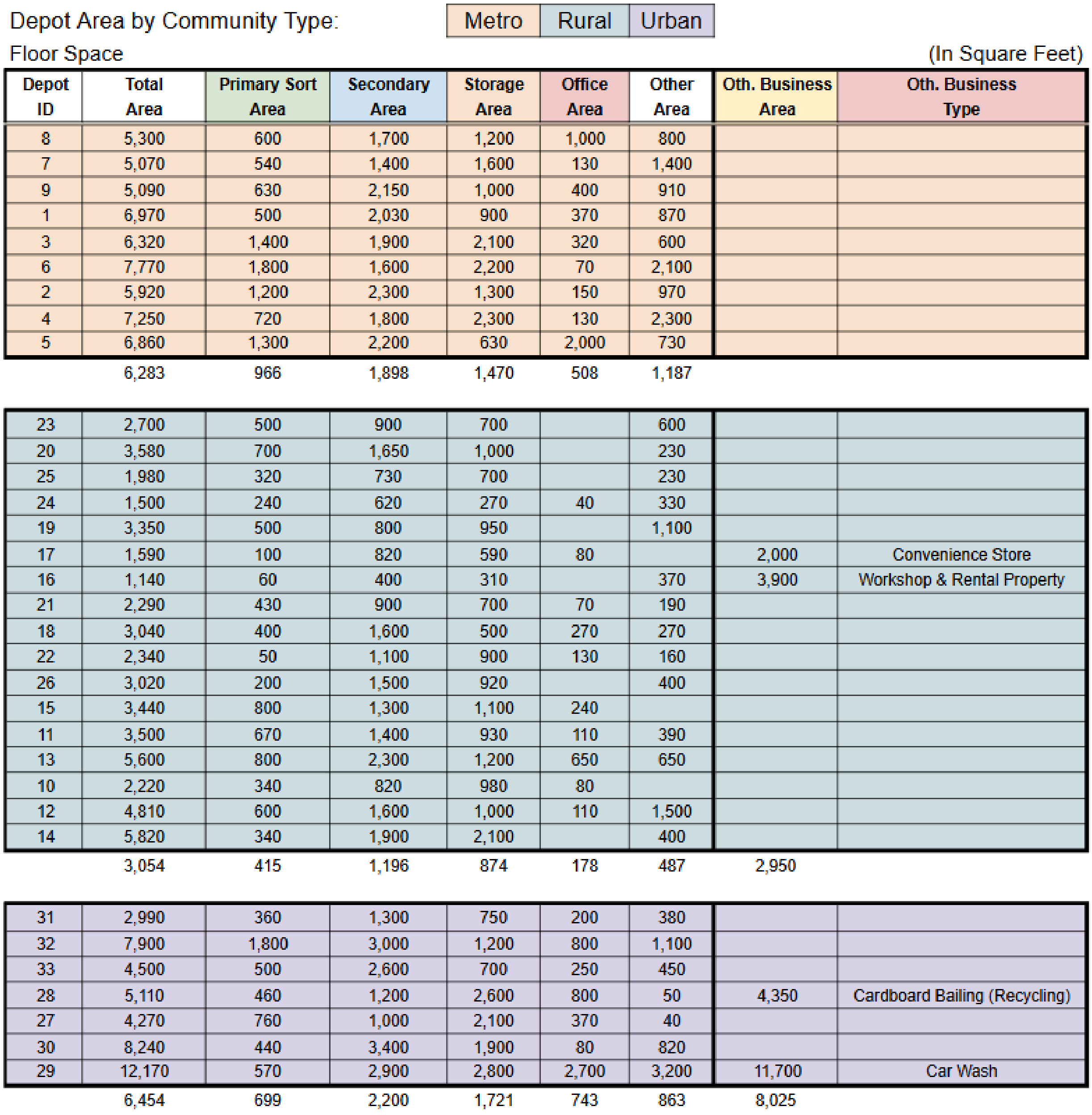


Figure 30: Total Depot Area by 2023 Volume

12.6. The same data can be arranged by Community Type:



Depot Area by Community Type: Metro | Rural | Urban

Floor Space (In Square Feet)

Depot ID	Total Area	Primary Sort Area	Secondary Area	Storage Area	Office Area	Other Area	Oth. Business Area	Oth. Business Type
8	5,300	600	1,700	1,200	1,000	800		
7	5,070	540	1,400	1,600	130	1,400		
9	5,090	630	2,150	1,000	400	910		
1	6,970	500	2,030	900	370	870		
3	6,320	1,400	1,900	2,100	320	600		
6	7,770	1,800	1,600	2,200	70	2,100		
2	5,920	1,200	2,300	1,300	150	970		
4	7,250	720	1,800	2,300	130	2,300		
5	6,860	1,300	2,200	630	2,000	730		
	6,283	966	1,898	1,470	508	1,187		
23	2,700	500	900	700		600		
20	3,580	700	1,650	1,000		230		
25	1,980	320	730	700		230		
24	1,500	240	620	270	40	330		
19	3,350	500	800	950		1,100		
17	1,590	100	820	590	80		2,000	Convenience Store
16	1,140	60	400	310		370	3,900	Workshop & Rental Property
21	2,290	430	900	700	70	190		
18	3,040	400	1,600	500	270	270		
22	2,340	50	1,100	900	130	160		
26	3,020	200	1,500	920		400		
15	3,440	800	1,300	1,100	240			
11	3,500	670	1,400	930	110	390		
13	5,600	800	2,300	1,200	650	650		
10	2,220	340	820	980	80			
12	4,810	600	1,600	1,000	110	1,500		
14	5,820	340	1,900	2,100		400		
	3,054	415	1,196	874	178	487	2,950	
31	2,990	360	1,300	750	200	380		
32	7,900	1,800	3,000	1,200	800	1,100		
33	4,500	500	2,600	700	250	450		
28	5,110	460	1,200	2,600	800	50	4,350	Cardboard Bailing (Recycling)
27	4,270	760	1,000	2,100	370	40		
30	8,240	440	3,400	1,900	80	820		
29	12,170	570	2,900	2,800	2,700	3,200	11,700	Car Wash
	6,454	699	2,200	1,721	743	863	8,025	

Figure 31: Depot Area by Community Type

12.6.1. Similar trends can be seen in Community Type and Depot Size, though Metro and urban depots have very similar space requirements.

12.6.2. Urban Depots have a wide range of work space from 2,990 to 12,170 square feet.

12.6.3. The four non-related businesses reside in Urban and Rural communities, not Metro.

12.6.4. Depot Area trends are illustrated within the following Stacked Bar Chart:

Community Type	Primary Sort Area	Secondary Sort Area	Storage Area	Office Area	Other Area
Rural	415	1,196	874	178	487
Metro	600	1,700	1,200	1,000	800
Urban	699	2,200	1,721	743	863

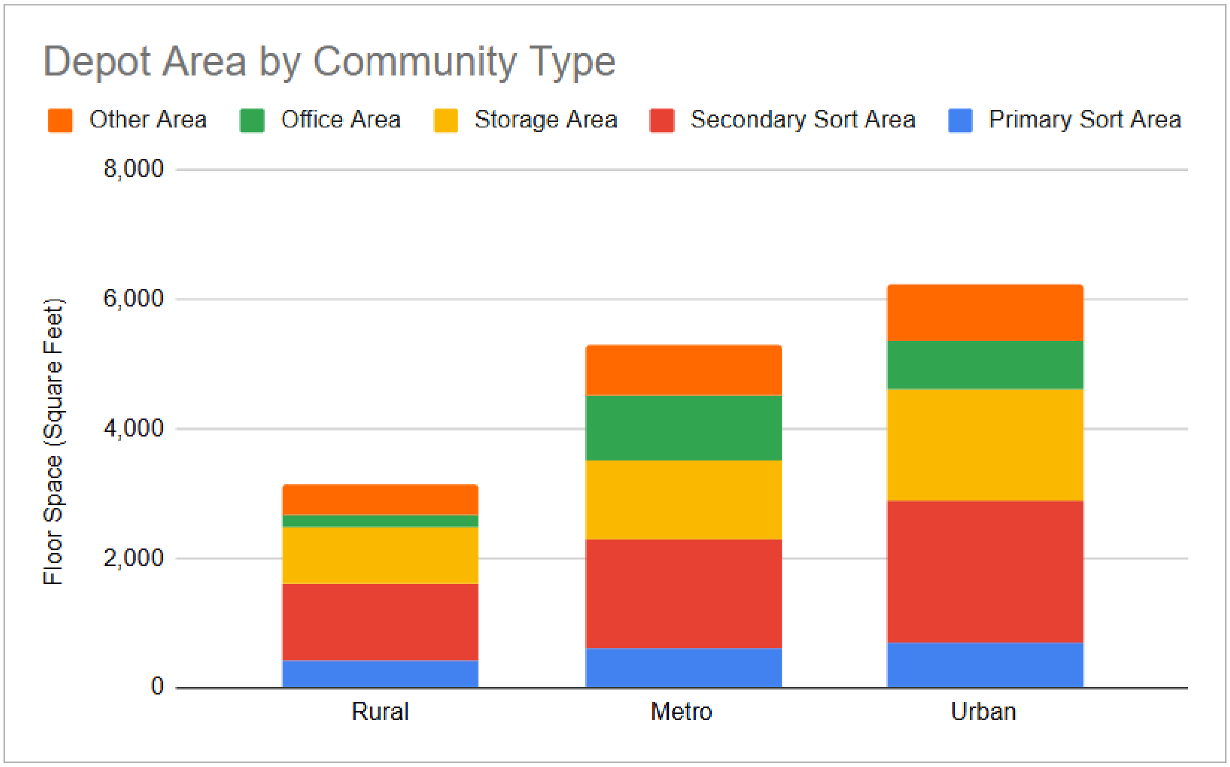


Figure 32: Depot Area by Community Type - Stacked Bar Chart

13. Validation

13.1. At several points, this report identifies the level of confidence in the data it represents.

13.2. During the proposal phase, RIVR Solutions identified an ideal sample size of **64** depots to establish a **90%** Confidence Level and **15%** Margin of Error.

13.2.1. Given the budget and timeline established, sixty-four (64) depots were not feasible. Therefore, a sample size of **33** depots was established, which adds 12 samples from the 2018 Study.

13.2.2. Based on the sample size of 33 depots, a proportionate number of depots were identified for each Depot Size and Community Type group. Those numbers were then adjusted so that each population group had a known confidence level of **90%** and a Margin of Error of **24%.**

13.3. Section 6 acknowledges that the Total Time per Container values are higher than those in the 2018 Study and illustrates that RIVR captured a larger proportion of labour observed at each depot.

13.3.1. The structure of the data collection methodology is inherently additive. Direct and Indirect handling are added together, and then each activity category is added, thus potentially inflating the final result.

13.3.2. This assumption was validated when only Direct handling in Primary Sort and Secondary Count activities was added to Storage and Loading activities, resulting in a Total Core Time of **2.14** seconds per container. The 2018 study's **2.16** Total Core Time supports this value. It is unclear why this is the case, but there were likely differences in data collection and coding that amplified the indirect time in this study.

13.4. Total Non-Core Time was also calculated at twice the value of the 2018 Study. There are a few points for justifying the resulting non-core values:

13.4.1. RIVR wanted to ensure that all data in this report was “actual rather than relying on artificial values. This means that each result can be justified by going back to the raw data to see the actual activity that led to the coding category and the number of containers assigned to that moment of recorded time. As seen in Section 7, “actual” Non-Core data can then be related to each activity category, and the observations can be justified within the intended activity.

13.4.2. The 2018 Study Non-Core Time was treated as a function of Core Time. The study attempted to determine how much Non-Core Time was spent in proportion to the amount of corresponding Core Time, which was found to be **35.2%** across material streams and depots. The RIVR study treated Non-Core time independently of Core time and could be evaluated by depot, as seen in Section 7. The total time results weighted by Moments removes the influence of Annual Volume but focuses on the same types of observations that the 2018 study would have identified. Using moment data, Non-Core Time was **38.9%** of Total Core Time, which is on track with the observed percentage of the 2018 Study. This generalization validates the Non-Core Time weighted by annual volume.

13.4.3. It is not clear from the 2018 Study how much labour was actually coded for each of the activities. Generally, in the 2024 study, coded moments were end-to-end within a work process, ensuring that walking back to the work station was part of the assigned labour record.

14. Recommendations

14.1. The purpose of this Time and Motion Study is to determine one Total Time per Container value; the **sample size** could be reduced by having one population group, for example, by sampling the highest volume depots. This study was designed to ensure statistical significance in six different sizes and community type population groups, resulting in a sample size of 64 depots. The sample size was reduced to 33 depots, resulting in a 90% Confidence Level and a 24% margin of error. If the entire population of 221 depots is applied as a single group, the sample size could be reduced to 27. Using a sample size of 27 would guarantee the statistical significance of the Total Time per Container value. Depot selection could still be distributed among the six population groups, although statistical significance cannot be guaranteed in any one individual group.

14.2. If the client decides to explore a sample size of 33 depots again, RIVR recommends adding a minimum of two months to the **study's timeline**. One additional month to provide more time for data collection and video coding. Another month to scrub the data of errors and compile data of 33 depots. To achieve this prescribed timeline, 33 depots were analyzed seven days per week for 8-12 hours per day from mid September to November 5th. The data was scrubbed for errors, corrected, and aggregated to present in this report on the same work schedule, and yet this report is 10 days late to the prescribed draft report due date of November 15th.

14.3. If the client accepts and appreciates this level of data analysis, RIVR recommends adding a **Mixed Material Stream** Core Time category, much like Non-Core Time. This code would capture the time buried in other core time codes for paying the customer and opening material bags for counting. The Mixed Stream Core Time would be added to the Total Core Time and Non-Core Time, thus adding time to the Total Time per Container number. This level of definition would maintain the integrity of other core time codes absent of mixed stream time.

14.4. This time and motion study was not intended to **measure efficiency** or reduce non-core time. However, the data collected provides clues to where money and/or time could be saved in any one depot. RIVR recommends that the BCMB, ABCRC, or ABDA perform additional studies to eliminate waste as an extension of this study.

14.5. RIVR Recommends using the right hand column in Figure 7 as the data to assess labour by material stream, thus **excluding Non-Core Time in the final assessment**. In the past, Non-Core Time has always been determined as a percentage or proportion of Core Time. However, it has never been actually determined by material stream. This study found that Non-Core Time could not be attached to any material stream because it was nearly impossible to attach Non-Core Time to any one material stream.

14.6. Figure 7 contains **Time per Container Weighted by Moments**. RIVR recommends using this table, as it better represents the cross section of depots studied than the 2023 Volume data as explained in Section 5.1 above.

15. Conclusion

RIVR achieved the goals of this time and motion study, concluding that based on ‘actual’ data, the Total Time per Container is 5.59 seconds, weighted by the number of Moments and excluding Non-Core Time. This number better represents the demographics of Alberta depots while providing proportionate actual handling time by material stream. Utilizing the methodology, RIVR broke the final number into Depot Size and Community Type categorization and revealed trends between those groups. Total Core Time and Total Non-Core Time are fundamentally the same regardless of Depot Size and volume. Revealing that non-core time cannot be tied to material stream, RIVR recommends excluding the Non-Core Time from the final number. Analyzing the depots with outlying data, as illustrated in figure 13, could drive improvement for those depots. RIVR also characterized and analyzed the effects of automation, finding that some primary automation adds time to the process while secondary automation is generally beneficial across the board.

We thank MNP and BCMB for the opportunity to perform this study. We have enjoyed working with your organization and hope you will consider RIVR Solutions for future projects.