Zero Waste Analysis Tool Manual

Diversion Potential and Greenhouse Gas Emissions Reduction Analysis Tool

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Tool Overview

The **Diversion Potential and Greenhouse Gas Emissions Reduction Analysis Tool** or **Analysis Tool** is a scenario planning exercise that estimates the tons of material diverted from destructive disposal[1] and the metric tons of carbon dioxide equivalent (MTCO2E) reduced annually when all Zero Waste initiatives are implemented. This tool is taught during the Advanced Zero Waste Planning Class.

The Analysis Tool is used once all the Zero Waste initiatives are chosen. It is the next to the last tool used during the community planning process (see the Zero Waste USA Tools Manual).[2] The results show the annual tons estimated diverted and the annual GHG emissions estimated to be reduced once all initiatives are implemented.

Tool Use Description

The Analysis Tool is a scenario planning tool that estimates tons and GHG emissions that can be reduced or diverted annually once all the Zero Waste initiatives are implemented in a municipality. In addition, this tool estimates the new total diversion for a community once all Zero Waste initiatives are implemented.

File

The Zero Waste Analysis Tool is created in an Excel file. Different from the other Zero Waste USA tools, this is not ready-made. Each analysis needs its own file and spreadsheet; therefore, it's unavailable as a plug-in-and-go tool.

Purpose

This tool analyzes each initiative to estimate the amount of materials that can be reduced or diverted from destructive disposal per initiative and in total annually. It also calculates the GHG emissions estimated to be reduced for each initiative and annually for all Zero Waste initiatives.

Goal

This Analysis Tool aims to show a municipality the total impact of Zero Waste initiatives in reaching their goal. The chosen initiatives should work together to help the city achieve Zero Waste (i.e., 90% or greater diversion of destructive disposal tons). The estimated tons diverted through the initiatives will be added to the total tons diverted in the baseline year to estimate the **new total annual diversion** for the analyzed municipality manual to read about the New Total Diversion Tool).[3]

User

Participants taking the Advanced Zero Waste Planning classes will learn how to use this tool. In addition, Zero Waste professionals, including consultants and municipal employees, can use this tool to analyze the Zero Waste policies, programs, or infrastructure desired or included in a Zero Waste plan to estimate the impact.

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[1] Destructive disposal means landfill or incineration.
[2] Zero Waste USA created a community planning toolkit and a Tools Manual. They are both found on Zero Waste USA's Resources page.
[3] Zero Waste USA's community planning toolkit guides the Zero Waste planning process. The tools mentioned here are Generation and Diversion Tool & Estimating New Total Diversion Tool. The Analysis Tool is used after the Generation and Diversion Tool and before the Estimating New Diversion Tool.

Tool Use – Step by Step

Data Needed

Data needed to perform the Zero Waste Analysis include (Table 1):

- The **total tons** going to destructive disposal and the type of destructive disposal used (landfill and/or incineration and the total going to each).
- The **tons of material going to destructive disposal by sector** (i.e., single-family, multifamily, non-residential – industrial, commercial, institutional, construction and demolition, and/or municipal operations).
- **Initiatives** to analyze the type of initiative (policy, program, or infrastructure) and the sector it applies to (single-family, multifamily, non-residential – industrial, commercial, institutional, construction and demolition, and/or mandal operations).
    - The initiatives being analyzed are based on the ones that have been decided on through a lengthy stakeholder process using the Zero Waste USA community planning toolkit.
- **Material Characterization Study** data by sector for the municipality being analyzed or similar city reduction
- **Material-Specific Emission Factors** based on the type of destructive disposal (landfill, incineration, or both) in the municipality being analyzed (U.S. EPA WARM Tool).

Table 1. *List of data needed for the Zero Waste Analysis Tool and the source for those data. Proxy data can be used if needed. Proxy data used should be noted on the spreadsheet.*

Data	Source	Proxy
Tons going to DD	City or County that you're working with	Proxy is not recommended
Tons going to DD by Sector	City or County that you're working with	If sector data are unavailable, the analysis can be completed community-wide instead of by sector.
Initiatives	Zero Waste Planning process	Proxy is not recommended
Material Characterization Study	City or County that you're working with	Proxy characterization data are ok
Factors	U.S. EPA WARM Tool	None

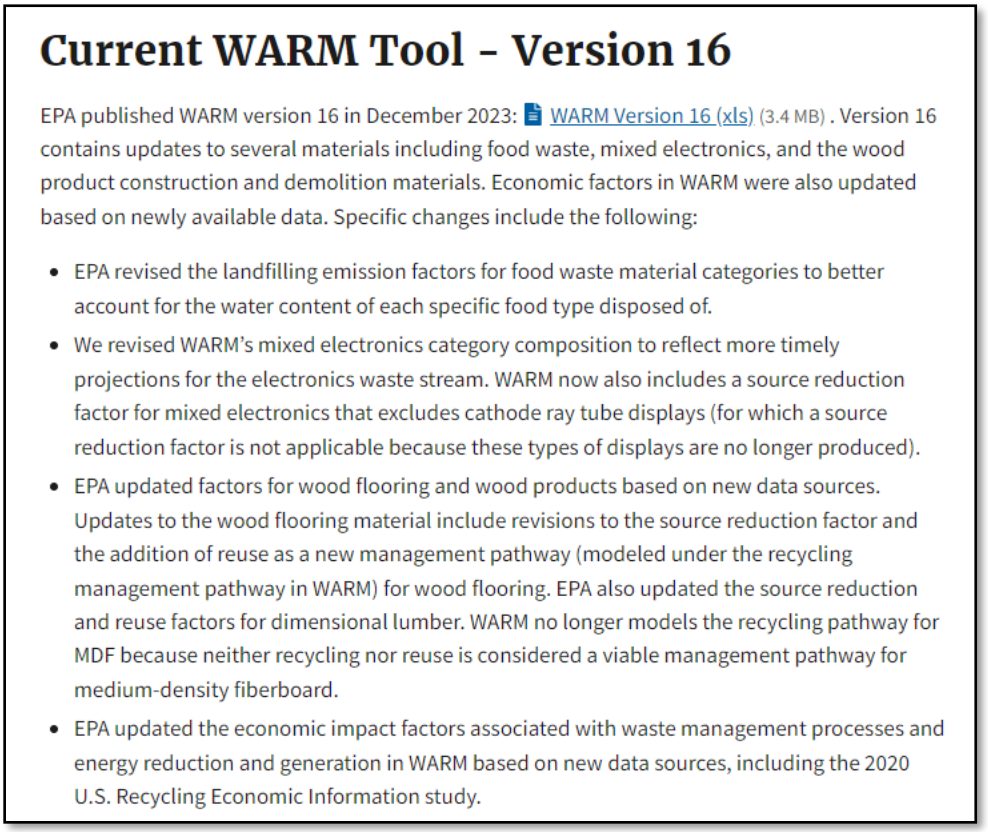
Generating Emissions and Material-Specific Emission Factors

The steps to generating factors used in the Zero Waste Analysis are:

1. Download the latest version of the WARM Tool (2022 – Version 16).[4]
2. Open the WARM Tool (Excel file) (Figure 1). Read the material related to the WARM Tool on the website and the instructions tab on the Excel file if you are unfamiliar with this tool.
3. In the WARM Tool on the second tab (**Analysis Input**), input data related to the municipality's baseline destructive disposal technique (landfill or incineration) is being analyzed. This is related to questions #3-#10. Note: There are more options if the baseline destructive disposal is landfilling, and the National Average or Default is always an option if specific details are unknown.

[4] US EPA Waste Reduction Model Tool Version 16

***Figure 1**. Image showing the US EPA WARM Tool Webpage. Click on Excel-Based Tool to download the tool.*



Current WARM Tool - Version 16

EPA published WARM version 16 in December 2023: WARM Version 16 (xls) (3.4 MB) . Version 16 contains updates to several materials including food waste, mixed electronics, and the wood product construction and demolition materials. Economic factors in WARM were also updated based on newly available data. Specific changes include the following:

- EPA revised the landfilling emission factors for food waste material categories to better account for the water content of each specific food type disposed of.
- We revised WARM's mixed electronics category composition to reflect more timely projections for the electronics waste stream. WARM now also includes a source reduction factor for mixed electronics that excludes cathode ray tube displays (for which a source reduction factor is not applicable because these types of displays are no longer produced).
- EPA updated factors for wood flooring and wood products based on new data sources. Updates to the wood flooring material include revisions to the source reduction factor and the addition of reuse as a new management pathway (modeled under the recycling management pathway in WARM) for wood flooring. EPA also updated the source reduction and reuse factors for dimensional lumber. WARM no longer models the recycling pathway for MDF because neither recycling nor reuse is considered a viable management pathway for medium-density fiberboard.
- EPA updated the economic impact factors associated with waste management processes and energy reduction and generation in WARM based on new data sources, including the 2020 U.S. Recycling Economic Information study.

4. In the WARM Tool, on the fourth tab (**Analysis Results MTCO2E**) is the list of emissions based on data inputs on the second tab. These are the emissions you will use to calculate material-specific emission factors.
5. Take the factors from tab four and create a tab in **your Zero Waste Analysis Tool Excel file** called **EPA Emission Factors**.
6. Calculate the factors for source reduction and recycling or composting (Figure 2).[5] For more detail, refer to the Zero Waste USA document called Emissions Factors, Generation and Calculations_July 2023.
7. Source Reduction Emissions Factor Formula for Glass (**Incineration**) = **(0.55)[6] MTCO2E per ton**
    a. (Source reduction emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Source Reduction Emissions Factor
    b. Example: (-0.53 MTCO2E * 1 / 1) – (0.02 MTCO2E * 1 / 1) = -0.55 MTCO2E
8. Recycling Emissions Factor Formula for Glass (**Incineration**) = **(0.30) MTCO2E per ton**
    a. (Recycling emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Recycling Emissions Factor
    b. Example: (-0.28 MTCO2E * 1 / 1) – (0.03 MTCO2E * 1 / 1) = -0.30 MTCO2E
9. Composting Emissions Factor Formula Food Waste (**Incineration**) = **0.0 MTCO2E**
    a. (Composting emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Composting Emissions Factor

[5] US EPA Waste Reduction Model
[6] GHG emissions produced are a positive number, and GHG emissions reduced or saved are negative or shown using parentheses ().

b. Example: (-0.12 MTCO2E * 1 / 1) – (-0.12 MTCO2E *1 / 1) = 0.0 MTCO2E

10. Color code the factors spreadsheet to differentiate the material types along the rows. Also, color code the two columns that contain the Factors for the Analysis (Columns H & I).
11. The information at the top of the spreadsheet should include the following.
    a. The parameters that were chosen to generate the factors.
    b. Link to the US EPA Warm Model.
    c. Definitions of what is on the table.
12. The information at the bottom of the spreadsheet should include the following.
    a. The calculations for the factors available for the analysis.
    b. Links to Documentation Chapters for Greenhouse Gas Emission, Energy, and Economic Factors Used in the Waste Reduction Model (WARM)
    c. Material-specific emissions factor calculation examples

***Figure 2**. EPA Emission Factors Spreadsheet for the Zero Waste Analysis Tool. Column H is the Source Reduction Factor used in the analysis and Column I is the Recycling or Composting Factor used.*

	A	B	C	D	E	F	G	H	I	J
1	**Emission Factors for Pennsylvania - Combustion - National Average - Columns H & I are used in the analysis**									
2	MTCO2E = Metric Tons of Carbon Dioxide Equivalent									
3	Note: Negative values denote net GHG emissions reduction or carbon storage from a materials management practice.									
4	Source: US EPA Waste Reduction Model - Version 16									
5	**Per Ton Estimates of GHG Emissions for Baseline and Alternative Management Scenarios**							Use In Analysis		
6	**Material**	**GHG Emissions per Ton of Material Produced (MTCO2E)**	**GHG Emissions per Ton of Material Source Reduced (MTCO2E)**	**GHG Emissions per Ton of Material Recycled (MTCO2E)**	**GHG Emissions per Ton of Material Landfilled (MTCO2E)**	**GHG Emissions per Ton of Material Combusted (MTCO2E)**	**GHG Emissions per Ton of Material Composted (MTCO2E)**	**Net MTCO2E reduced: Source Reduction/Reuse * instead of Combusted (MTCO2E)**	**Net MTCO2E reduced: Recycle or Compost instead of Combusted (MTCO2E)**	**GHG Emission per Ton of Material Anaerobically Digested (MTCO2E)**
7	Corrugated Containers	5.58	(5.58)	(3.14)	0.18	**(0.44)**	NA	**(5.13)**	**(2.69)**	NA
8	Magazines/third-class mail	8.57	(8.57)	(3.07)	(0.43)	**(0.32)**	NA	**(8.25)**	**(2.75)**	NA
9	Newspaper	4.68	(4.68)	(2.71)	(0.85)	**(0.50)**	NA	**(4.17)**	**(2.20)**	NA
10	Office Paper	7.95	(7.95)	(2.86)	1.13	**(0.42)**	NA	**(7.52)**	**(2.44)**	NA
11	Phonebooks	6.17	(6.17)	(2.62)	(0.85)	**(0.50)**	NA	**(5.66)**	**(2.12)**	NA
12	Textbooks	9.02	(9.02)	(3.10)	1.13	**(0.42)**	NA	**(8.60)**	**(2.68)**	NA
13	Mixed Paper (general)	6.07	(6.07)	(3.55)	0.07	**(0.44)**	NA	**(5.63)**	**(3.10)**	NA
14	Mixed Paper (primarily residential)	6.00	(6.00)	(3.55)	0.02	**(0.44)**	NA	**(5.56)**	**(3.10)**	NA
15	Mixed Paper (primarily from offices)	7.37	(7.37)	(3.58)	0.11	**(0.40)**	NA	**(6.96)**	**(3.18)**	NA
16	Food Waste	3.66	(3.66)	NA	0.50	**(0.12)**	(0.12)	**(3.54)**	**0.00**	(0.03)
17	Food Waste (non-meat)	0.76	(0.76)	NA	0.50	**(0.12)**	(0.12)	**(0.64)**	**0.00**	(0.03)
18	Food Waste (meat only)	15.10	(15.10)	NA	0.46	**(0.12)**	(0.12)	**(14.98)**	**0.00**	(0.03)
19	Beef	30.09	(30.09)	NA	0.43	**(0.12)**	(0.12)	**(29.97)**	**0.00**	(0.03)
20	Poultry	2.45	(2.45)	NA	0.49	**(0.12)**	(0.12)	**(2.33)**	**0.00**	(0.03)
21	Grains	0.62	(0.62)	NA	1.37	**(0.12)**	(0.12)	**(0.50)**	**0.00**	(0.03)
22	Bread	0.66	(0.66)	NA	0.99	**(0.12)**	(0.12)	**(0.54)**	**0.00**	(0.03)
23	Fruits and Vegetables	0.44	(0.44)	NA	0.23	**(0.12)**	(0.12)	**(0.32)**	**0.00**	(0.03)
24	Dairy Products	1.75	(1.75)	NA	0.48	**(0.12)**	(0.12)	**(1.63)**	**0.00**	(0.03)
25	Yard Trimmings	NA	NA	NA	(0.20)	**(0.15)**	(0.05)	**NA**	**0.09**	(0.09)
26	Grass	NA	NA	NA	0.12	**(0.15)**	(0.05)	**NA**	**0.09**	0.01
27	Leaves	NA	NA	NA	(0.53)	**(0.15)**	(0.05)	**NA**	**0.09**	(0.14)
28	Branches	NA	NA	NA	(0.54)	**(0.15)**	(0.05)	**NA**	**0.09**	(0.22)
29	HDPE	1.42	(1.42)	(0.76)	0.02	**1.42**	NA	**(2.84)**	**(2.18)**	NA
30	LDPE	1.80	(1.80)	NA	0.02	**1.43**	NA	**(3.22)**	**NA**	NA
31	PET	2.17	(2.17)	(1.04)	0.02	**1.31**	NA	**(3.49)**	**(2.35)**	NA
32	LLDPE	1.58	(1.58)	NA	0.02	**1.42**	NA	**(3.00)**	**NA**	NA
33	PP	1.52	(1.52)	(0.79)	0.02	**1.42**	NA	**(2.95)**	**(2.22)**	NA
34	PS	2.50	(2.50)	NA	0.02	**1.77**	NA	**(4.27)**	**NA**	NA
35	PVC	1.93	(1.93)	NA	0.02	**0.72**	NA	**(2.64)**	**NA**	NA
36	Mixed Plastics	1.87	(1.87)	(0.93)	0.02	**1.36**	NA	**(3.23)**	**(2.28)**	NA

Initiatives | EPA Emission Factors | PA DEP Composition Data | Spreadsheet | Analysis Residential | Analysis Commercial | Results

Choosing the Right Factors

Once all the factors are generated and the **EPA Emission Factors** spreadsheet is created in Excel, the appropriate factors will be chosen. During this process, match up factors with material types from the

material characterization study on the analysis spreadsheet. (See setting up the spreadsheet below). Not all factors will be used; some can be used as proxies for material types.[7]

Customizing

This analysis is customized by using local material characterization data for each sector and generating factors based on local data. It is also customized because the initiatives will be uniquely chosen through the stakeholder-driven Zero Waste planning process.

Setting up the Spreadsheet for the Analysis

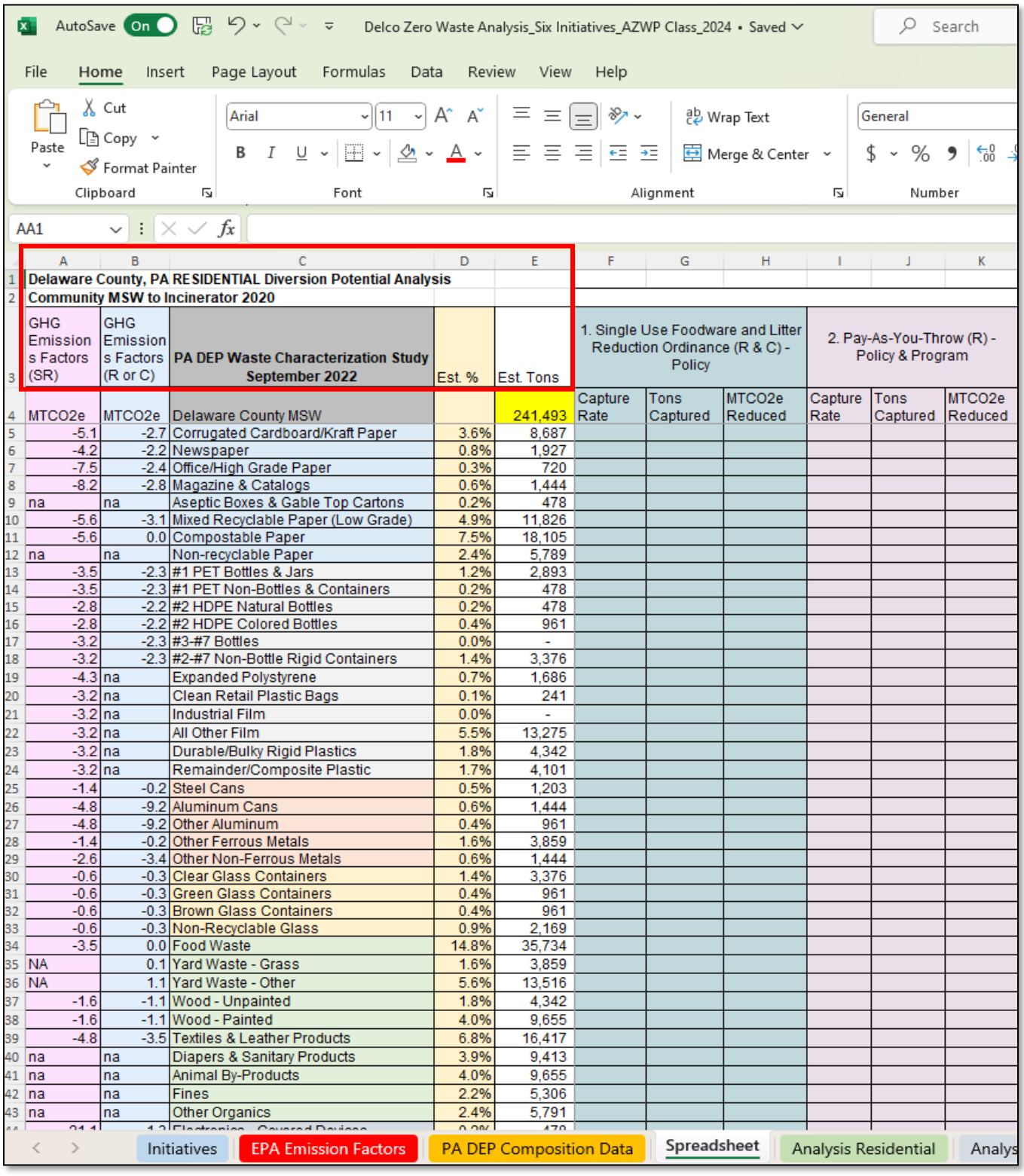
A new Excel file will be created each time a Zero Waste Analysis is performed. The file will minimally contain the following tabs: an Initiatives tab, an EPA Emission Factors tab, an analysis tab for each sector (e.g., Residents, Commercial) tab, and a Results tab. The Excel file may also contain a tab showing the blank spreadsheet and a tab showing the characterization data.

Setting up the analysis spreadsheet is an important step that takes time. The best way to begin is by looking at an example spreadsheet. For students, that can be the example file provided by your instructor. For a professional, it can be by looking at a past analysis or contacting the Zero Waste USA instructor for guidance.

The analysis spreadsheet generally included the source reduction and recycling/composting factors in the first two columns. The following two columns have the material characterization data. Cell F3 contains the number of tons going to destructive disposal from the analyzed sector (e.g., residential tons going to DD in Delaware County, PA is 241,493). Column F (Figure 3) applies the characterization data by material type to the tons going to DD. For example, according to the PA Waste Characterization Study, 3.6% of residential materials going to the landfill in the southeast of Pennsylvania is *Corrugated Cardboard/Kraft Paper*, which equates to 8,687 tons. The following two columns have the destructive disposal data related to the characterization data by material type (Figure 3). To calculate the number of tons represented in the DD stream by material type, multiply the percentage by the total tons. For example, the formula for calculating the tons of material of *Other Plastic* in the residential stream is =E4*D5, which is 3.6% * 241,493 tons = 8,687 tons.

[7] Using WARM Emission Factors for Materials and Pathways Not in WARM

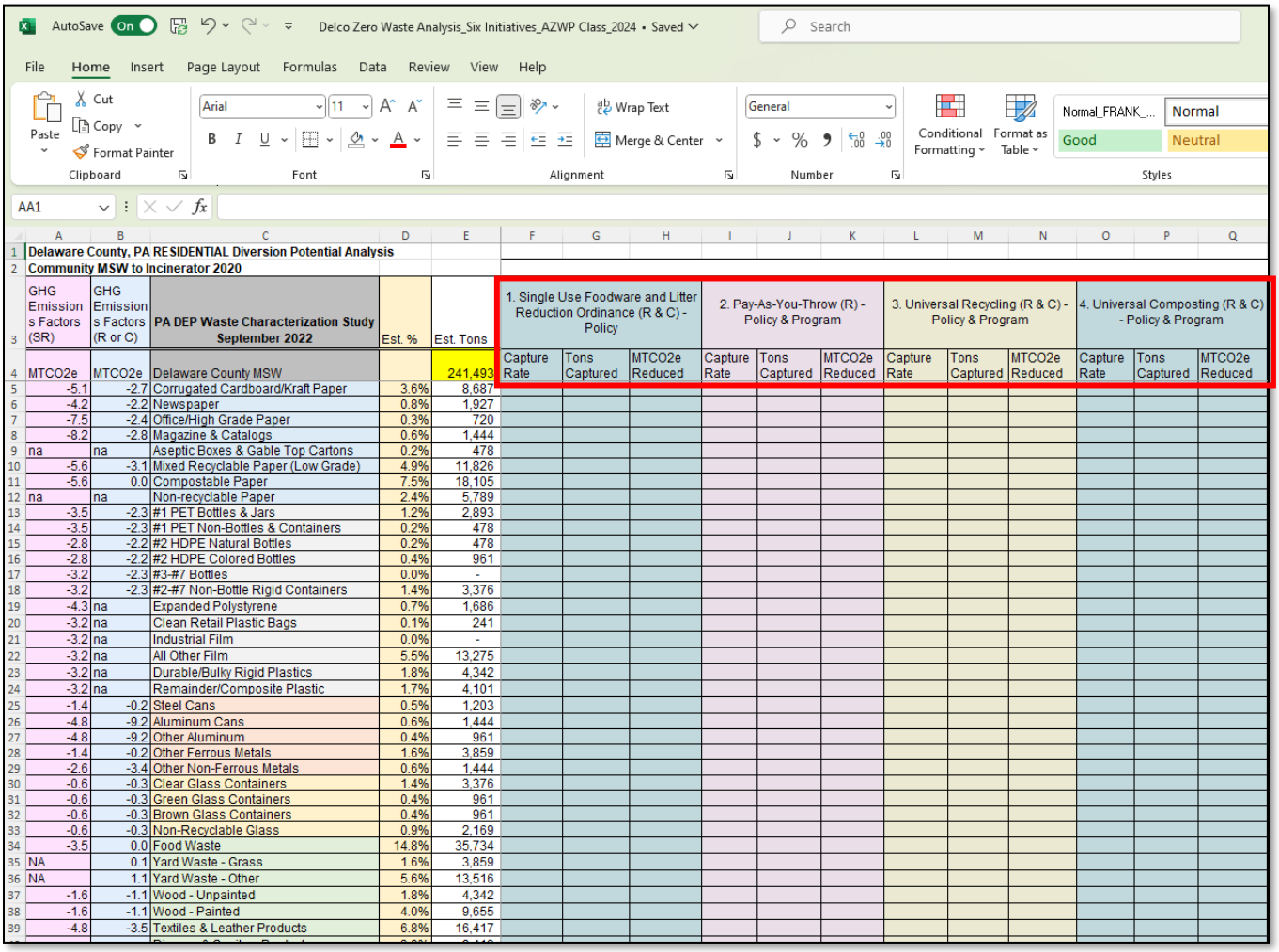
***Figure 3**. Zero Waste Analysis shows the factor and material columns with characterization data. Column A contains the Source Reduction Factors, and Column B contains the Recycling or Composting Factors. Column C includes materials from the Material Characterization Study, and Column D has the associated percentage of material in the destructive disposal stream. Finally, Column E shows the number of tons by material type going to destructive disposal for the sector (residents) being analyzed.*



	A	B	C	D	E	F	G	H	I	J	K
1	**Delaware County, PA RESIDENTIAL Diversion Potential Analysis**										
2	**Community MSW to Incinerator 2020**										
3	GHG Emissions Factors (SR)	GHG Emissions Factors (R or C)	**PA DEP Waste Characterization Study September 2022**	Est. %	Est. Tons	1. Single Use Foodware and Litter Reduction Ordinance (R & C) - Policy			2. Pay-As-You-Throw (R) - Policy & Program		
4	MTCO2e	MTCO2e	Delaware County MSW		241,493	Capture Rate	Tons Captured	MTCO2e Reduced	Capture Rate	Tons Captured	MTCO2e Reduced
5	-5.1	-2.7	Corrugated Cardboard/Kraft Paper	3.6%	8,687						
6	-4.2	-2.2	Newspaper	0.8%	1,927						
7	-7.5	-2.4	Office/High Grade Paper	0.3%	720						
8	-8.2	-2.8	Magazine & Catalogs	0.6%	1,444						
9	na	na	Aseptic Boxes & Gable Top Cartons	0.2%	478						
10	-5.6	-3.1	Mixed Recyclable Paper (Low Grade)	4.9%	11,826						
11	-5.6	0.0	Compostable Paper	7.5%	18,105						
12	na	na	Non-recyclable Paper	2.4%	5,789						
13	-3.5	-2.3	#1 PET Bottles & Jars	1.2%	2,893						
14	-3.5	-2.3	#1 PET Non-Bottles & Containers	0.2%	478						
15	-2.8	-2.2	#2 HDPE Natural Bottles	0.2%	478						
16	-2.8	-2.2	#2 HDPE Colored Bottles	0.4%	961						
17	-3.2	-2.3	#3-#7 Bottles	0.0%	-						
18	-3.2	-2.3	#2-#7 Non-Bottle Rigid Containers	1.4%	3,376						
19	-4.3	na	Expanded Polystyrene	0.7%	1,686						
20	-3.2	na	Clean Retail Plastic Bags	0.1%	241						
21	-3.2	na	Industrial Film	0.0%	-						
22	-3.2	na	All Other Film	5.5%	13,275						
23	-3.2	na	Durable/Bulky Rigid Plastics	1.8%	4,342						
24	-3.2	na	Remainder/Composite Plastic	1.7%	4,101						
25	-1.4	-0.2	Steel Cans	0.5%	1,203						
26	-4.8	-9.2	Aluminum Cans	0.6%	1,444						
27	-4.8	-9.2	Other Aluminum	0.4%	961						
28	-1.4	-0.2	Other Ferrous Metals	1.6%	3,859						
29	-2.6	-3.4	Other Non-Ferrous Metals	0.6%	1,444						
30	-0.6	-0.3	Clear Glass Containers	1.4%	3,376						
31	-0.6	-0.3	Green Glass Containers	0.4%	961						
32	-0.6	-0.3	Brown Glass Containers	0.4%	961						
33	-0.6	-0.3	Non-Recyclable Glass	0.9%	2,169						
34	-3.5	0.0	Food Waste	14.8%	35,734						
35	NA	0.1	Yard Waste - Grass	1.6%	3,859						
36	NA	1.1	Yard Waste - Other	5.6%	13,516						
37	-1.6	-1.1	Wood - Unpainted	1.8%	4,342						
38	-1.6	-1.1	Wood - Painted	4.0%	9,655						
39	-4.8	-3.5	Textiles & Leather Products	6.8%	16,417						
40	na	na	Diapers & Sanitary Products	3.9%	9,413						
41	na	na	Animal By-Products	4.0%	9,655						
42	na	na	Fines	2.2%	5,306						
43	na	na	Other Organics	2.4%	5,791						

The Analysis Spreadsheet also contains the Initiatives that correlate to the analyzed sector. The initiatives are listed in row 3 (Figure 4). Within each initiative are three columns: capture rate, tons diverted, and MTCO2E (metric tons carbon dioxide equivalent) reduced (Figure 4). Additional information can be placed in the cell with the initiative name, such as the sector or type of initiative (policy, program, or infrastructure).

***Figure 4**. The initiatives (policy, program, or infrastructure recommendations to get to Zero Waste) are in Row 3. For each initiative, three types of data are calculated, including Capture Rate, Tons Captured, and MTCO2E Reduced. Use a series of at least three colors to differentiate among the initiatives. This helps to keep the spreadsheet readable and organized.*



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	**Delaware County, PA RESIDENTIAL Diversion Potential Analysis**																
2	**Community MSW to Incinerator 2020**																
3	GHG Emissions Factors (SR)	GHG Emissions Factors (R or C)	**PA DEP Waste Characterization Study September 2022**	Est. %	Est. Tons	1. Single Use Foodware and Litter Reduction Ordinance (R & C) - Policy			2. Pay-As-You-Throw (R) - Policy & Program			3. Universal Recycling (R & C) - Policy & Program			4. Universal Composting (R & C) - Policy & Program		
4	MTCO2e	MTCO2e	Delaware County MSW		241,493	Capture Rate	Tons Captured	MTCO2e Reduced	Capture Rate	Tons Captured	MTCO2e Reduced	Capture Rate	Tons Captured	MTCO2e Reduced	Capture Rate	Tons Captured	MTCO2e Reduced
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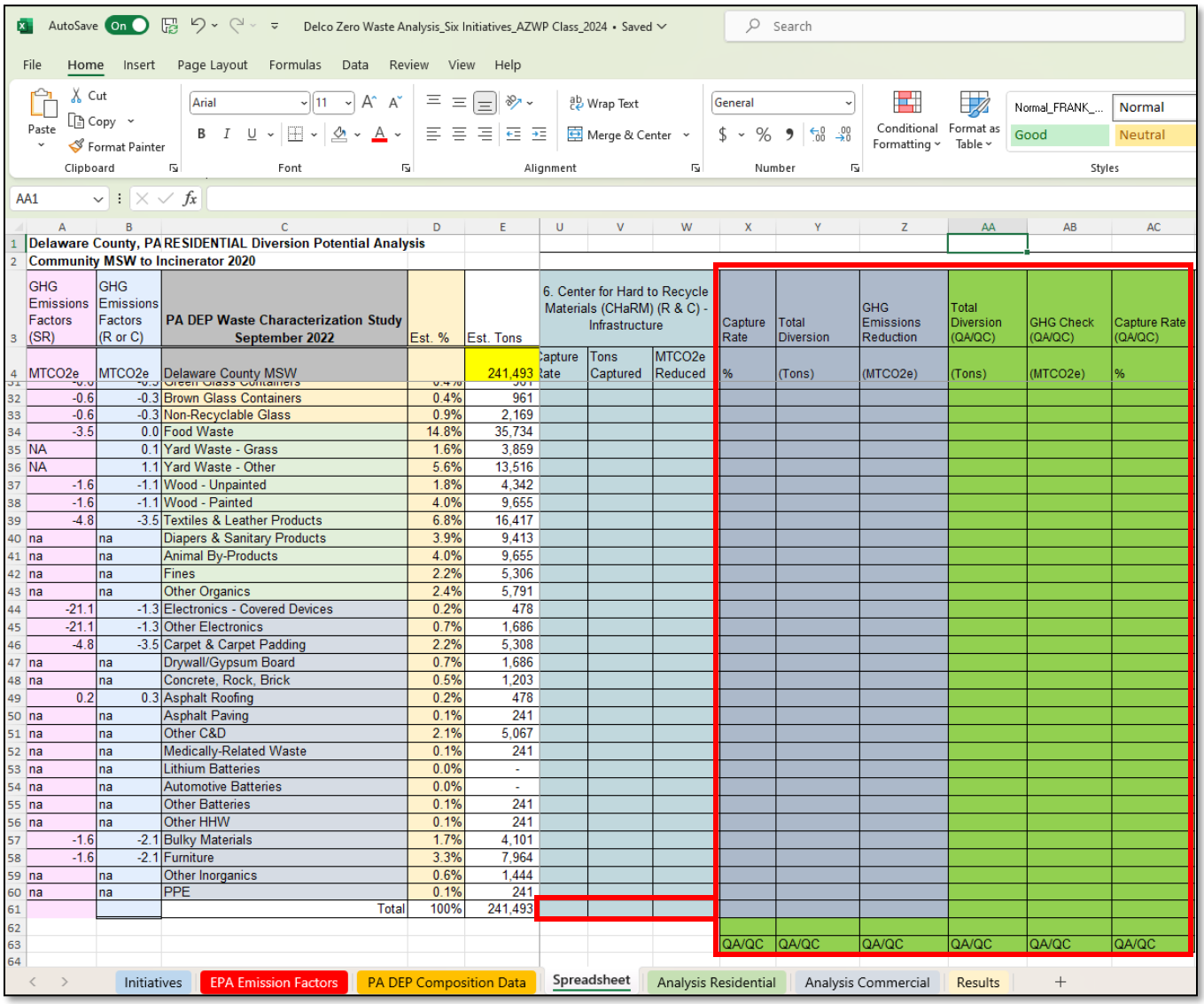
38	-1.6	-1.1	Wood - Painted	4.0%	9,655												
39	-4.8	-3.5	Textiles & Leather Products	6.8%	16,417												

The last columns in the spreadsheet include the total for the capture rate, tons diverted, and MTCO2E reduced by material type along the rows. It also included the total capture rate, tons diverted, and MTCO2E for the analyzed sector (e.g., Residents). Finally, Quality Assurance/Quality Control (QA/QC) columns and cells are created to double-check all calculations (Figure 5).[8]

[8] QA/QC

***Figure 5**. Zero Waste Analysis showing the totals. Columns X, Y, and Z show the totals by material type. Row 61 shows the totals for each Analysis (Initiative #6 is shown). Columns AA, AB, AC, and Cell X62, Y62, and Z62 show QA/QC for this analysis.*



Delaware County, PA RESIDENTIAL Diversion Potential Analysis
Community MSW to Incinerator 2020

GHG Emissions Factors (SR)	GHG Emissions Factors (R or C)	PA DEP Waste Characterization Study September 2022	Est. %	Est. Tons	6. Center for Hard to Recycle Materials (CHaRM) (R & C) - Infrastructure			Capture Rate	Total Diversion	GHG Emissions Reduction	Total Diversion (QA/QC)	GHG Check (QA/QC)	Capture Rate (QA/QC)
MTCO2e	MTCO2e	Delaware County MSW		241,493	Capture Rate	Tons Captured	MTCO2e Reduced	%	(Tons)	(MTCO2e)	(Tons)	(MTCO2e)	%
-0.6	-0.3	Brown Glass Containers	0.4%	961									
-0.6	-0.3	Non-Recyclable Glass	0.9%	2,169									
-3.5	0.0	Food Waste	14.8%	35,734									
NA	0.1	Yard Waste - Grass	1.6%	3,859									
NA	1.1	Yard Waste - Other	5.6%	13,516									
-1.6	-1.1	Wood - Unpainted	1.8%	4,342									
-1.6	-1.1	Wood - Painted	4.0%	9,655									
-4.8	-3.5	Textiles & Leather Products	6.8%	16,417									
na	na	Diapers & Sanitary Products	3.9%	9,413									
na	na	Animal By-Products	4.0%	9,655									
na	na	Fines	2.2%	5,306									
na	na	Other Organics	2.4%	5,791									
-21.1	-1.3	Electronics - Covered Devices	0.2%	478									
-21.1	-1.3	Other Electronics	0.7%	1,686									
-4.8	-3.5	Carpet & Carpet Padding	2.2%	5,308									
na	na	Drywall/Gypsum Board	0.7%	1,686									
na	na	Concrete, Rock, Brick	0.5%	1,203									
0.2	0.3	Asphalt Roofing	0.2%	478									
na	na	Asphalt Paving	0.1%	241									
na	na	Other C&D	2.1%	5,067									
na	na	Medically-Related Waste	0.1%	241									
na	na	Lithium Batteries	0.0%	-									
na	na	Automotive Batteries	0.0%	-									
na	na	Other Batteries	0.1%	241									
na	na	Other HHW	0.1%	241									
-1.6	-2.1	Bulky Materials	1.7%	4,101									
-1.6	-2.1	Furniture	3.3%	7,964									
na	na	Other Inorganics	0.6%	1,444									
na	na	PPE	0.1%	241									
		Total	100%	241,493									
								QA/QC	QA/QC	QA/QC	QA/QC	QA/QC	QA/QC

Sources and Assumptions

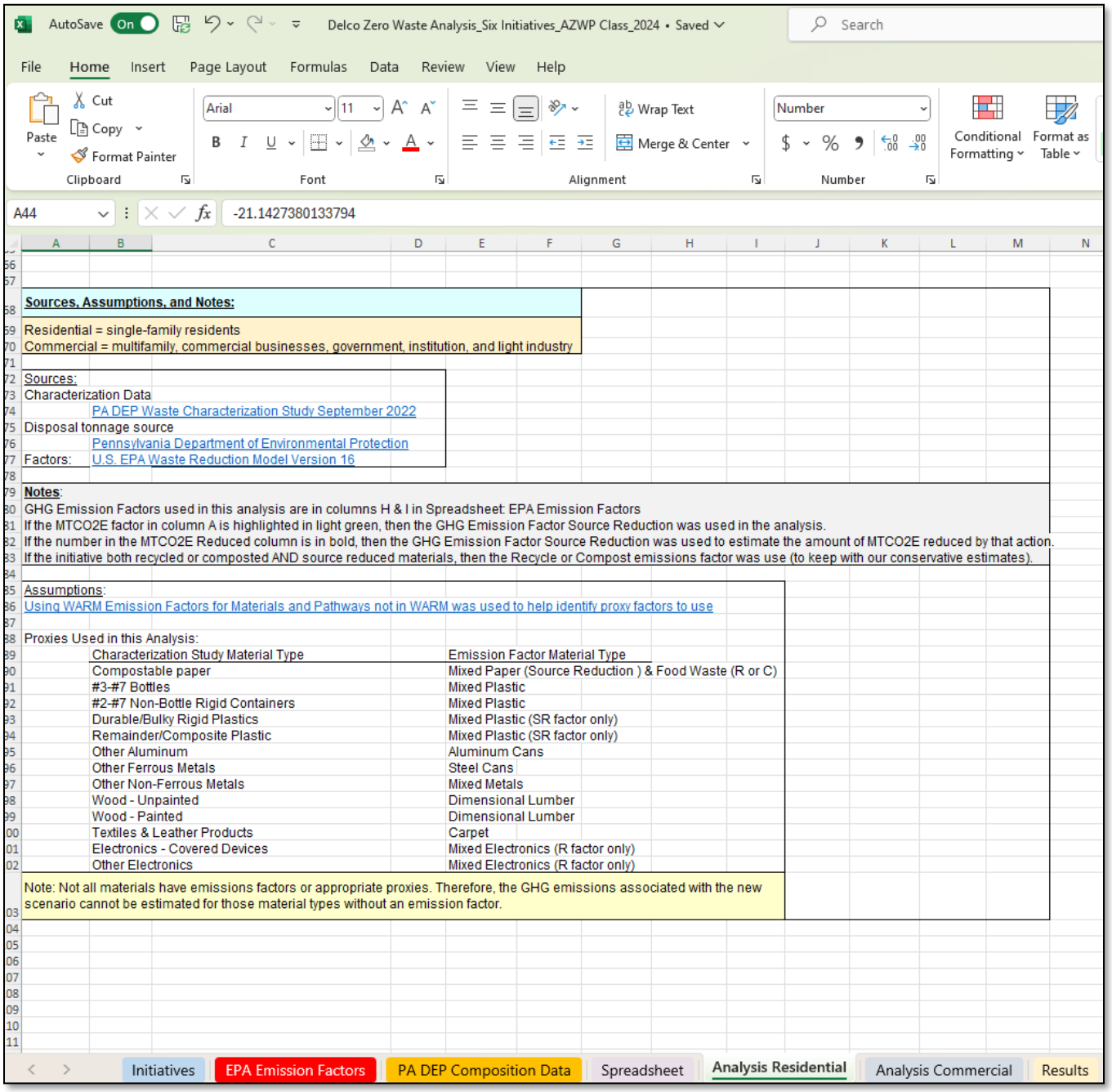
Additional information should be included in the calculation spreadsheet at the top of the sheet and below the calculations (Figure 6). The top should include the municipality name and baseline year (2020). Below the calculations, add information about the data sources, assumptions, and any notes related to the analysis.

Include the sources for the following data:

- Destructive disposal tons
- Material characterization data
- Factors

For assumptions, identify if any proxy factors were used and state the material typically associated with a proxy. Also, identify if a proxy material characterization study was used.[9] [10]

***Figure 6**. The sources, assumptions, and notes section. This goes below the calculations on each spreadsheet containing the Zero Waste Analysis calculations.*



[9] Modeling Reuse in EPA's Waste Reduction Model
[10] Using WARM Emission Factors for Materials and Pathways Not in WARM

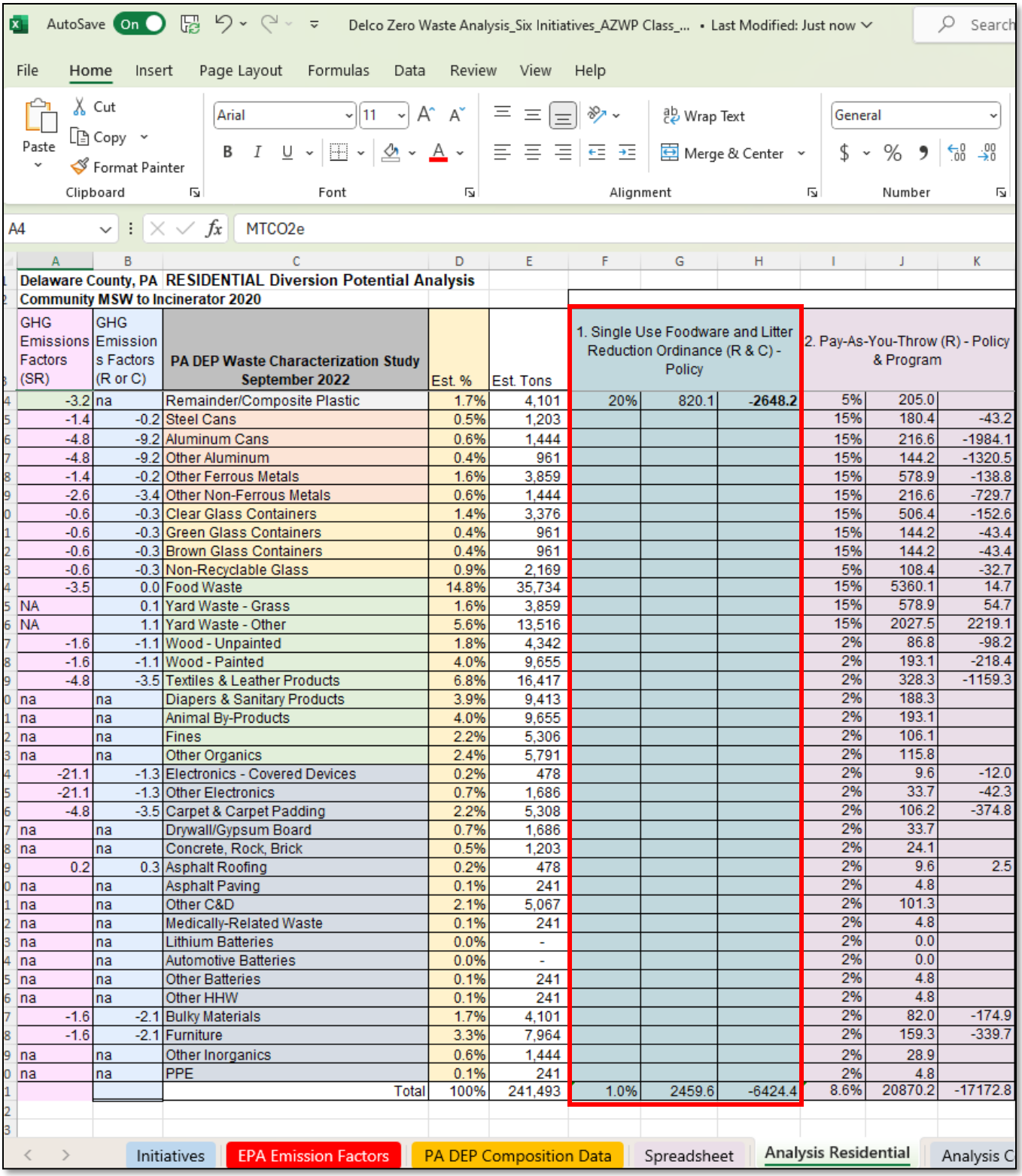
Calculations

Once the spreadsheet is set up, the calculations can begin. The first calculation performed is estimating the capture rates. Capture rates (percentage) are calculated for **each material** that could be reduced or diverted through the initiative. The material types that receive a capture rate estimate can differ for each initiative and depend on the initiative. For example, a Wasted Food Prevention Program initiative will target the material type of food scraps. A Mandatory Recycling/Source Separation Policy will target traditional curbside recyclables (e.g., plastic bottles, metal cans, and paper). Not all material types will receive a capture rate; the material types that receive a capture rate will vary based on the initiative (Figure 7).

Capture rates are estimates (percentage) for the **material** that can be reduced or diverted from destructive disposal. The capture rate estimations are based on knowledge from other community implementations or best estimates based on reports and first-hand knowledge.

After the capture rate is estimated, multiply the percentage by the number of tons (column E) for each material type that contains a capture rate for the initiative. Next, multiply the estimated tons reduced or diverted by the appropriate factor (source reduction factor or recycling/composting factor) (Figure 7). The initiative determines the factor used. For example, a single-use plastic bag ban will use the source reduction factor. A Mandatory Recycling/Source Separation Policy would use the recycling or composting factor.

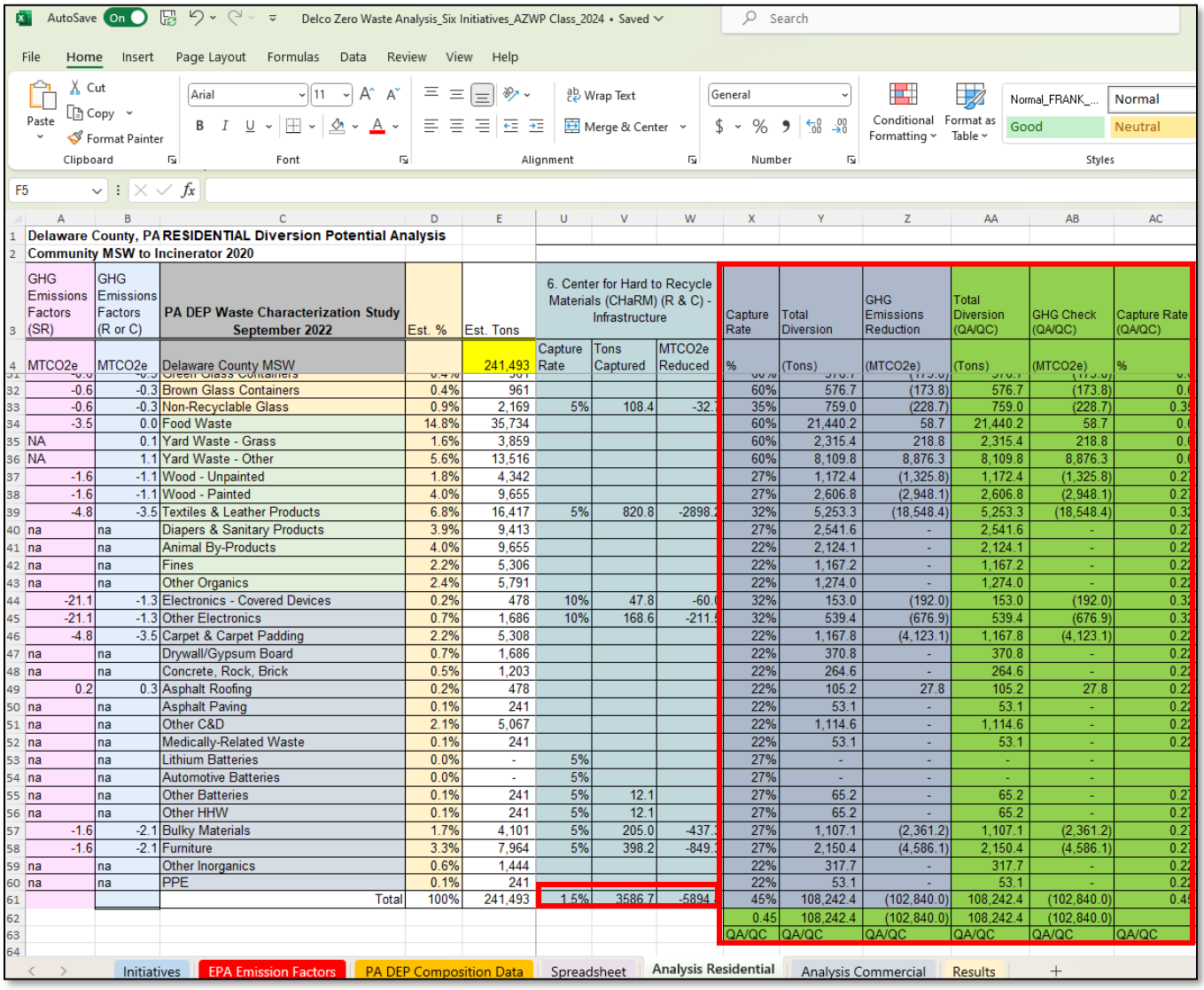
***Figure 7**. Calculate the capture rate, tons captured, and MTCO2E reduced for each material type associated with the initiative. Then, add up the totals in columns Q and R. For example, the capture rate for this sector initiative is in Cell P45.*



	A	B	C	D	E	F	G	H	I	J	K
1	**Delaware County, PA**		**RESIDENTIAL Diversion Potential Analysis**								
2	**Community MSW to Incinerator 2020**										
3	GHG Emissions Factors (SR)	GHG Emissions Factors (R or C)	**PA DEP Waste Characterization Study September 2022**	Est. %	Est. Tons	1. Single Use Foodware and Litter Reduction Ordinance (R & C) - Policy			2. Pay-As-You-Throw (R) - Policy & Program		
4	-3.2	na	Remainder/Composite Plastic	1.7%	4,101	20%	820.1	**-2648.2**	5%	205.0	
5	-1.4	-0.2	Steel Cans	0.5%	1,203				15%	180.4	-43.2
6	-4.8	-9.2	Aluminum Cans	0.6%	1,444				15%	216.6	-1984.1
7	-4.8	-9.2	Other Aluminum	0.4%	961				15%	144.2	-1320.5
8	-1.4	-0.2	Other Ferrous Metals	1.6%	3,859				15%	578.9	-138.8
9	-2.6	-3.4	Other Non-Ferrous Metals	0.6%	1,444				15%	216.6	-729.7
10	-0.6	-0.3	Clear Glass Containers	1.4%	3,376				15%	506.4	-152.6
11	-0.6	-0.3	Green Glass Containers	0.4%	961				15%	144.2	-43.4
12	-0.6	-0.3	Brown Glass Containers	0.4%	961				15%	144.2	-43.4
13	-0.6	-0.3	Non-Recyclable Glass	0.9%	2,169				5%	108.4	-32.7
14	-3.5	0.0	Food Waste	14.8%	35,734				15%	5360.1	14.7
15	NA	0.1	Yard Waste - Grass	1.6%	3,859				15%	578.9	54.7
16	NA	1.1	Yard Waste - Other	5.6%	13,516				15%	2027.5	2219.1
17	-1.6	-1.1	Wood - Unpainted	1.8%	4,342				2%	86.8	-98.2
18	-1.6	-1.1	Wood - Painted	4.0%	9,655				2%	193.1	-218.4
19	-4.8	-3.5	Textiles & Leather Products	6.8%	16,417				2%	328.3	-1159.3
20	na	na	Diapers & Sanitary Products	3.9%	9,413				2%	188.3	
21	na	na	Animal By-Products	4.0%	9,655				2%	193.1	
22	na	na	Fines	2.2%	5,306				2%	106.1	
23	na	na	Other Organics	2.4%	5,791				2%	115.8	
24	-21.1	-1.3	Electronics - Covered Devices	0.2%	478				2%	9.6	-12.0
25	-21.1	-1.3	Other Electronics	0.7%	1,686				2%	33.7	-42.3
26	-4.8	-3.5	Carpet & Carpet Padding	2.2%	5,308				2%	106.2	-374.8
27	na	na	Drywall/Gypsum Board	0.7%	1,686				2%	33.7	
28	na	na	Concrete, Rock, Brick	0.5%	1,203				2%	24.1	
29	0.2	0.3	Asphalt Roofing	0.2%	478				2%	9.6	2.5
30	na	na	Asphalt Paving	0.1%	241				2%	4.8	
31	na	na	Other C&D	2.1%	5,067				2%	101.3	
32	na	na	Medically-Related Waste	0.1%	241				2%	4.8	
33	na	na	Lithium Batteries	0.0%	-				2%	0.0	
34	na	na	Automotive Batteries	0.0%	-				2%	0.0	
35	na	na	Other Batteries	0.1%	241				2%	4.8	
36	na	na	Other HHW	0.1%	241				2%	4.8	
37	-1.6	-2.1	Bulky Materials	1.7%	4,101				2%	82.0	-174.9
38	-1.6	-2.1	Furniture	3.3%	7,964				2%	159.3	-339.7
39	na	na	Other Inorganics	0.6%	1,444				2%	28.9	
40	na	na	PPE	0.1%	241				2%	4.8	
41			Total	100%	241,493	1.0%	2459.6	-6424.4	8.6%	20870.2	-17172.8
42											
43											

Once all the calculations for each material type for an initiative are complete, add up the total tons diverted at the bottom and the total MTCO2E reduced at the bottom. Then, calculate the estimated capture rate for the initiative by dividing the total tons estimated to be reduced or diverted by the total tons going to destructive disposal (column E – bottom cell) (Figure 8).

***Figure 8**. Add the total tons captured (column V) and total MTCO2E reduced (column W) for each initiative. Then, divide the total tons for the initiative by the tons going to destructive disposal (for Initiative 6, 3,586 tons / 241,493 tons = 1.5%) to estimate the capture rate for that initiative. Repeat these steps for each initiative analyzed. Figure 8 also shows the totals for each material type (capture rate, tons diverted, and MTCO2E) and QA/QC calculations.*



	A	B	C	D	E	U	V	W	X	Y	Z	AA	AB	AC
1	Delaware County, PA RESIDENTIAL Diversion Potential Analysis													
2	Community MSW to Incinerator 2020													
3	GHG Emissions Factors (SR)	GHG Emissions Factors (R or C)	PA DEP Waste Characterization Study September 2022	Est. %	Est. Tons	6. Center for Hard to Recycle Materials (CHaRM) (R & C) - Infrastructure			Capture Rate	Total Diversion	GHG Emissions Reduction	Total Diversion (QA/QC)	GHG Check (QA/QC)	Capture Rate (QA/QC)
4	MTCO2e	MTCO2e	Delaware County MSW		241,493	Capture Rate	Tons Captured	MTCO2e Reduced	%	(Tons)	(MTCO2e)	(Tons)	(MTCO2e)	%
32	-0.6	-0.3	Brown Glass Containers	0.4%	961				60%	576.7	(173.8)	576.7	(173.8)	0.6
33	-0.6	-0.3	Non-Recyclable Glass	0.9%	2,169	5%	108.4	-32.7	35%	759.0	(228.7)	759.0	(228.7)	0.35
34	-3.5	0.0	Food Waste	14.8%	35,734				60%	21,440.2	58.7	21,440.2	58.7	0.6
35	NA	0.1	Yard Waste - Grass	1.6%	3,859				60%	2,315.4	218.8	2,315.4	218.8	0.6
36	NA	1.1	Yard Waste - Other	5.6%	13,516				60%	8,109.8	8,876.3	8,109.8	8,876.3	0.6
37	-1.6	-1.1	Wood - Unpainted	1.8%	4,342				27%	1,172.4	(1,325.8)	1,172.4	(1,325.8)	0.27
38	-1.6	-1.1	Wood - Painted	4.0%	9,655				27%	2,606.8	(2,948.1)	2,606.8	(2,948.1)	0.27
39	-4.8	-3.5	Textiles & Leather Products	6.8%	16,417	5%	820.8	-2898.2	32%	5,253.3	(18,548.4)	5,253.3	(18,548.4)	0.32
40	na	na	Diapers & Sanitary Products	3.9%	9,413				27%	2,541.6	-	2,541.6	-	0.27
41	na	na	Animal By-Products	4.0%	9,655				22%	2,124.1	-	2,124.1	-	0.22
42	na	na	Fines	2.2%	5,306				22%	1,167.2	-	1,167.2	-	0.22
43	na	na	Other Organics	2.4%	5,791				22%	1,274.0	-	1,274.0	-	0.22
44	-21.1	-1.3	Electronics - Covered Devices	0.2%	478	10%	47.8	-60.0	32%	153.0	(192.0)	153.0	(192.0)	0.32
45	-21.1	-1.3	Other Electronics	0.7%	1,686	10%	168.6	-211.5	32%	539.4	(676.9)	539.4	(676.9)	0.32
46	-4.8	-3.5	Carpet & Carpet Padding	2.2%	5,308				22%	1,167.8	(4,123.1)	1,167.8	(4,123.1)	0.22
47	na	na	Drywall/Gypsum Board	0.7%	1,686				22%	370.8	-	370.8	-	0.22
48	na	na	Concrete, Rock, Brick	0.5%	1,203				22%	264.6	-	264.6	-	0.22
49	0.2	0.3	Asphalt Roofing	0.2%	478				22%	105.2	27.8	105.2	27.8	0.22
50	na	na	Asphalt Paving	0.1%	241				22%	53.1	-	53.1	-	0.22
51	na	na	Other C&D	2.1%	5,067				22%	1,114.6	-	1,114.6	-	0.22
52	na	na	Medically-Related Waste	0.1%	241				22%	53.1	-	53.1	-	0.22
53	na	na	Lithium Batteries	0.0%	-	5%			27%	-	-	-	-	
54	na	na	Automotive Batteries	0.0%	-	5%			27%	-	-	-	-	
55	na	na	Other Batteries	0.1%	241	5%	12.1		27%	65.2	-	65.2	-	0.27
56	na	na	Other HHW	0.1%	241	5%	12.1		27%	65.2	-	65.2	-	0.27
57	-1.6	-2.1	Bulky Materials	1.7%	4,101	5%	205.0	-437.3	27%	1,107.1	(2,361.2)	1,107.1	(2,361.2)	0.27
58	-1.6	-2.1	Furniture	3.3%	7,964	5%	398.2	-849.1	27%	2,150.4	(4,586.1)	2,150.4	(4,586.1)	0.27
59	na	na	Other Inorganics	0.6%	1,444				22%	317.7	-	317.7	-	0.22
60	na	na	PPE	0.1%	241				22%	53.1	-	53.1	-	0.22
61			Total	100%	241,493	1.5%	3586.7	-5894.7	45%	108,242.4	(102,840.0)	108,242.4	(102,840.0)	0.45
62									0.45	108,242.4	(102,840.0)	108,242.4	(102,840.0)	
63									QA/QC	QA/QC	QA/QC	QA/QC	QA/QC	QA/QC
64														

Repeat these steps for all initiatives in each sector being analyzed. Once each initiative has been analyzed, add up the total capture rate, total tons estimated to be diverted, and total MTCO2E estimated to be reduced for each material type (across the rows) (Grey columns in Figure 8). Each material type's total capture rate cannot exceed 100%. Finally, double-check all calculations by performing QA/QC calculations.

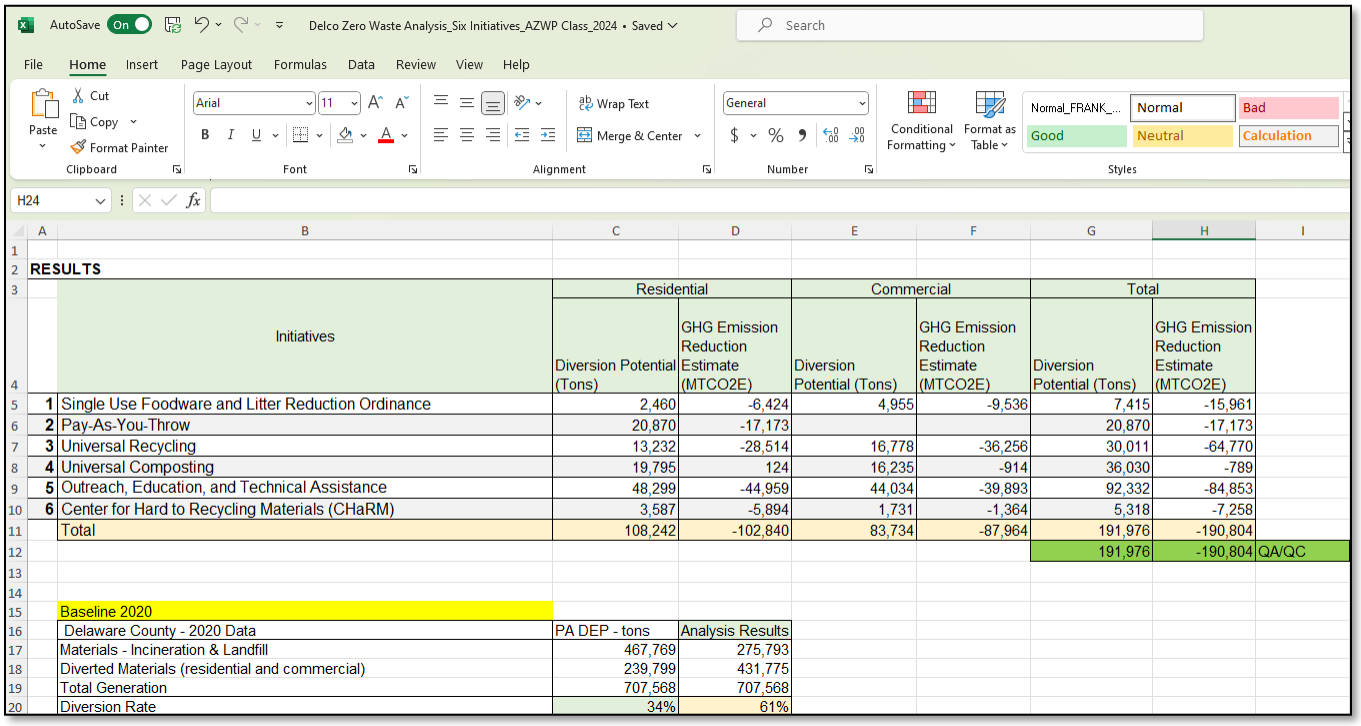
To perform QA/QC calculations, add the tons of materials estimated to be diverted and tons of MTCO2E estimated to be reduced across rows and totals down the columns of X, V, Z, AA, AB, and AC. Make sure the numbers match. The best way to work through QA/QC is to read this document and

have an example spreadsheet open where the calculations are completed. To check the capture rate, divide the total tons for each material by the total tons that the material represents in the destructive disposal stream (e.g., for Steel Cans in Figure 8, divide 781.7 tons by 1,203 tons, which equals 65%).

Interpreting and Presenting the Results

The Zero Waste Analysis Tool's results tab summarizes the results across sectors and initiatives to estimate the additional tons diverted annually and the estimated GHG emissions reduced **annually** once all initiatives are implemented. Therefore, the results tab should include data for each sector and initiative and the total data (Figure 8).

***Figure 9**. The results tab shows the tons of materials estimated to be reduced or diverted from destructive disposal annually for each initiative by sector and total. It also shows the GHG emissions estimated to be reduced by each initiative by sector and the total annually.*



RESULTS

	Initiatives	Residential		Commercial		Total		
		Diversion Potential (Tons)	GHG Emission Reduction Estimate (MTCO2E)	Diversion Potential (Tons)	GHG Emission Reduction Estimate (MTCO2E)	Diversion Potential (Tons)	GHG Emission Reduction Estimate (MTCO2E)	
1	Single Use Foodware and Litter Reduction Ordinance	2,460	-6,424	4,955	-9,536	7,415	-15,961	
2	Pay-As-You-Throw	20,870	-17,173			20,870	-17,173	
3	Universal Recycling	13,232	-28,514	16,778	-36,256	30,011	-64,770	
4	Universal Composting	19,795	124	16,235	-914	36,030	-789	
5	Outreach, Education, and Technical Assistance	48,299	-44,959	44,034	-39,893	92,332	-84,853	
6	Center for Hard to Recycling Materials (CHaRM)	3,587	-5,894	1,731	-1,364	5,318	-7,258	
	Total	108,242	-102,840	83,734	-87,964	191,976	-190,804	
						191,976	-190,804	QA/QC

Baseline 2020		
Delaware County - 2020 Data	PA DEP - tons	Analysis Results
Materials - Incineration & Landfill	467,769	275,793
Diverted Materials (residential and commercial)	239,799	431,775
Total Generation	707,568	707,568
Diversion Rate	34%	61%

The total tons estimated to be reduced or diverted from destructive disposal annually can be added to the baseline data. For example, a community had a 34% diversion rate and diverted 239,799 tons of materials from destructive disposal before any Zero Waste initiatives. The Zero Waste Analysis Tool estimated that 191,976 tons of materials could be reduced or diverted annually through the Zero Waste initiatives. So, 191,976 tons can be added to the 239,799 tons for 431,775 tons annually, increasing the community's diversion to 61%. Additionally, showing the new diversion rate in a chart (Figure 10) is a great way to show the results.

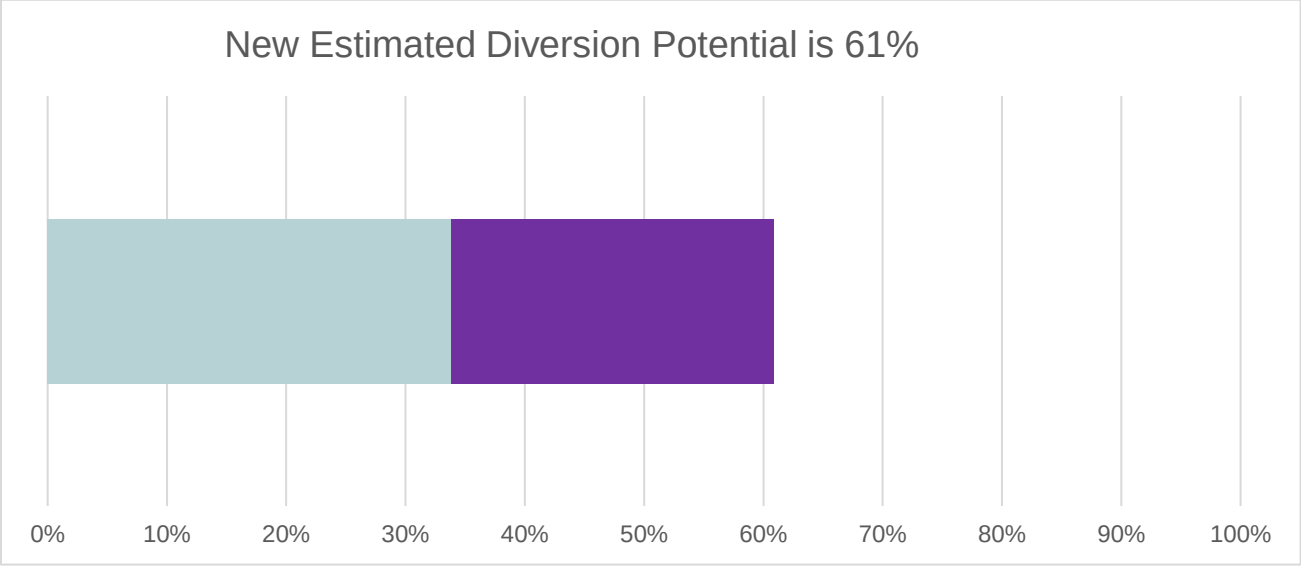
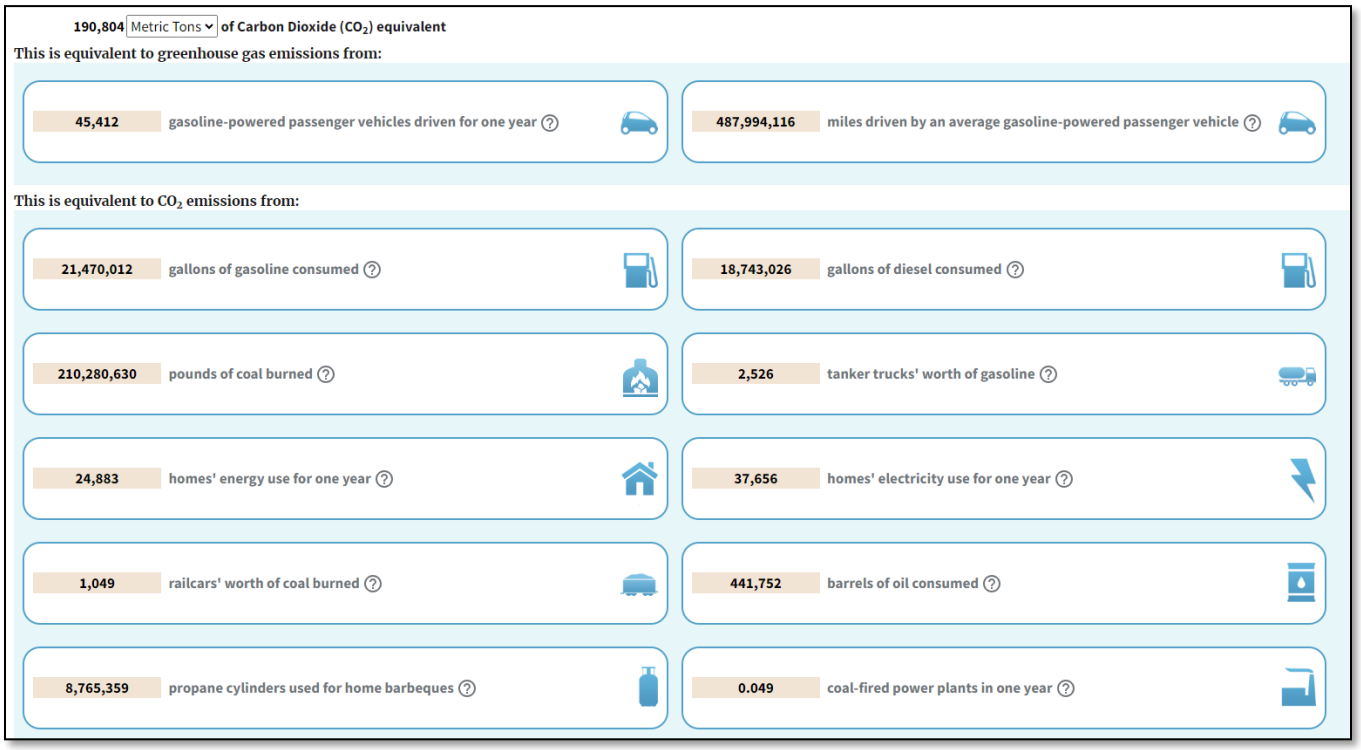
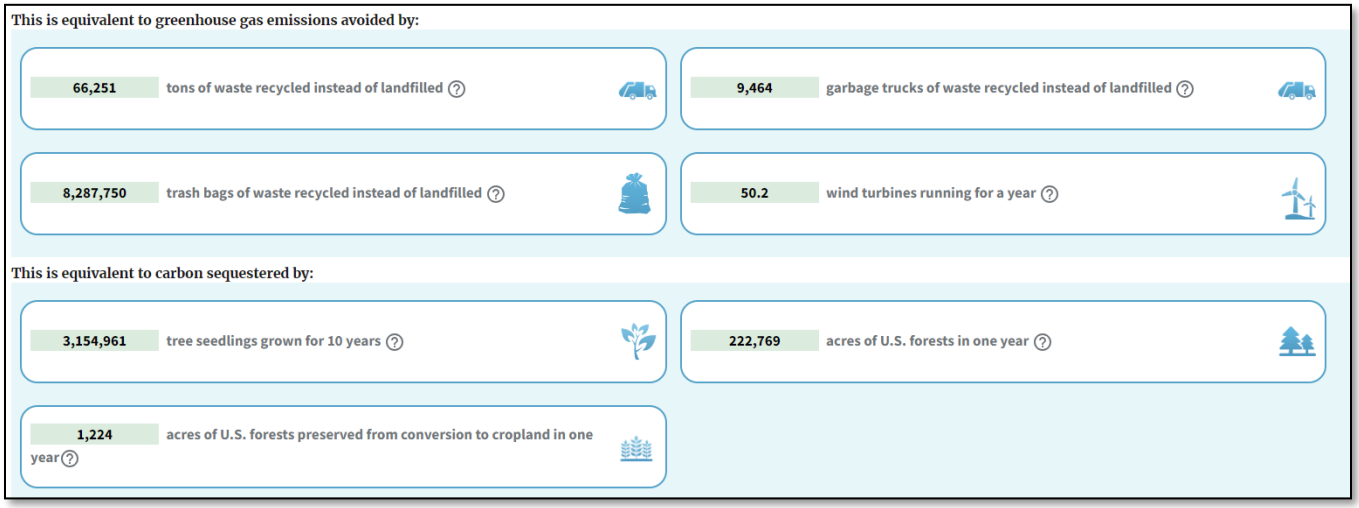


Figure 10. Once all Zero Waste initiatives are implemented, the new estimated diversion potential is 61%.

The GHG emissions results that estimate annual emission reductions are hard to digest and visualize, so we suggest using the US EPA Greenhouse Gas Equivalencies Calculator[11] to interpret the results. For this analysis, we estimated that 190,804 MTCO2E will be reduced annually once all six initiatives are implemented. Using the equivalencies calculator, that equals the greenhouse gas emissions from 44,323 cars driven for one year. The results can be made into a graphic. Below is a screenshot showing the results.



[11] US EPA Greenhouse Gas Equivalencies Calculator



Created by Zero Waste USA in August 2023

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