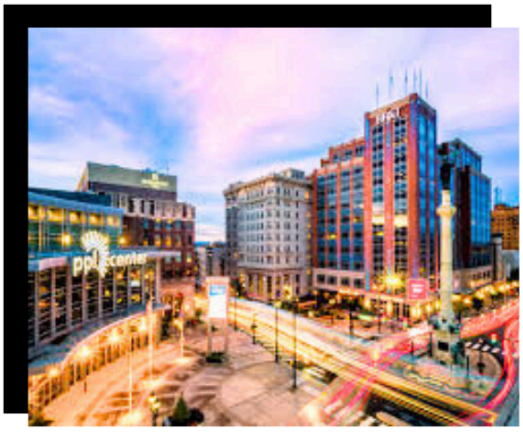
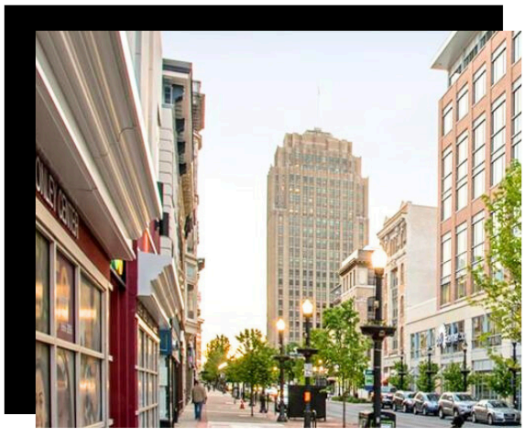
2024

Greenhouse Gas Inventory Update

Prepared for the City of Allentown PA
Community Scale: 2022 Data

Conducted in May 2024 by Jessica Rosen B.A. in Sustainability Studies.





This Interim Greenhouse Gas Inventory sets the groundwork for providing a comprehensive understanding of Allentown's emissions and subsequent action that can be taken to influence change. Read to learn more about the city's contribution to climate change to inform both citizen and governmental decision making.

City of Allentown 2024 Greenhouse Gas Inventory
Interim Report: Inventory Year 2022

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Introduction

The City of Allentown is committed to sustainability as demonstrated through the development of programs and initiatives documented in the Allentown Environmental Advisory Council's (EAC) 2021 Climate Action Report. In the past decade, the EAC has conducted greenhouse gas inventories, identified climate hazards, and developed and implemented a variety of climate adaptation and mitigation strategies. EAC members have partnered with the city and surrounding community through offering internships, educational programming and social and environmental advocacy to develop climate actions strategies. These all aim to mobilize stakeholders in advancing social, environmental and economic sustainability while reducing the city's greenhouse gas (GHG) emissions.

This interim Greenhouse Gas Emissions (GHG) Inventory report supports Allentown in identifying the city's contribution to climate change by providing a comprehensive understanding of where emissions are coming from and subsequent focus areas needed to influence positive change. The insights described below can then inform decision making, increase the city's sustainability transparency, and help the city identify focus areas for improvement through minimizing emissions.[6] A more comprehensive description of the value of GHG inventories is outlined in Appendix A.

This report presents the results of the GHG inventory conducted in the Spring of 2024 by the Allentown Environmental Advisory Council (EAC) through a Muhlenberg College Internship.

The intern, Jessica Rosen, uncovered important potential inaccuracies in the 2018 data collected in Allentown's 2020 GHG report. The methodologies outlined in this updated report offer new approaches for future data collection and lays the groundwork for future reports to integrate more precise data inputs and analysis. This inventory establishes the basis to visualize

Figure 1: The Geographic Boundary of Allentown

Inventory Boundary	Information
Name of City	Allentown, PA
Country Inventory Year	2022
Geographic Boundary	Zip Codes: All of 18101 & Parts of 18102, 18103, 18104, 18109
Land Area (mi^2)	18.01 mi^2
Resident Population	125,094 people
GDP (US$)	$46,645.491
Climate	Humid Continental Climate

key emission trends within Allentown. Due to the suspected data inaccuracies with the 2020 inventory, actual visualizations will await the amended version of this report which will include new data beyond the GHG inventory timeline. The EAC will amend this report in the 2024 calendar year and an updated report will be issued every 2–3 years. Specific potential inaccuracies of the 2018 data are outlined in Appendix B.

This comprehensive 2024 GHG Inventory Report in its amended state shall include a compilation of all GHG scope 1 and 2 emissions during the continuous 12-month reporting period of 2022. Refer to Appendix C to understand the distinction between scope 1, 2, and 3 emissions. This interim report includes 2022 emissions attributable to the following activities within the geographic boundary of the City of Allentown: electricity use, a portion of transportation, solid waste receptacles and pickup within the city boundaries. While this inventory includes GHG emissions associated with municipal operations, the city is also completing a separate inventory that outlines municipal emission contributions.

This GHG Emissions Inventory was conducted under industry standards, consistent with the IPCC Guidelines and the U.S Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. View Appendix D to learn about the notation keys used and guidelines followed in this inventory.

The calculation methodologies and tools were provided by the International Organization, Local Governments for Sustainability (ICLEI), a leading association of cities and governments that supports local action to contribute to global sustainability. [2] [4] ClearPath software was utilized in this report to examine Scope 1 and 2 emissions within the City of Allentown's boundary.

What are Greenhouse Gases?

Greenhouse gasses (GHG) are characterized by any gas that traps heat in earth's atmosphere, amplifying the natural greenhouse effect which is the natural process that traps heat near the surface to maintain Earth at a habitable temperature. In our industrial world, greenhouse gasses are being emitted at a rate that results in a net increase in global temperatures thus changing Earth's climate leading to cascading environmental effects, such as habitat shifts, biodiversity loss, the destruction of natural resources and much more.[5] This inventory is being conducted to minimize the city's contribution to global warming and climate change.

The blanket term GHG includes gasses such as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). As each of these gasses impact the atmosphere and contribute to global warming in varying ways. The emissions in this inventory have been converted to a standard one unit—carbon dioxide equivalents (CO_2e).

Methodology

This inventory includes a compilation of City-wide data for the following sectors: residential, commercial and industrial electricity, portions of transportation and mobile services, and portions of solid waste. Appendix E outlines the various emission sources that are included in fully complete inventories.

The majority of the GHG emission sources included in this report were estimated through multiplying activity data by emission factors associated with the activity and the proportional Allentown population when applicable. The CO_2e emissions were calculated using ClearPath's online software.

Each inventory item will be reported by sector, sub-sector and scope all expressed by CO_2 equivalent (CO_2e). The CO_2 equivalents were determined by multiplying each gas by its respective global warming potential (GWP) via the ClearPath calculator.

Methodology for Determining Emission Factors

ClearPath provides a database of historical emission factors that are automatically loaded in with the US national default emission factors, including grid electricity emissions factors Integrated Database factors or egrid. To conduct the inventory, the factor set's emission year must indicate the year the inventory is being calculated for, in this case, 2022.

Some factors were pre-loaded into ClearPath based on Environmental Protection Agency's (EPA) standards, some were not. Emission factors used were obtained from the EPA's "ghg-emission-factors-hub-2022" excel sheet or were determined by making informed assumptions through extensive research. Research on American transportation consumption patterns were leveraged to make high level assumptions to create accurate emission factors for the transportation sector. Data on American vehicle purchasing patterns, average miles per gallon, and popular motorcycle and car models for 2022 were leveraged when deciding key

emission factors. The specific emission factors were imported into ClearPath manually. Emission factors are measures of the mass of GHG emissions relative to a unit of activity and changes based on the emission source.[1]

View below a comparison of the total CO_2e breakdown of 2018 and 2022 data. Please note that the electricity data from 2018 was likely overestimated because it was not broken out by zip code, meaning it may have included electricity usage outside of City boundaries. Electricity data received this year was organized by zip code. For the 2022 inventory, the data has been scaled to accurately reflect usage within the city boundaries. View a more detailed explanation in Appendix B.

Overview Emissions by Category (Table): A Comparison of 2018 & 2022 Data

Category	2018 Totals CO_2e (Metric Tons)	2022 Totals CO_2e (Metric Tons)
Residential Energy	388,977	82,754
Industrial Energy	179,079	35,317
Commercial Energy	441,503	2,689
Transportation/ Mobile Sources	1,350,888	641
Solid Waste	64,245	285

Note the 2018 emissions may have been overcalculated and the 2022 emissions are not fully complete.[1]

Stationary Energy: Residential, Industrial and Commercial

Energy emissions generated from fuel combustion like gas, propane, oil and electricity usage comprises one of the largest footprints in any city's GHG emissions inventory. This report is limited to electricity use and includes stationary energy's sub sectors: residential, commercial and institutional buildings and facilities. Energy emission data is essential for reporting as it

allows cities like Allentown to compare their emissions in relation to other cities, communities, and/or municipalities similar in size.

The electricity data was provided by PPL Electric Utilities. The best available data did not align with the geographical boundary of the City of Allentown so the data was adapted to meet the inventory boundary using unique scaling factors. Data was derived through leveraging QGIS systems and zip code files to calculate Allentown's proportionate energy usage. Learn more about the process in Appendix F.

UGI Utilities and other partners were unable to provide natural gas, oil, propane and wood stove emissions data in the timeframe of this inventory. Due to the lack of availability of this data, this inventory is ongoing. Emissions from these fuel types will be examined during a further analysis within the calendar year.

Electricity Usage Emissions Results

In 2022, the City of Allentown reported their population to be 125,094 people. In the same year the city generated 82,754 metric tons (MT) of CO_2e from residential buildings, 35,317 MT of CO_2e from commercial areas such as hotels, office buildings and retail spaces as well as 2,689 MT of CO_2e from industrial buildings such as warehouses, storage areas and manufacturing spaces. Governmental and “other” buildings are included in the commercial emissions attributable to electric use. This inventory assumes that residential and commercial areas, in the same zip codes, use an equal amount of electricity.

Electricity Emissions by Category (Table)

Category	Total kWh used	Totals CO_2e (MT)	Percent of Total Electricity
Residential Electricity	278,388,739.3	82,754	68.53%
Commercial Electricity	118,806,292	35,317	29.24%
Industrial Electricity	9,046,342	2,689	2.23%

Total energy usage emissions data, other than electricity will be added in the amended inventory.

Transportation & Other Mobile Sources

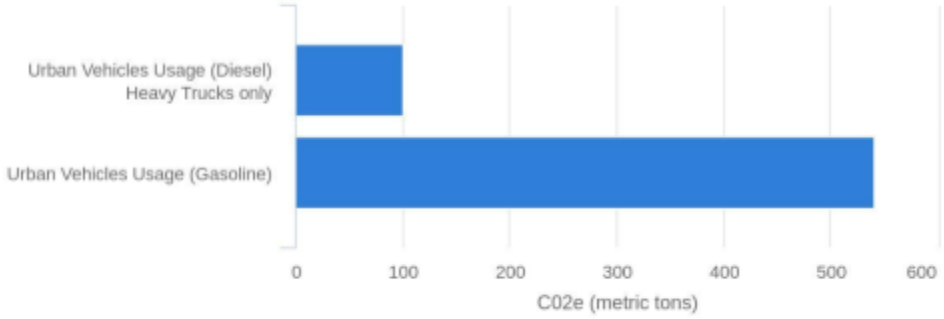
Allentown's transportation system is designed to allow residents and visitors to move people and goods in, out, and within the city's borders. In this initial analysis, emissions were calculated from the Pennsylvania Department of Transportation's Highway Statistics for on on-road and off-road travel occuring within the geographic boundary of the state of Pennsylvania scaled to reflect the resident population of Allentown. The proportional vehicle miles traveled and subsequent GHG emissions were then allocated based on the number of residents of Allentown. It was assumed that all cars and smaller trucks were powered by gasoline and heavy trucks by diesel. Further analysis to better refine transportation emissions will be included in the final GHG emissions report.

On-Road Transportation & Other Mobile Sources by Category (Table)

2022 Urban Transportation Vehicle Type	Annual Vehicle Miles Traveled (In Allentown)	CO_2e (MT)
Light Truck	1,639,702	540
Heavy Truck	141,149	101
Totals	1,780,851	641

The confidence in this data is low. This table will be amended shortly.

Figure 6 - 2022 Transportation in Metric Tons of CO2e



Transportation Results

The 2024 transportation calculations done to date have resulted in significantly lower emissions than in the 2020 GHG Inventory Report and the 2023 Lehigh Valley Planning Commission's climate modeling. Therefore, the confidence in this data is low. A supplemental examination of

transportation will need to be conducted to achieve better emissions insights for this subsection's GHG contribution. Nonetheless, the results of the preliminary analysis are presented here for use in the further analysis of transportation emissions.

Note that the City of Allentown has decided to not take credit for the 64 electric hybrid buses in their urban light truck fleet of 86 buses. Accounting for these buses would likely slightly lower the calculated emissions.

Solid Waste

Waste disposal and treatment produces GHG emissions through aerobic or anaerobic decomposition or incineration. GHG emissions from solid waste are calculated based on the disposal route, namely landfill, biological treatment, incineration and open burning. Data was received from The City of Allentown and Lehigh County.

Solid Waste by Category (Table)

Waste Management Type	Solid Waste Produced in Tons	CO_2e (MT)	Percent of Total
Landfill	42,629	285	93%
Composting	3,085.5	Not Accounted for in Inventory	~7%
Recyclables	45.1	Not Accounted for in Inventory	.09%

Solid Waste Results

In 2022, solid waste generated 270 MT CO_2e. The data provided for this inventory period by Lehigh County and Allentown's Bureau of Recycling and Solid Waste consisted of only waste collected through curbside residential collection and city trash receptacles. This data excludes commercial and industrial waste as those spaces often contract private waste haulers. Since there is no centralized database of waste collected by private parties, waste calculations account for significantly smaller emissions attributed to Allentown, especially compared to the EPA's 2018 estimated nationwide average of 4.9 tons per capita. [7] This data challenge poses barriers to

making data-driven decisions on waste minimization. For the succeeding inventory an effort will be made to obtain missing data on commercial and industrial waste for Allentown. Moreover, curbside collection numbers are lower than expected and will be investigated further in the finalized inventory.

The solid waste ClearPath calculation tool only accounts for landfill emissions. Due to time constraints, any net negative emissions associated with composting or recycling are not taken credit for in this inventory. Additionally, the EPA's Waste Reduction Model (WARM) presented the City with the tools to account for GHG reductions attributed to recycling and composting activities, however, these estimations were outside of the inventories time parameters. Transportation and electricity needed for waste treatment is included under the stationary energy and transportation sections of this inventory.

Composting and Recycling Exclusion Explanation

Note, this inventory assumes that yard waste including grass, branches, & dimensional lumber are composted through the City's curbside composting service available select days from early April to late November each year. It is expected that the city could take a small credit for emissions reductions associated with composting activities related to yard waste collections but there is a lack of data available on composting rates; Therefore, there was low confidence in the ability to accurately estimate the emissions reductions. As such, the emissions associated with tonnage that can be attributed to yard waste has been omitted from the inventory but no credit was taken for GHG reduction associated with yard waste.

Recycling should ideally contribute net negative GHG emissions in an inventory. Therefore, ClearPath's software does not have a recycling waste characterization factor set. Tools can be used to calculate emission offsets.

Exclusions

This report has limitations due to time and data constraints. It shall be amended with more accurate data to address the challenges noted in the inventory.

Overall, this report does not include fugitive emissions as the city does not operate any landfills, fossil-fuel-powered generation sites or significant gas transmissions within its boundaries. Since these tasks are outsourced, fugitive emissions are considered Scope 3, indirect and downstream

emissions which are out of this inventory's boundary. Items such as the composition of the economy, climate, upstream activities, consumption and land use activities were excluded from this inventory due to lack of data and time constraints as well as applicability. Water and wastewater operation emissions are encompassed in the city's energy calculations.

Within the Transportation sector, this inventory excludes commuters who travel to the city as non-Allentown residents. Moreover, hybrid and electric vehicles, transboundary trips, railway activity, water transport and aviation activities were not considered.

The Solid Waste reporting does not account for commercial and industrial wastes which are likely a much larger component of Allentown's overall GHG footprint than the residential wastes that are in the inventory. The City has chosen not to take credit for emission reductions associated with compostable and recyclable material. ClearPath's software does not have a recycling waste characterization factor set. If recycling emission offsets would like to be considered, use the EPA's WARM model and the Local Greenhouse Gas Inventory Tool as tools.

Note: Some of the aforementioned exclusions will be addressed in an updated inventory.

Conclusions

Overall, this inventory adds value to the City of Allentown as it acts as a blueprint for further inventories. It lays out the proper methodologies and essential questions to consider to ensure a highly accurate investigation is conducted. The use of data management tools, preparatory spreadsheets, documented assumptions/thought processes and QGIS software provide an excellent groundwork for others to replicate similar work. Particularly, the methodologies and step-by-step procedures outlined for determining the proportionate city energy use based on zip code, will be essential in creating future reports that are accurate, usable and impactful.

With the challenging procedures outlined and an extended inventory timeline, upcoming amendments should include GHG emissions associated with gas and other energy sources, and more accurate transportation and waste data. With the completion of this ongoing inventory, Allentown can deploy cost-effective strategies to achieve emission reduction targets.

Following this examination next steps may include:

- The implementation of climate action to achieve emission reductions and address the physical and transitional impacts of climate change.
- Climate forecasting that supports Allentown in prioritizing long term climate resilience initiatives.
- The development of a comprehensive Climate Action Plan.

  & more

Appendix

A. Learn more about why GHG Inventories are Important:[2] [6]

They help cities…

- Aggregate key GHG emission generating areas to support the development of comprehensive climate action planning documents and political policies.
- Establish a repository of GHG emissions inventory to set and track reduction targets.
- Allows cities to track their targets against internationally recognized GHG accounting and reporting principles.
- Demonstrates the impact that cities have on climate change to mobilize municipalities into tackling climate change
- Supports sustainable action within cities to become more resilient, resource-efficient, biodiverse, and less fossil fuel reliant

B. It remains uncertain whether the 2018 GHG emissions inventory data mistakenly attributed electric use to areas excluded in the official municipal boundary of Allentown. The data was not provided by zip code for 2018 but was provided by zip code for 2022. Estimations based on the percentage of the population within each zip code resulted in significantly lower calculated energy use than reflected in the 2018 data. This discrepancy must be further understood. Similar discrepancies may exist for gas. This will be determined when the gas data is received from UGI.

   This report uses a new methodology to properly allocate electric use to Allentown by leveraging QGIS systems and zip code files to find Allentown's proportionate energy usage. Additionally, although a significant amount of analysis was done on transportation emissions, the emissions accounted for in this inventory are missing data on key commuter and non-resident transportations emissions.

C. IPCC Guidelines can be found at the following links:
   https://icleiusa.org/us-community-protocol/
   https://www.ipcc.ch/2019/05/13/ipcc-2019-refinement/

View Figure B to understand the distinction between scope 1, 2, and 3 emissions that comprise every GHG Inventory.

Figure B

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary.
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

[2]

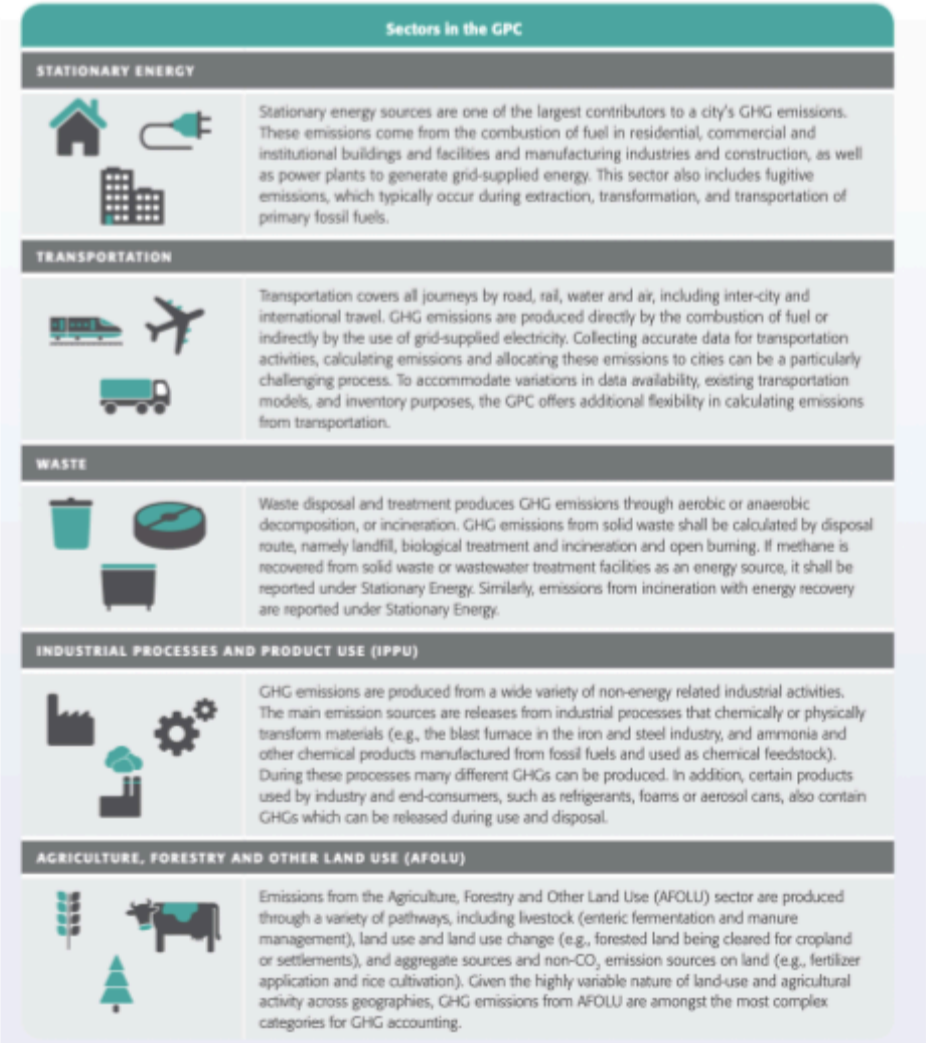
D. These notation keys were used to characterize the emissions data on ClearPath. They are used under IPCC guidelines to streamline communicating the confidence a municipality has in their emissions data, especially when the data is a high level estimate. This system acknowledges the limitations on data availability and differences in emission sources between local governments. [3]

Notation key	Definition	Explanation
IE	Included Elsewhere	GHG emissions for this activity are estimated and presented in another category of the inventory. That category shall be noted in the explanation.
NE	Not Estimated	Emissions occur but have not been estimated or reported; justification for exclusion shall be noted in the explanation.
NO	Not Occurring	An activity or process does not occur or exist within the city.
C	Confidential	GHG emissions which could lead to the disclosure of confidential information and can therefore not be reported.

[2]

E. Figure C outlines the emission sources accounted for in each GHG Inventory.

Figure C



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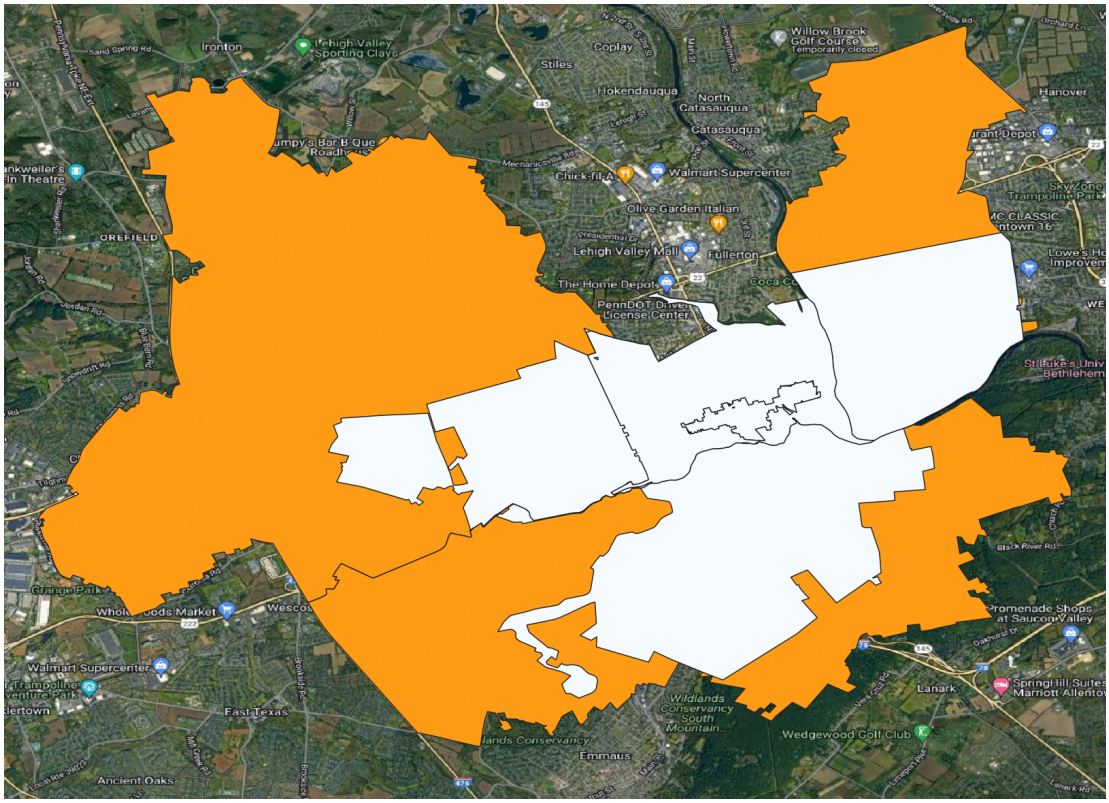
F. View the full process of creating the High Level Estimate of Electricity Usage:
   - Reached out to PPL & UGI for Energy Data.
   - After obtaining the data, it was reviewed and determined that it was organized by zip codes that had an Allentown mailing address, however, not all residents with a mailing address are included within the Allentown city limits.
   - To correct for the data, a QGIS map was created to allocate the proper proportional electricity use for the city based on official Allentown boundary files. This avoided the mistake made in 2018, to import all kWh provided by PPL into ClearPath.
     - Created a QGIS map to determine which zip codes are fully and partly in Allentown. There were 3 polygon layers: The base layer of a google maps

layer; the Allentown Boundary layer and a Lehigh County Zip Codes layer.

- GIS was used to merge the Allentown Boundary Layer and the zip code layer.
- Then the geographic area of the Allentown layer was clipped.
- The total area within Allentown's boundary was determined within each Zip Code.
- After that, the electricity data provided by PPL was multiplied by the area found to be within the Allentown Boundary.
    - The data was tabulated allowing for the proper emissions to be calculated based on the area included in Allentown compared to the emissions associated with the overall Zip Code.

Figure D: QGIS Allentown Zip Codes Map



Above is the map created by 2024 intern Jessica Rosen to determine the proportionate energy allocation to the City of Allentown. View the full zip codes in orange and the Allentown Municipal Boundary outlined by the shapes in white. Note how some zip codes are fully in Allentown however many are only partially.

References

[1] Chiesa, Hannah. *City of Allentown 2020 Greenhouse Gas Inventory Report*. 2020.

[2] Fong, Wee Kean , et al. *An Accounting and Reporting Standard for Cities Global Protocol for Community-Scale Greenhouse Gas Emission Inventories*.

[3] "GHG Notation Keys - Open Risk Manual." *Www.openriskmanual.org*, www.openriskmanual.org/wiki/GHG_Notation_Keys. Accessed 10 May 2024.

[4] "ICLEI Europe •• Who We Are." *Iclei-Europe.org*, iclei-europe.org/who-we-are/#:~:text=ICLEI%20%E2%80%93%20Local%20Governments%20for%20Sustainability.

[5] Mann, Michael E. "Greenhouse Gas | Definition, Emissions, & Greenhouse Effect." *Encyclopædia Britannica*, 19 Mar. 2019, www.britannica.com/science/greenhouse-gas.

[6] "STARS, Sustainability Tracking Assessment & Rating System." *The Sustainability Tracking, Assessment & Rating System*, stars.aashe.org/.

[7] US EPA. "National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA." *US EPA*, 2 Oct. 2017, www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#NationalPicture.