A TOOL FOR ESTIMATING GHG EMISSIONS FROM STREET EXCAVATION

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AGENDA

INTRODUCTION

- Urban areas, particularly with aging infrastructure, frequently undergo road excavation for various reasons such as utility maintenance, new infrastructure installations, or road repairs.
- These activities result in significant amounts of waste material and associated greenhouse gas (GHG) emissions.
- There Is a need for quantifying and reducing the environmental impact of street excavation projects, promoting sustainability, and ensuring compliance with environmental regulations..

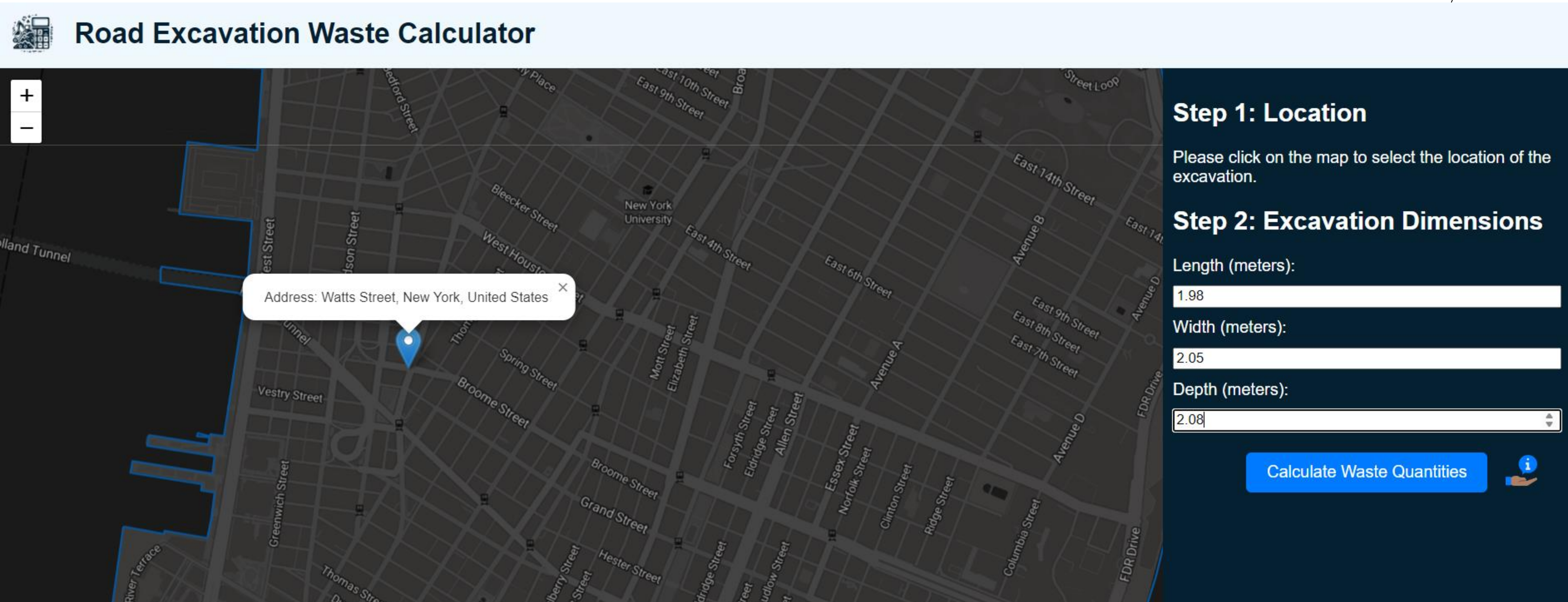
OBJECTIVE

The primary objective of the Street Excavation Waste Calculator is to provide a detailed estimation of the GHG emissions associated with road excavation activities. The tool achieves this by:

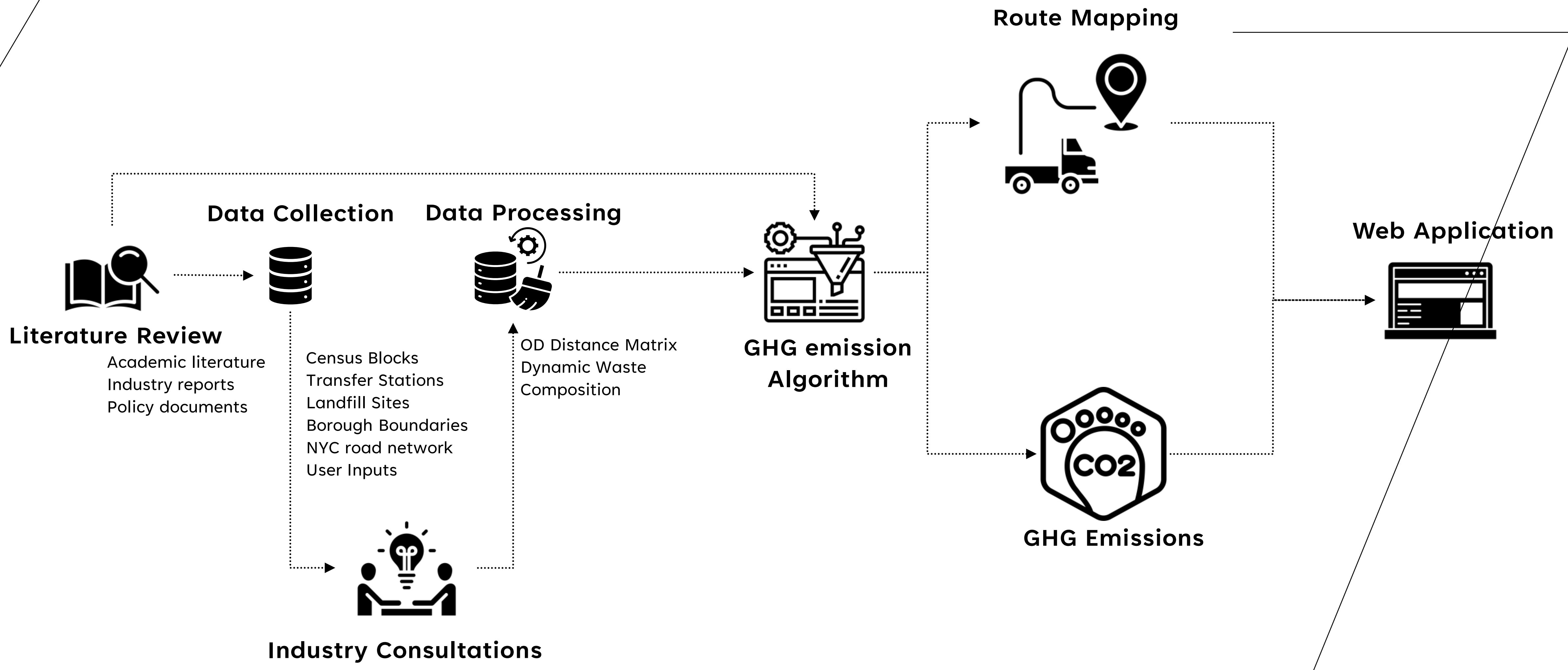
- Calculating the volume of waste generated based on user-defined excavation dimensions.
- Estimating GHG emissions from material production, equipment operation, and transportation.
- Identifying the nearest Construction and Demolition Waste (CDW) Transfer Station and landfill, providing the most efficient route and calculating the associated transportation emissions.
- Offering users a breakdown of emissions by source, fostering informed decision-making for more sustainable construction practices.

USER INPUTS

- **Location:** The user can click on a map to enter a specific address to define the excavation site's location.
- **Excavation Dimensions:** The user specifies the length, width, and depth of the excavation in meters.



METHODOLOGY OVERVIEW



DYNAMIC WASTE COMPOSITION CALCULATION

The waste composition generated from an excavation depends on the depth and standard pavement design. The application assumes that the pavement consists of multiple layers, each with a different material, following U.S. pavement design standards:

Layer Thicknesses:

- Asphalt: 6 inches (0.1524 meters)
- Concrete Base: 6 inches (0.1524 meters)
- Underlying Materials (e.g., gravel, dirt): Depends on the depth beyond the asphalt and concrete layers.

The application dynamically calculates the waste composition based on the user-provided depth:

- **Full Layer:** If the depth exceeds the thickness of a layer, the material is considered fully excavated.
- **Partial Layer:** If the depth only partially covers a layer, the proportionate amount is calculated

OD MATRIX AND DISTANCE CALCULATION

OD Matrix Creation:

The tool uses precomputed origin-destination (OD) matrices to accurately estimate the distance from the excavation site to the nearest CDW Transfer Station and from the Transfer Station to the nearest landfill. These matrices were created using the centroids of census blocks and the transfer station and landfill locations.

Distance Calculation Workflow:

- When a user selects an excavation location, the tool spatially determines which census block the location falls within by checking the spatial intersection with the census block geometries.
- Using the OD matrix, the tool identifies the closest transfer station based on the network cost (converted to miles) from the selected census block's centroid to the transfer stations.
- Similarly, the tool determines the closest landfill based on the distance from the identified transfer station to the available landfill sites.

GHG EMISSION CALCULATION

Volume: Calculated using V = Length × Width × Depth × 0.8.

Dynamic Waste Composition: Allocates volume to materials (asphalt, concrete) based on depth.

Emissions:

- Material Production: Emissions based on volume and emission factors (e.g., asphalt: 85 kg CO_2e/m^3).
- Equipment Operation: Calculated from usage rates (e.g., excavator: 25 kg CO_2e/hour).
- Transportation: Based on material weight, distance, and emission factor (0.15 kg CO_2e/ton-mile).
- Waste Management: Only 10% of waste assumed to go to landfill, with emission factors applied.

Total: Sum of all emission components.

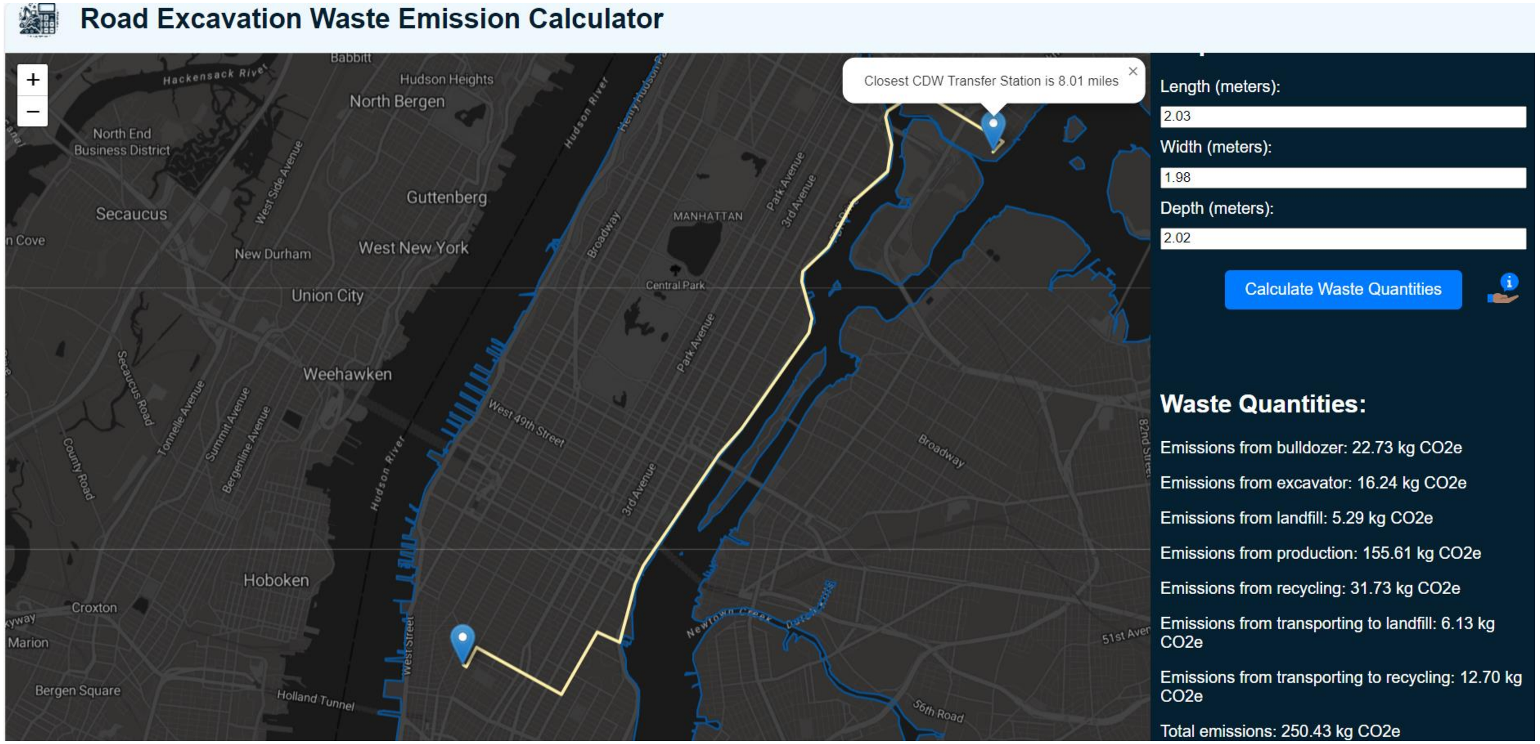
APPLICATION FEATURES

Real-Time Route Mapping

Demonstrate the map interface that plots the route from the excavation site to the transfer station.

Emission Calculation Results

Explain the output format and what the user receives (e.g., total emissions, emissions by source).



SCHEMA FOR USER'S UNDERSTANDING

Road Excavation Waste Emission Calculator

Schema for GHG Emissions Calculation

Close

The GHG emissions are calculated from various sources, including material production, equipment operation, and transportation. The calculation steps are as follows:

1. **Volume of Excavated Material:**
   The volume of the excavation (V) is calculated using the formula:
   $V = Length \times Width \times Depth \times 0.8$
   where 0.8 is a fill factor representing the portion of the excavated volume that is solid material.
2. **Waste Composition:**
   The dynamic waste composition calculated earlier is used to allocate the excavated volume to different materials (e.g., asphalt, concrete).
3. **Emission Factors:**
   Material Production: Emission factors for different materials are applied to calculate the emissions from the production of each material:
   $Emissions_{prod\_material} = V_{material} \times EF_{prod\_material}$
   where EF represents the emission factor for the production of the material in kg $CO2e/m^3$.
   Emission Factors Used:
   - Asphalt Production: 85 kg $CO2e/m^3$
   - Concrete Production: 120 kg $CO2e/m^3$
   - Gravel Production: 20 kg $CO2e/m^3$
   - Dirt Production: 10 kg $CO2e/m^3$
4. **Equipment Operation:**
   Excavation Equipment: Emissions from the operation of excavation equipment (e.g., excavator, bulldozer) are calculated based on usage rates and emission factors:
   $Emissions_{excavator} = V \times Usage\ Rate_{Excavator} \times EF_{excavator}$
   Usage Rates and Emission Factors:
   - Excavator Usage Rate: 0.1 $hours/m^3$
   - Bulldozer Usage Rate: 0.05 $hours/m^3$
   - Excavator Emission Factor: 25 kg CO2e/hour
   - Bulldozer Emission Factor: 70 kg CO2e/hour
5. **Transportation:**
   Transport Emissions: Emissions from transporting waste to the recycling center and then to the landfill are calculated:
   $Emissions_{transport} = Weight_{material} \times Distance \times EF_{transport}$

TECHNICAL IMPLEMENTATION

Technology Stack

List the technologies and frameworks used (e.g., Python, Flask, Geopandas, Shapely, OSRM for routing).

Deployment

Mention how the application is hosted (e.g., using Render or any other platform).

LIMITATIONS

Excluded Emissions

The model does not account for emissions from the recycling process beyond transportation, nor does it include emissions from the construction or demolition process itself.

Simplified Routing

The tool assumes straightforward transportation within the five boroughs, without considering potential delays or specific road conditions.

Circular Economy Focus

Only 10% of the waste is assumed to be sent to the landfill, based on feedback from stakeholders who operate recycling units and transfer stations.

CONCLUSION

Impact

It supports informed decision-making for more sustainable excavation practices by providing detailed emissions data and providing efficient waste management routes.

The tool is particularly useful for construction companies, urban planners, and environmental consultants aiming to minimize the environmental impact of urban excavation activities.

Future Work

The next version will give more options on user inputs on processing centers to calculate accurate emissions

Q&A

THANK YOU

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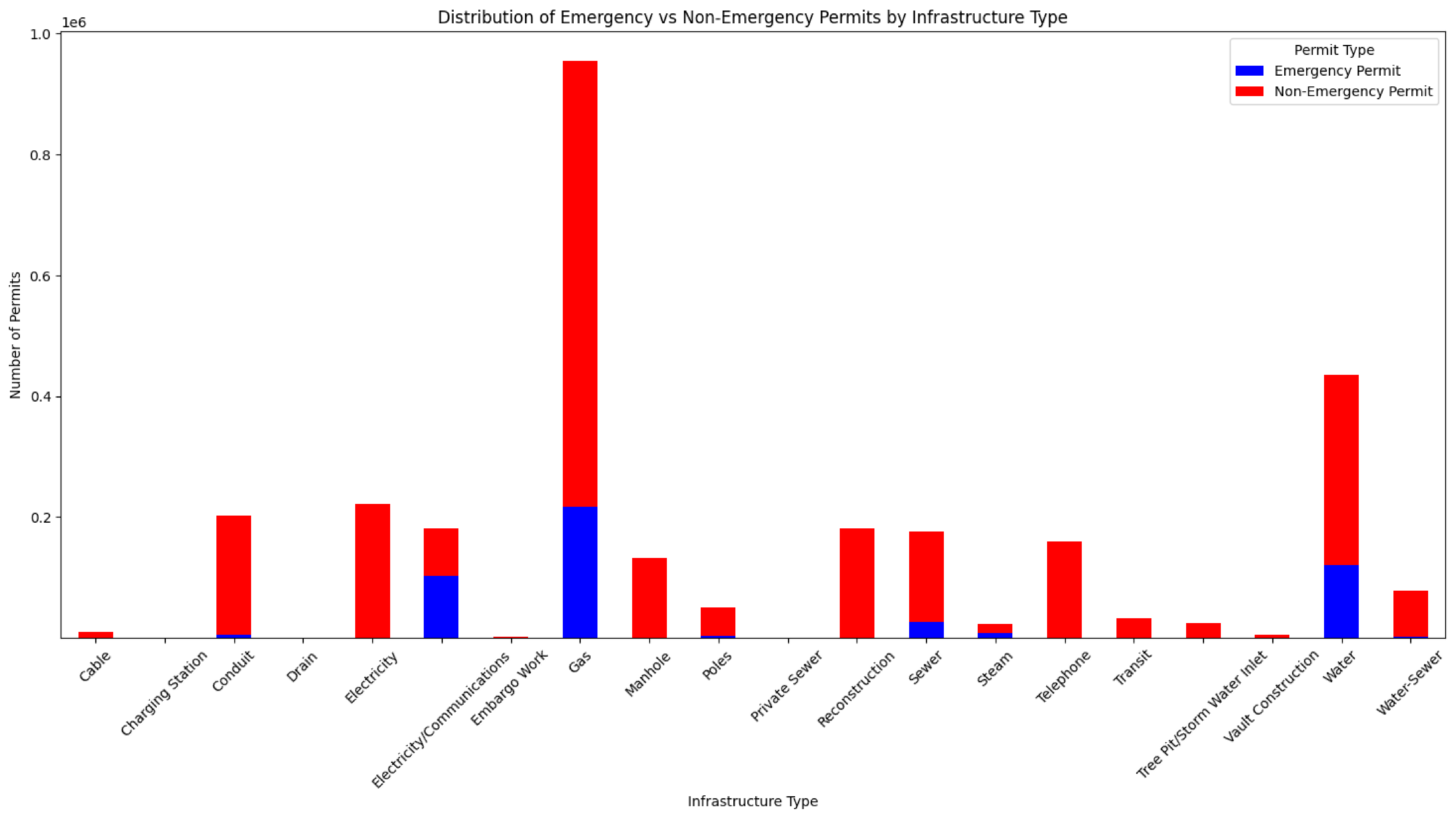
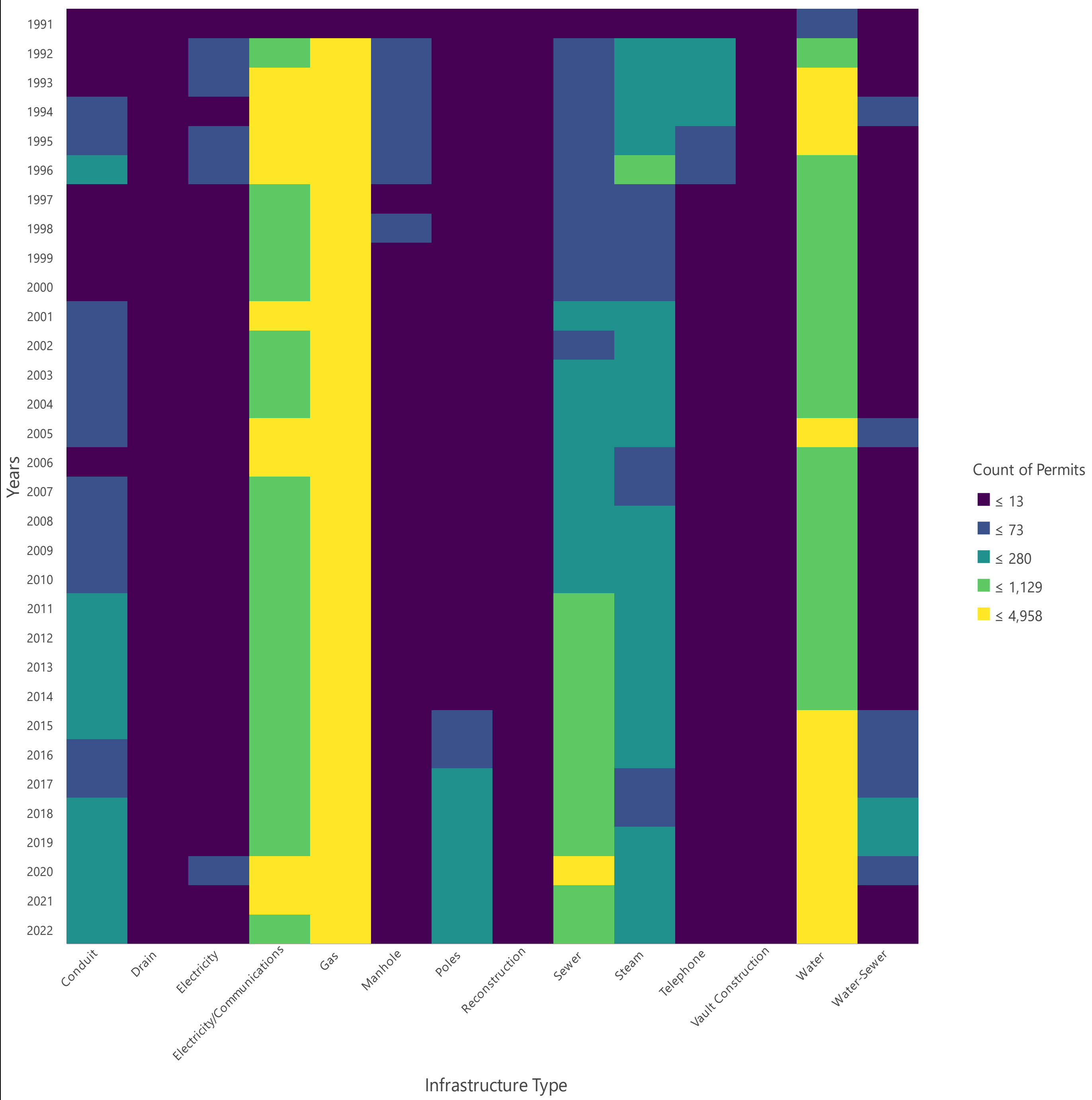
Debra Laefer (NYU)

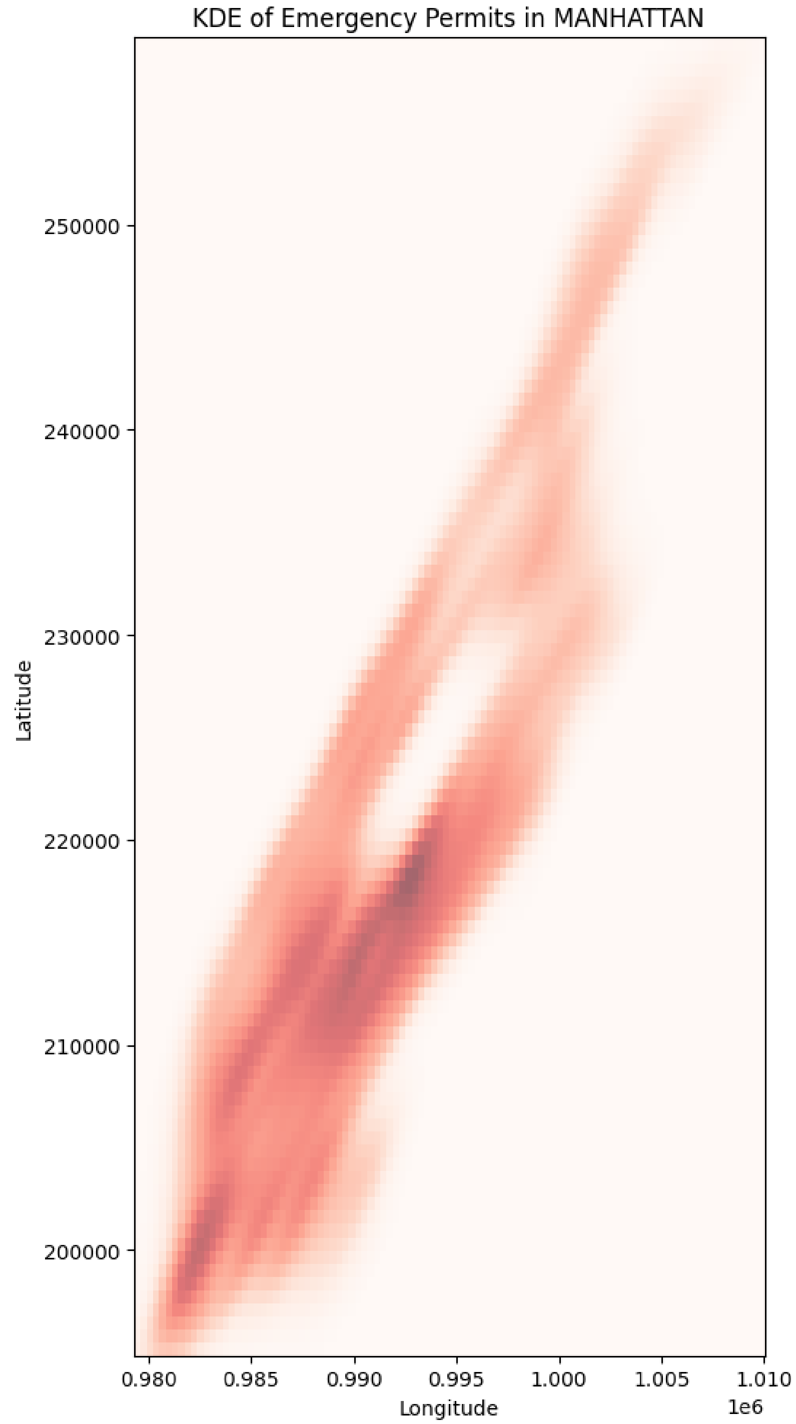
EXTENDED ANALYSIS



Distribution of Emergency vs Non-Emergency Permits by Infrastructure Type
1e6
1.0
0.8
0.6
0.4
0.2
Number of Permits
Permit Type
Emergency Permit
Non-Emergency Permit
Cable
Charging Station
Conduit
Drain
Electricity
Electricity/Communications
Embargo Work
Gas
Manhole
Poles
Private Sewer
Reconstruction
Sewer
Steam
Telephone
Transit
Tree Pit/Storm Water Inlet
Vault Construction
Water
Water-Sewer
Infrastructure Type

Emergency Permits in Protected Streets by Infrastructure Type




KDE of Emergency Permits in MANHATTAN
Latitude
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240000
230000
220000
210000
200000
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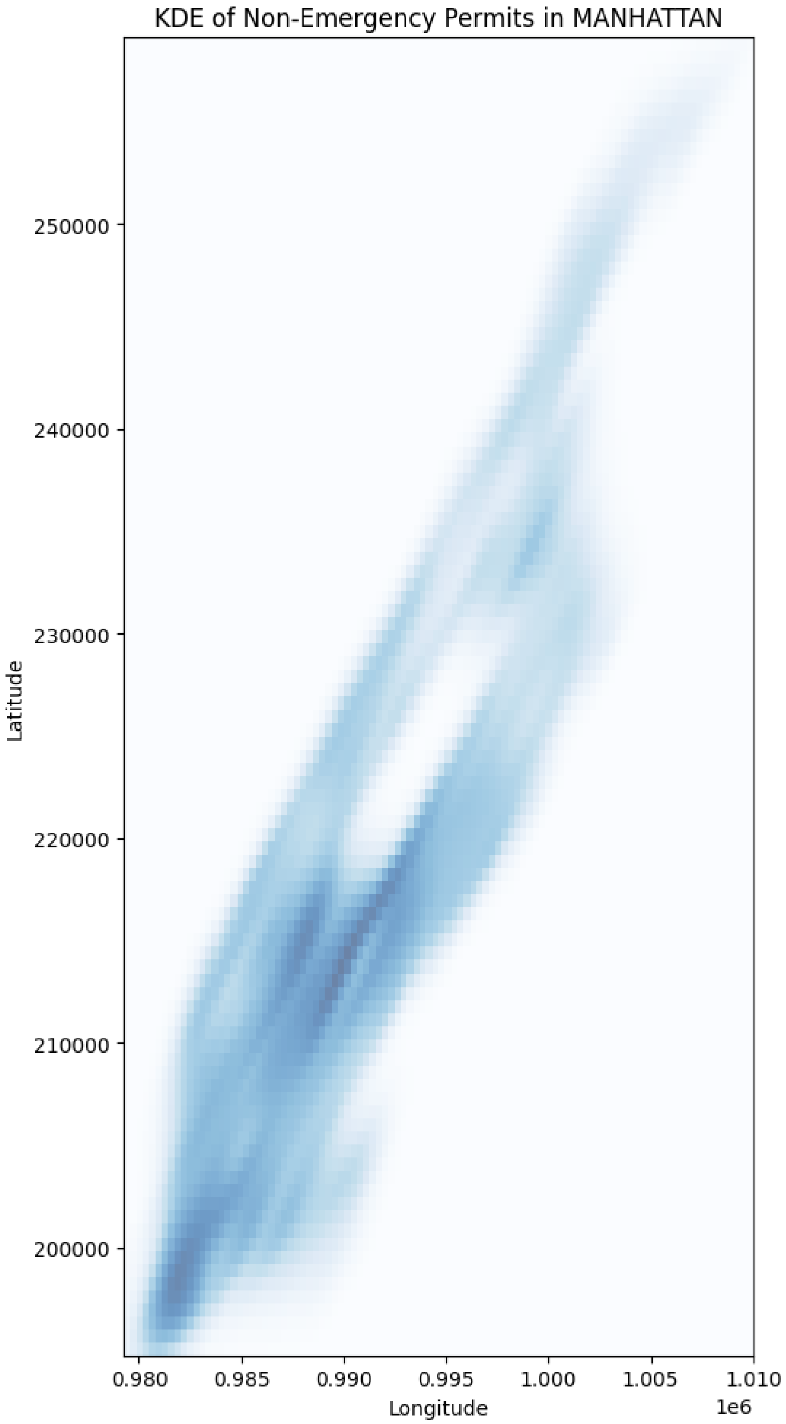
0.985
0.990
0.995
1.000
1.005
1.010
1e6
Longitude


KDE of Non-Emergency Permits in MANHATTAN
Latitude
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240000
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200000
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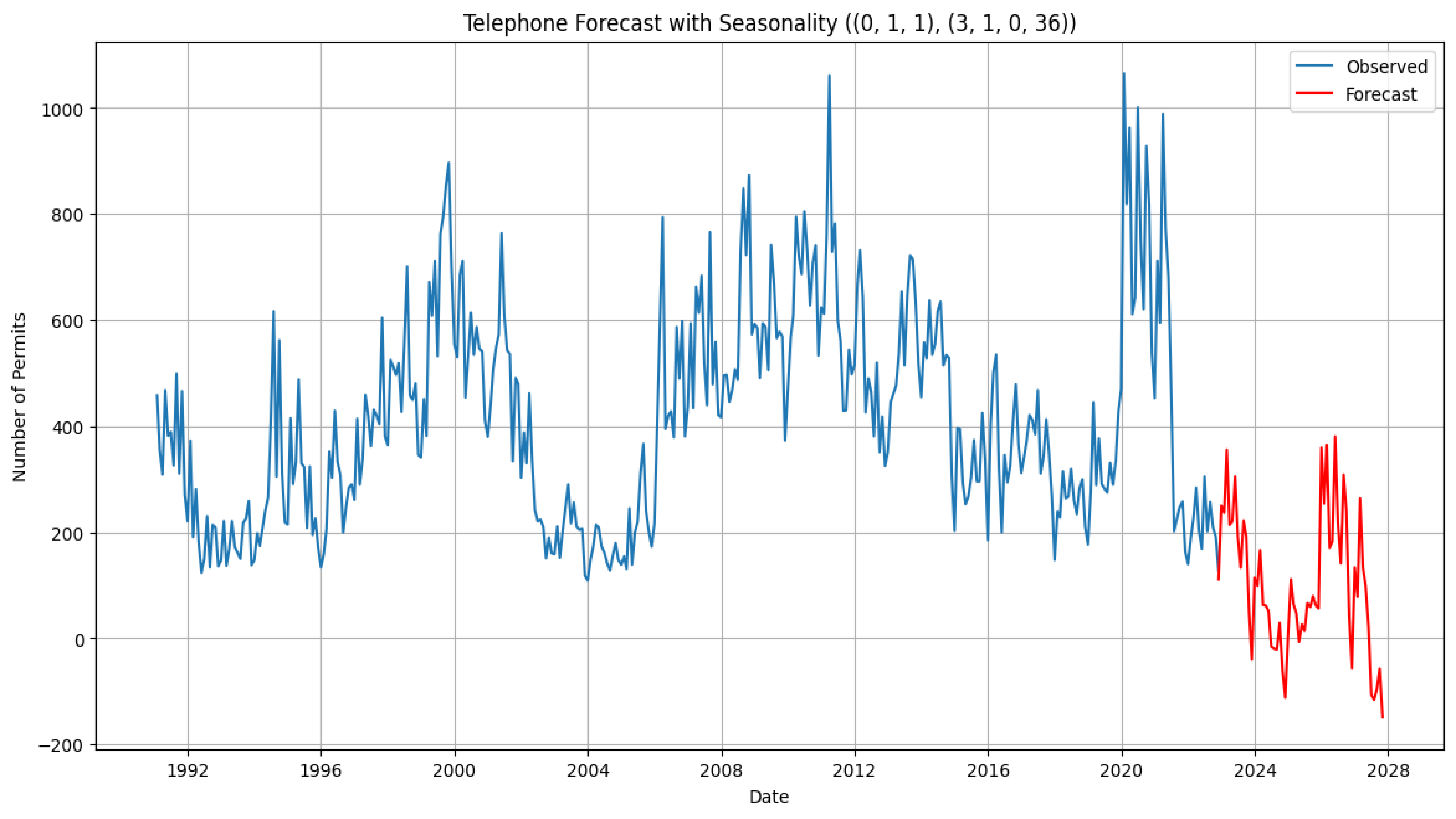
0.990
0.995
1.000
1.005
1.010
1e6
Longitude


Telephone Forecast with Seasonality ((0, 1, 1), (3, 1, 0, 36))
Observed
Forecast
Number of Permits
Date
1000
800
600
400
200
0
−200
1992
1996
2000
2004
2008
2012
2016
2020
2024
2028

TIME SERIES DECOMPOSITION FOR TELEPHONE RELATED PERMITS