

New York Metropolitan Transportation Council Regional Waste Movement Study

2025

Task 7 Waste Generation and Movement Forecast

Prepared For

New York Metropolitan Transportation Council

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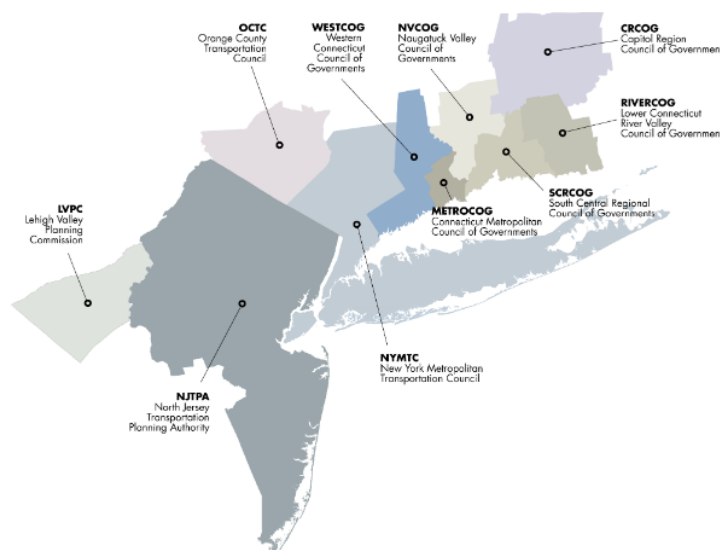
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1. Introduction

The Regional Waste Movement Study (RWMS) is focused on identifying the “needs and opportunities associated with the movement of municipal solid waste (MSW) and construction and demolition (C&D) debris” or waste in the Metropolitan Area Planning (MAP) Forum, which encompasses six Councils of Governments (COG) in Connecticut and four Metropolitan Planning Organizations (MPO) in New Jersey, New York, and Pennsylvania (refer to **Figure 1**) [1].

Figure 1: Metropolitan Area Planning (MAP) Forum Study Area [2]



This memorandum analyzes waste movement in the study area based on waste generation forecasts for the years 2035 and 2050. This memorandum details the methodology used for waste generation forecasting and presents the forecasted future waste quantities for the 2035 intermediate horizon and the 2050 horizon. It also describes the methodology used for waste movement modeling, its limitations, and elaborates on the effects of increased waste generation in 2035 and 2050, while also discussing factors such as increased rail use and changes in recycling rates within the study area.

This study employed a per-capita methodology for waste generation forecasts, although a Multiple Linear Regression (MLR) model would have been preferable. An MLR model would have provided a more robust statistical method of projecting future waste generation by incorporating multiple independent variables (e.g., number of households, household size, recycling rates, population density). However, the available data did not allow for this preferred approach. MLR modeling requires a statistical base of at least 30 cases, but the study area provided only 15 cases. Additionally, historical waste data was unavailable for New York State, meaning that the most significant waste-generating region of the study would not be represented in the MLR model.

For the waste movement model, the study used a shortest-trip destination methodology. This model was based on the calculated waste baseline from 2017-2021 and the waste projections for 2035 and 2050. Additionally, factors such as modal split, waste distribution, facility types and capacities, and mode capacities were considered. After creating a baseline model with the waste generation data from 2017 to 2021, a total of ten additional scenarios were developed to analyze the influence of changes in waste generation, modal split, waste destinations, and the life cycle of landfills within the region. The results expressed as annual tons, number of trips and travelled miles, were compared to the baseline model, leading to recommendations for future waste movement within the area.

2. Waste Generation Forecast

2.1 Methodology

This study utilized the per capita (waste/population) methodology to estimate waste generation [3, 4, 5].¹ This approach assumes current waste generation rates will remain constant in the future. While numerous alternative methodologies exist for developing waste forecasts including input/output models [6]; statistical models [7]; mixed methods models [8]; time-series analysis [9]; artificial neural networks [10, 11]; and Artificial Intelligence (AI) models [12, 13, 14], most of these approaches are more resource-intensive or are used primarily in an academic research rather than practical planning applications.

The per capita forecasting methodology used the best available waste generation and population data for each of the counties in the study area, except for CT, where the unit of analysis is the Councils of Governments (COGs).

To create the per capita ratio used for the calculation of the waste generation forecast quantities for each county or COG, the baseline quantities of waste generation were divided by the population numbers for the counties and COGs, respectively:

$$\text{Per capita waste generation} = \frac{\text{Average waste generation}}{\text{Population}}$$

2.1.1 Data

Waste Generation

The waste generation data used in the numerator for the waste per capita ratio was based on the following data:

- CT: 2017-2021 average – source: email request from the Connecticut Department of

¹ Initially, a statistical model using multiple linear regression (MLR) was considered, however limitations in the existing data and the low number of cases did not support the development of a statistically significant model that was representative of the entire study area (refer to **Attachment I**).

Energy & Environmental Protection (CTDEEP)²

- NJ: 2017-2021 average – source: New Jersey Department of Environmental Protection website [15]
- NY: 2018 only – source: New York State Solid Waste Management Plan [16]
- PA: 2017-2021 average – source: Pennsylvania Department of Environmental Protection website [17, 18]

Population

The population data by county/COG used as the denominator for the waste per capita ratio was as follows:

- CT: 2020 COG-level population data from the Connecticut Population Projections (Connecticut Council of Governments) [19]
- NJ: 2020 U.S. Decennial Census (county) [20, 21]
- NY: 2018 population estimates from the New York State Solid Waste Management Plan³ [16]
- PA: 2020 U.S. Decennial Census (county) [20, 21]

2.1.2 Waste Generation Forecast for 2035 and 2050

To create the 2035 and 2050 waste generation forecasts, the per capita ratios were multiplied by the population forecast estimates for the counties and COGs in the study area. Population estimates for 2035 and 2050 were provided by NYMTC for New York, New Jersey, and Pennsylvania [22].⁴ As presented in **Attachment III**, since the NYMTC population forecast does not include the population estimates for the CT COGs, the Connecticut Population Projections [19] were used instead. However, as these projections only extend until 2040, the population forecast for 2050 was calculated by estimating projections from 2040 to 2050 based on the increase or decrease of the projected population in the years 2015 through 2040 for the individual COGs.

Future efforts could enhance the waste generation forecasts by developing alternative scenarios that incorporate potential changes in waste compositions, different waste generation rates due to policy initiatives, or planned regulations impacting recycling rates. However, this type of scenario modeling would be most effective with consistent data across the study area, something that is not currently available, as detailed in the Task 4 Memorandum.

The per capita waste generation forecasts assume constant recycling rates and considers projections of waste diverted from disposal operations (i.e., landfill, incineration) to processing

² Personal communications with Connecticut Department of Energy & Environmental Protection, for Connecticut waste volumes for 2015, 2017, 2019, 2020, 2021, & 2022. June through August 2024. The CT source waste data reported at the town level and was aggregated to the COG level by the research team.

³ 2018 population estimates were used to align with available waste data from 2018.

⁴ Email of 10/21/24 from New York Metropolitan Transportation Council (Mike Chiume). It should be noted that recent research on population forecasts suggests a change in the age/sex pyramid (refer to **Attachment IV**). Specifically, instead of having the expected bulges in particular age ranges, the shape becomes more cylinder-like by 2050. This change could have yet to be examined consequences for waste generation.

facilities (sorting and recycling) based on the existing distribution of waste disposal processes reflected in the baseline waste generation data.

2.1.3 Waste types

The study incorporated MSW and C&D waste in the waste generation forecast and waste movement modeling. MSW data were used as reported across all jurisdictions. For C&D waste, the study used data as reported in PA and NY, where C&D is tracked separately. In NJ and CT, where C&D waste is not reported separately, the study used Non-MSW data instead, which includes C&D as well as some additional waste types. Specifically:

- New Jersey: Non-MSW includes C&D waste, animal and food processing waste, and dry-industrial waste. While the quantity of animal and food processing waste is very small, C&D waste and dry-industrial waste constitute large portions of Non-MSW in NJ.⁵
- Connecticut: Non-MSW includes bulky waste, C&D, land clearing, and special wastes. Because facilities and towns are not consistent with reporting categories, these categories are combined.⁶

Table 1 summarizes the waste types used for each state in the study area.

Table 1. Waste Types Included for the Waste Generation Forecast by State

State	Municipal Solid Waste (MSW)	Construction and Demolition Waste (C&D)	Non-Municipal Solid Waste (Non-MSW)
New Jersey	X		X
Pennsylvania	X	X	
Connecticut	X		X
New York	X	X	

2.2 Results of the waste generation forecasts for 2035 and 2050

Between 2017 and 2021, the study area's baseline waste generation averaged approximately 44.1 million tons annually, produced by a population of 23.6 million residents. This translates to an overall per capita waste generation rate of 1.87 tons per person per year.

The waste generation forecasts for 2035 and 2050 are presented in **Table 2** through **Table 9** and illustrated in **Figure 2** through **Figure 5**. There are significant disparities in waste generation rates across states:

- New York generates the largest share of total waste by volume, approximately 54% (23.8 million tons), corresponding to its substantial population of nearly 13 million.

⁵ Communication with Bayshore on New Jersey waste data and volumes, July 8, 2024.

⁶ Communications with Connecticut Department of Energy & Environmental Protection for Connecticut waste volumes for 2015, 2017, 2019, 2020, 2021, & 2022. June through August 2024.

- New Jersey follows with 38% (16.6 million tons) of total waste, despite a smaller population of 6.8 million.
- Together, New York and New Jersey contribute about 92% of the total regional waste, disproportionately higher than their combined population share of approximately 84%.
- Connecticut and Pennsylvania are minor contributors, responsible for 6% and 2% of regional waste generation, respectively.

Percentagewise, relatively little change occurs at the different time horizons. Some general observations are presented below.

Waste per-capita

- New Jersey has the highest per capita of waste generation in the study area at 2.44 tons per capita annually.
- New York's per capita rate is slightly lower, at 1.83 tons per capita annually.
- Pennsylvania's per capita rate is a modest 1.32 tons per capita annually.
- Connecticut has the lowest rate of waste generation at 0.89 tons per capita annually.

However, there are notable variations with each state.

- In NJ counties in the study area, waste generation rates range from 1.54 tons/capita in Warren County to 3.36 tons/capita in Middlesex County. Further, while Bergen County is the most densely populated county, Middlesex County generates the most waste.
- In the two PA counties in the study area, populations and waste generation rates (1.19 and 1.48 tons per capita) are relatively similar and low compared to counties in other states except Connecticut.
- In the CT COGs in the study area, waste generation rates range from 0.68 tons/capita in the Naugatuck Valley COG to 1.23 in the Western COG.
- In the NY counties in the study area, waste generation rates range from 1.48 tons/capita in Westchester County to 2.46 tons/capita in the Long Island counties. Further, while New York City County is the about 3 times more densely populated than Long Island, it only generates about 2 times more waste.

Waste generation and population growth

- 2035 population projections indicate moderate growth in NY and NJ, reaching approximately 14.0 million and 7.4 million respectively (up from 2020 baselines of 13.0 million and 6.8 million).
- By 2050, populations are projected to increase further to 14.7 million in NY and 7.9 million in NJ, while populations in PA and CT remain relatively stable.
- Despite growth, NY and NJ will maintain about 92% of waste generation proportions.
- NJ counties account for roughly half the population of NY counties but generate approximately 70% of NY's waste due to higher per capita rates.

Overall, the study area's waste generation is expected to increase by 13.4%, from 44.0 million tons to 50.0 million tons by 2050, driven predominantly by NY and NJ, which will contribute

approximately 3.1 million and 2.6 million tons respectively of the projected 6 million-ton regional increase.

Table 2. Waste Generation Forecast for study area

State	% of Regional Waste by State		
	Baseline	2035	2050
New Jersey	37.6	38.0	38.4
Pennsylvania	2.1	2.0	1.9
Connecticut	6.3	5.9	5.7
New York	54.0	54.1	54.0

Table 3. Baseline for Waste Generation Forecast for study area

State	Study area	Historical waste generation, ton	State, %	Study Area, %	Population baseline	Waste Generation per capita, ton/yr
State	New Jersey County	Average Waste Generation (2017-2021), ton	State, %	Study Area, %	Population 2020	Waste per capita, ton
NJ	Bergen	2,179,624	13.14%	4.95%	936,513	2.33
NJ	Essex	1,506,451	9.08%	3.42%	801,211	1.88
NJ	Hudson	1,246,811	7.52%	2.83%	678,229	1.84
NJ	Hunterdon	252,303	1.52%	0.57%	128,043	1.97
NJ	Middlesex	2,842,557	17.14%	6.45%	845,251	3.36
NJ	Monmouth	1,973,614	11.90%	4.48%	635,267	3.11
NJ	Morris	1,176,039	7.09%	2.67%	510,334	2.30
NJ	Ocean County	1,259,959	7.60%	2.86%	603,675	2.09
NJ	Passaic	1,403,129	8.46%	3.18%	515,359	2.72
NJ	Somerset	801,233	4.83%	1.82%	334,507	2.40
NJ	Sussex	260,940	1.57%	0.59%	151,005	1.73
NJ	Union	1,514,182	9.13%	3.44%	557,963	2.71
NJ	Warren	170,658	1.03%	0.39%	110,760	1.54
	Total	16,587,500	100.00	37.64%	6,808,117	2.44
State	Pennsylvania County	Average Waste Generation (2017-2021), ton	State, %	Study Area, %	Population 2020	Waste per capita, ton
PA	Lehigh	445,780	49.14%	1.01%	374,477	1.19
PA	Northampton	461,454	50.86%	1.05%	312,774	1.48
	Total	907,234	100.00%	2.06%	687,251	1.32

Table 3. Baseline for Waste Generation Forecast for study area

State	Study area	Historical waste generation, ton	State, %	Study Area, %	Population baseline	Waste Generation per capita, ton/yr
State	Connecticut COG	Average Waste Generation (2017-2021), ton	State, %	Study Area, %	Population 2020	Waste per capita, ton
CT	Capitol Region	831,901	30.17%	1.89%	994,214	0.84
CT	Lower CT River Valley	138,465	5.02%	0.31%	176,940	0.78
CT	Metropolitan	289,843	10.51%	0.66%	318,379	0.91
CT	Naugatuck Valley	304,899	11.06%	0.69%	451,413	0.68
CT	South Central	481,260	17.45%	1.09%	575,652	0.84
CT	Western	711,346	25.79%	1.61%	579,083	1.23
	Total	2,757,715	100.00%	6.26%	3,095,681	0.89
State	New York County	Waste generation 2018, ton	State, %	Study Area, %	Population 2018	Waste per capita, ton
NY	New York City	14,120,606	59.28%	32.04%	8,390,081	1.68
NY	Long Island	6,983,966	29.32%	15.85%	2,833,381	2.46
NY	Orange	586,200	2.46%	1.33%	382,126	1.53
NY	Putnam	212,900	0.89%	0.48%	98,814	2.15
NY	Rockland	485,000	2.04%	1.10%	325,522	1.49
NY	Westchester	1,432,500	6.01%	3.25%	968,213	1.48
	Total	23,821,172	100.00%	54.05%	12,998,137	1.83
Study Area	Total	44,073,620			23,589,186	1.87
<i>Notes:</i> 1. The baseline waste quantities differ from the numbers reported in the Task 5 of the Regional Waste Movement Study, as the above numbers are based on a calculated average of the years 2017-2021 (except NY). <i>Sources:</i> <i>NJ:</i> New Jersey Department of Environmental Protection. NJDEP-Recycling Information [15] <i>PA:</i> Pennsylvania Department of Environmental Protection, Bureau of Waste Management. Disposal Data Pennsylvania Department of Environmental Protection, Bureau of Waste Management. Recycling Data [17, 18] <i>CT:</i> Communications with Connecticut Department of Energy & Environmental Protection <i>NY:</i> NYSDEC New York State Solid Waste Management Plan [16]						

Table 4. Waste Generation Forecast 2035 for study area

State	New Jersey County	Waste Generation per capita, ton	Population Forecast 2035	Waste Forecast 2035, ton	State, %	Study Area, %
NJ	Bergen	2.33	1,014,224	2,360,485	13.09%	4.98%
NJ	Essex	1.88	901,202	1,694,455	9.40%	3.58%

Table 4. Waste Generation Forecast 2035 for study area

State	New Jersey County	Waste Generation per capita, ton	Population Forecast 2035	Waste Forecast 2035, ton	State, %	Study Area, %
NJ	Hudson	1.84	779,618	1,433,198	7.95%	3.02%
NJ	Hunterdon	1.97	133,033	262,135	1.45%	0.55%
NJ	Middlesex	3.36	913,318	3,071,465	17.04%	6.48%
NJ	Monmouth	3.11	659,033	2,047,450	11.36%	4.32%
NJ	Morris	2.30	523,451	1,206,265	6.69%	2.55%
NJ	Ocean County	2.09	714,569	1,491,411	8.27%	3.15%
NJ	Passaic	2.72	554,034	1,508,428	8.37%	3.18%
NJ	Somerset	2.40	362,060	867,230	4.81%	1.83%
NJ	Sussex	1.73	149,597	258,507	1.43%	0.55%
NJ	Union	2.71	607,754	1,649,302	9.15%	3.48%
NJ	Warren	1.54	114,663	176,671	0.98%	0.37%
	Total	2.44	7,426,555	18,027,003	100%	38.03%
State	Pennsylvania County	Average Waste Generation per capita, ton	Population 2035	Waste Generation 2035, ton	State, %	Study Area, %
PA	Lehigh	1.19	398,856	474,801	50.70%	1.00%
PA	Northampton	1.48	312,902	461,643	49.30%	0.97%
	Total	1.32	711,758	936,443	100%	1.98%
State	Connecticut COG	Average Waste Generation per capita, ton	Population 2035	Waste Generation 2035, ton	State, %	Study Area, %
CT	Capitol Region	0.84	1,025,364	857,966	30.83%	1.81%
CT	Lower CT River Valley	0.78	174,107	136,248	4.90%	0.29%
CT	Metropolitan	0.91	324,081	295,034	10.60%	0.62%
CT	Naugatuck Valley	0.68	450,600	304,350	10.94%	0.64%
CT	South Central	0.84	593,319	496,030	17.82%	1.05%
CT	Western	1.23	564,567	693,515	24.92%	1.46%
	Total	0.89	3,132,038	2,783,143	100%	5.87%
State	New York County	Average Waste Generation per capita, ton	Population 2035	Waste Generation 2035, ton	State, %	Study Area, %
NY	New York City	1.68	8,963,676	15,085,973	58.82%	31.83%
NY	Long Island	2.46	3,078,552	7,588,285	29.58%	16.01%
NY	Orange	1.53	450,958	691,791	2.70%	1.46%
NY	Putnam	2.15	103,240	222,436	0.87%	0.47%
NY	Rockland	1.49	373,518	556,510	2.17%	1.17%
NY	Westchester	1.48	1,017,033	1,504,731	5.87%	3.17%
	Total	1.83	13,986,977	25,649,726	100%	54.12%

Table 4. Waste Generation Forecast 2035 for study area

State	New Jersey County	Waste Generation per capita, ton	Population Forecast 2035	Waste Forecast 2035, ton	State, %	Study Area, %
Study Area	Total	1.87	25,257,328	47,396,316		
<i>Notes:</i> 1. The totals of waste per capita (ton) for the individual states and the study area in total represents the average for the study area based on the total baseline population and waste generation. The totals of the 2035 projected total waste generation are not calculated by totals of waste per capita (ton) and the 2035 projected totals of population, but the sum of the individual counties' or COGs' figures. <i>Sources:</i> <i>NJ:</i> New Jersey Department of Environmental Protection. NJDEP-Recycling Information [15] <i>PA:</i> Pennsylvania Department of Environmental Protection, Bureau of Waste Management. Disposal Data Pennsylvania Department of Environmental Protection, Bureau of Waste Management. Recycling Data [17, 18] <i>CT:</i> Communications with Connecticut Department of Energy & Environmental Protection <i>NY:</i> NYSDEC New York State Solid Waste Management Plan [16]						

Table 5. Waste Generation Forecast 2050 for study area in New Jersey, Pennsylvania, Connecticut and New York

State	Study area	Waste Generation per capita, ton	Pop Forecast 2050	Waste Forecast 2050, ton	State, %	Study Area, %
State	New Jersey County	Average Waste/ Pop2020, ton	Population 2050	Waste Generation 2050, ton	State, %	Study Area, %
NJ	Bergen	2.33	1,100,975	2,562,387	13.34%	5.13%
NJ	Essex	1.88	964,789	1,814,013	9.44%	3.63%
NJ	Hudson	1.84	875,849	1,610,103	8.38%	3.22%
NJ	Hunterdon	1.97	135,661	267,315	1.39%	0.53%
NJ	Middlesex	3.36	956,858	3,217,890	16.75%	6.44%
NJ	Monmouth	3.11	682,707	2,120,997	11.04%	4.24%
NJ	Morris	2.30	538,359	1,240,620	6.46%	2.48%
NJ	Ocean County	2.09	778,458	1,624,757	8.46%	3.25%
NJ	Passaic	2.72	594,700	1,619,145	8.43%	3.24%
NJ	Somerset	2.40	371,734	890,403	4.63%	1.78%
NJ	Sussex	1.73	152,228	263,054	1.37%	0.53%
NJ	Union	2.71	664,404	1,803,039	9.38%	3.61%
NJ	Warren	1.54	116,097	178,881	0.93%	0.36%
	Total	2.44	7,932,819	19,212,603	100%	38.44%

Table 6. New Jersey Waste Generation Forecast 2035-2050, ton

County	Average Waste Generation (2017-2021)	Waste Generation 2035	Waste Generation 2050
Bergen County	2,179,624	2,360,485	2,562,387
Essex County	1,506,451	1,694,455	1,814,013
Hudson County	1,246,811	1,433,198	1,610,103
Hunterdon County	252,303	262,135	267,315
Middlesex County	2,842,557	3,071,465	3,217,890
Monmouth County	1,973,614	2,047,450	2,120,997
Morris County	1,176,039	1,206,265	1,240,620
Ocean County	1,259,959	1,491,411	1,624,757
Passaic County	1,403,129	1,508,428	1,619,145
Somerset County	801,233	867,230	890,403
Sussex County	260,940	258,507	263,054
Union County	1,514,182	1,649,302	1,803,039
Warren County	170,658	176,671	178,881
Total	16,587,500	18,027,003	19,212,603

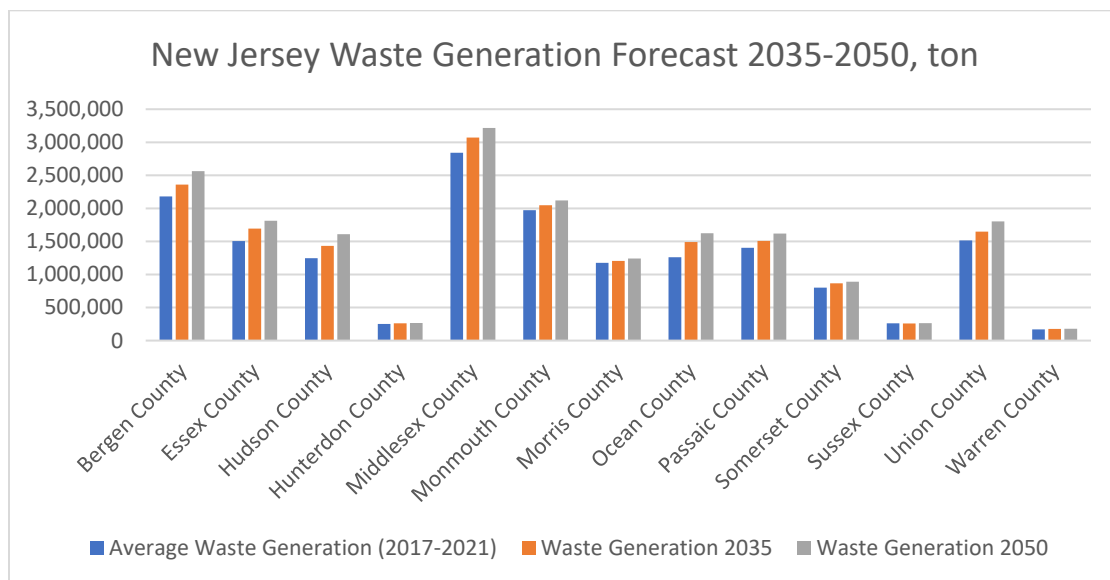
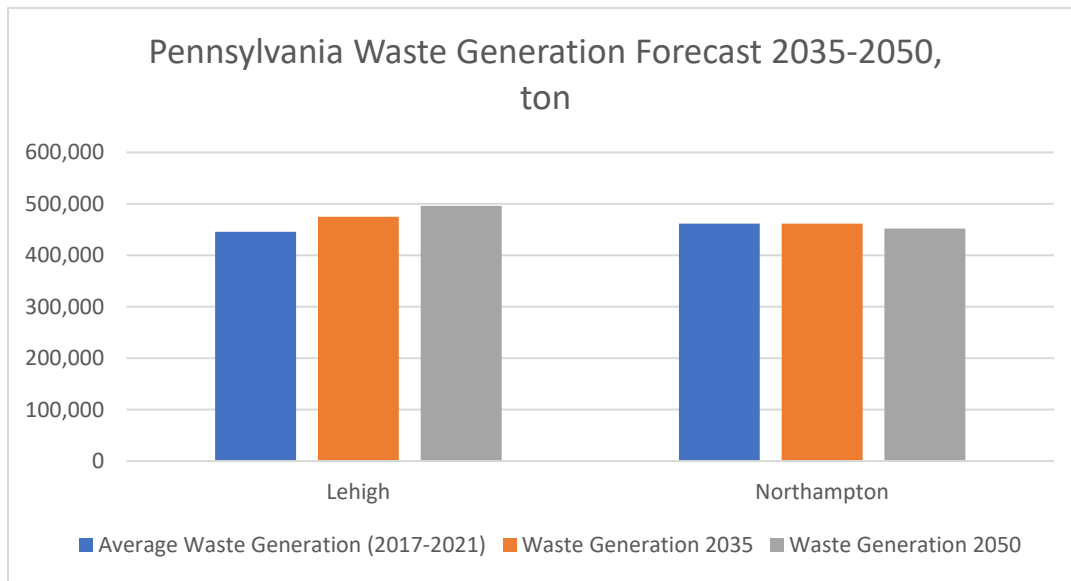
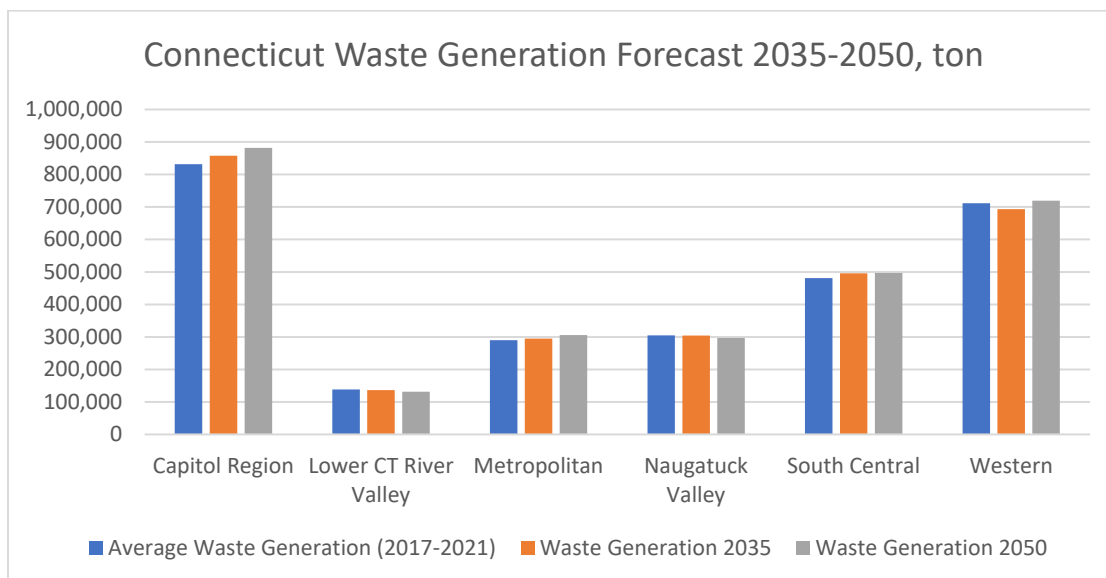
Figure 2: New Jersey Waste Generation Forecast 2035-2050, ton

Table 7. Pennsylvania Waste Generation Forecast 2035-2050, ton

County	Average Waste Generation (2017-2021)	Waste Generation 2035	Waste Generation 2050
Lehigh	445,780	474,801	496,173
Northampton	461,454	461,643	451,895
Total	907,234	936,443	948,068

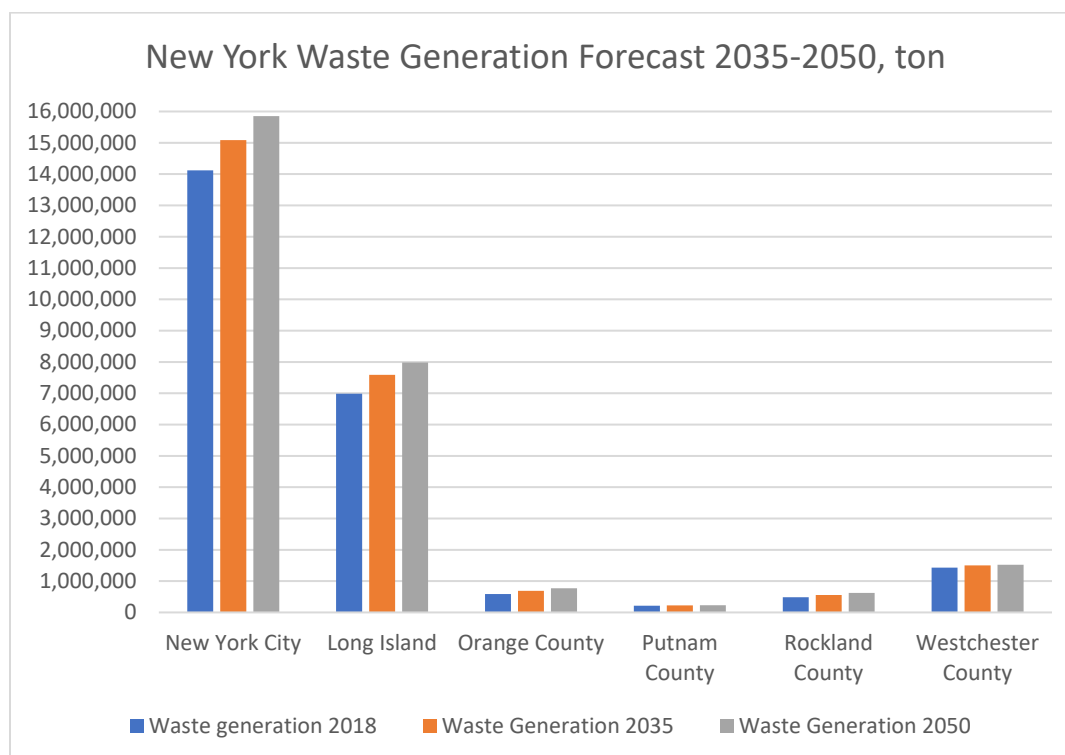
Figure 3: Pennsylvania Waste Generation Forecast 2035-2050, ton**Table 8. Connecticut Waste Generation Forecast 2035-2050, ton**

COG	Average Waste Generation (2017-2021)	Waste Generation 2035	Waste Generation 2050
Capitol Region	831,901	857,966	881,759
Lower CT River Valley	138,465	136,248	131,365
Metropolitan	289,843	295,034	305,792
Naugatuck Valley	304,899	304,350	296,990
South Central	481,260	496,030	496,816
Western	711,346	693,515	719,254
Total	2,757,715	2,783,143	2,831,976

Figure 4: Connecticut Waste Generation Forecast 2035-2050, ton**Table 9. New York Waste Generation Forecast 2035-2050, ton**

County	Waste generation 2018	Waste Generation 2035	Waste Generation 2050
New York City	14,120,606	15,085,973	15,851,373
Long Island	6,983,966	7,588,285	7,982,191
Orange County	586,200	691,791	770,833
Putnam County	212,900	222,436	230,772
Rockland County	485,000	556,510	624,626
Westchester County	1,432,500	1,504,731	1,523,126
Total	23,821,172	25,649,726	26,982,923

Figure 5: New York Waste Generation Forecast 2035-2050, ton



2.3 Conclusions and Recommendations

The waste generation forecasts used the most reliable and recent available data for each state within the study area. Due to data limitations, further scenario development (e.g., changes in the distribution of waste amounts or different waste destinations) was not feasible. Therefore, the waste generation forecasts reflect projected changes in population. Relative to the baseline period (average waste generation 2017-2021 for NJ, PA and CT; and 2018 for NY), waste generation is projected to increase by 7.5% in 2035 and by 13.4% in 2050.

Waste generation rates vary significantly across the study area, from 2.44 tons per capita annually in New Jersey to 0.89 tons per capita in Connecticut. Generally, more densely populated areas generate less waste per capita. For instance, New York County (Manhattan) is about three times more densely populated than the Long Island counties but only generates twice as much waste. New York and New Jersey remain the primary contributors to study area waste, together accounting for 92 percent of the total waste generated. However, despite having roughly half the population of New York counties, New Jersey counties accounts for about 70 percent of New York's volume of waste generated due to higher per capita rates.

A key observation is the necessity for uniform waste data collection, reporting methods, and definitions across counties within the study area. Current differences in waste type definitions and inconsistent time series data reporting significantly limit direct comparisons and comprehensive regional analyses. Implementing standardized reporting frameworks would

enhance accuracy, comparability, and overall reliability of waste generation forecasting in future studies.

3. Waste Movement Modeling

3.1 Methodology

The waste movement modeling aimed to predict and analyze trip patterns between waste collection points and waste disposal or processing facilities. Specifically, the modeling sought to answer the following questions:

- What annual tonnage of waste is transported through the study area?
- What are the annual number of trips by mode of transport?
- Where are the forecasted waste destinations⁷?
- What distance does waste travel?

Due to limited data availability and inconsistencies across the study area regarding detailed waste flow information, the model analyzed MSW and C&D waste movement using a shortest-trip distribution method using Quantum Geographical Information System (QGIS). In this approach, waste was allocated to the nearest suitable landfill, incinerator, or processing facility, based primarily on proximity, available facility capacity, and the selected transportation mode. Waste disposal contracts, agreements, and other regulatory constraints were not considered. The model also accounted for waste being exported from the study area by assigning these flows to locations just beyond the study area's boundary. However, imported waste flows from outside the study area were not included.

The shortest-trip distribution method, while practical for modeling purposes, has limitations. It assumes a fixed relationship between travel cost or distance and trip generation, which may oversimplify actual travel behavior. The approach does not account for variations due to changing travel costs, times, or external factors such as fuel prices, tolls, or regulatory constraints, nor does the model incorporate qualitative considerations such as operator preferences, regulatory constraints, or land use. Furthermore, the method presumes that travel behavior is primarily driven by distance and size (population or employment) of zones, overlooking socio-economic differences and behavior variability. While the method uses travel cost or distance as a deterrent function, it often assumes a fixed relationship between these and trip generation. In reality, travel costs (e.g., fuel prices, tolls) and travel times (e.g. state permits) can change significantly, altering trip patterns in ways the model cannot capture accurately. As a result, trip projections are likely oversimplified.

Despite these limitations, the waste movement model illustrates patterns of waste distribution, providing data on out-of-study-area exports, intra-state transfers in the study area, and inter-state movements in the study area. The model outputs include clear metrics on waste movement distribution patterns, trip counts, and mileage traveled.

⁷ No data on movement patterns for waste transport was available therefore definitive, quantitative statements about effects on specific corridors could not be made.

In addition to the waste generation baseline from 2017-2021 and the 2035 and 2050 forecasts, scenarios were also analyzed to understand the influence of potential changes in rail use and decrease or increase in the use of recycling facilities.

3.2 Model Inputs

The waste movement model used the following inputs: transportation mode network (road, rail and barge), waste origins and destinations, destination capacities, modal splits, waste distribution patterns, waste generation forecasts, and transportation mode capacities.

3.2.1 Network

The road and rail network were sourced from the TranSearch⁸ database, including road types, and routes where trucks are permitted to transport waste, such as interstate and state highways. The barge network, derived from OpenStreetMap, included only connections within the study area. As a result, barges were not considered as a mode to transport waste outside the study area, but instead, were assumed to be used in combination with trains as intermodal transportation.

3.2.2 Waste Origins and Destinations

Waste origins and destinations used in this model were identified in Tasks 4 and 5. Waste origins include municipalities and transfer stations within the study area. Destinations include landfills, incinerators, and processing facilities. To represent waste exports out of the study area, destinations were designated at points on highways and rail lines just beyond the study area boundary. Detailed locations of external waste destinations were not included. Therefore, the network length for vehicles leaving the study area only includes the travel distance through the study area (i.e., it does not include the total length of trips).

Additionally, intermodal facilities were located based on Tasks 4 and 5. These facilities functioned not as final destinations, but intermediate destinations used to transfer waste from one mode of transport to another (i.e., from truck to train or barge to train).

3.2.3 Waste Destination Capacities

Waste destination facilities included landfills, incinerators, and processing facilities. A lifecycle analysis, detailed in the Task 6 Memorandum, was conducted for landfills and incinerators, estimating anticipated closure dates based on current facility capacities and potential expansions. Due to inadequate data regarding processing facility capacities, the model assumed that these facilities could handle incoming waste volumes, directing waste flows to the nearest processing facility within the study area.

The landfill lifecycle analysis assessed facility availability using two distinct approaches: the Constant Stream (CS) scenario and the Open Market (OM) scenario. Under the CS scenario, landfill capacities were projected based on historical waste acceptance rates, assuming each facility would continue to accept waste consistently until closure. In contrast, the OM scenario

⁸ <https://www.spglobal.com/market-intelligence/en/solutions/products/transearch-freight-transportation-research>

modeled landfill capacity as a regional resource without restrictions, assuming waste could freely move to any landfill across the region without regulatory, infrastructure, or economic constraints. The projected availability of landfill capacity under these two scenarios for the years 2035 and 2050 is summarized in **Table 10**.

Table 10. Landfill availability with expansion according to Life Cycle Analysis

Name	State	Open in 2035 CS	Open in 2035 OM	Open in 2050 CS	Open in 2050 OM
Bethlehem Landfill	Pennsylvania	no	yes	no	no
Chrin Brothers Sanitary Landfill	Pennsylvania	yes	yes	no	no
Grand Central Sanitary Landfill	Pennsylvania	yes	yes	no	no
110 Sand Company Clean Fill Disposal Site	New York	yes	yes	yes	no
Babylon Southern Ashfill	New York	yes	yes	no	no
Blydenburgh Road Landfill Complex	New York	yes	yes	no	no
Brookhaven Waste Management Facility	New York	no	yes	no	no
Port Jefferson Village Clean Fill	New York	no	yes	no	no
Landfill - Avon	Connecticut	no	no	no	no
Landfill - Essex	Connecticut	no	no	no	no
Landfill - Glastonbury	Connecticut	no	no	no	no
Town of Manchester Landfill	Connecticut	no	no	no	no
Landfill - Monroe	Connecticut	no	no	no	no
Suffield Landfill	Connecticut	yes	no	yes	no
Landfill - Thomaston	Connecticut	no	no	no	no
Middlesex County Landfill	New Jersey	no	yes	no	no
Monmouth County Regional Sanitary Landfill	New Jersey	no	yes	no	no
Ocean County LF Corp	New Jersey	yes	yes	no	no
Sussex County Solid Waste Complex	New Jersey	yes	yes	yes	no
Warren County -PCFAWC	New Jersey	yes	yes	yes	no

Incinerator capacities within the study area (see Task 6 Memorandum) are summarized in **Table 11**.

Table 11. Incinerator Capacities

State	Name	Permitted Capacity (Tons per Year)
New York	Hempstead Resource Recovery Facility	1,040,250
New York	Babylon Resource Recovery Facility	287,442
New York	Reworld MacArthur Renewable Energy	177,025
New York	Huntington Resource Recovery Facility	350,400
New York	Wheelabrator Westchester L.P.	755,000
New Jersey	Essex County RRF Newark*	985,500
New Jersey	Union County RRF Rahway*	562,100
Connecticut	Reworld Bristol Resource Recovery Facility	261,340
Connecticut	Wheelabrator Bridgeport Resource Recovery Facility	821,250

3.2.4 Modal split

The modal split was provided by members of the steering committee, obtained from publicly available information or, where data was unavailable, assumed based on the modal split in other counties or COGs in the state. In New Jersey, an overall allocation of 93% truck, 3% train and 4% barge for the state was provided by the North Jersey Transportation Planning Authority (NJTPA). Based on the modeling approach and lack of intermodal facilities supporting barge movement, the 4% barge modal split was removed and that proportion reallocated evenly between truck and train. This resulted in a final 95% truck and 5% rail modal split in New Jersey with the modal split of individual counties determined as:

- 1: *Counties without intermodal facilities*: Assumed to only have trucks for waste movement.
- 2: *Counties with an intermodal facility*: the modal split was uniformly adjusted between truck and rail to establish a statewide allocation that was close to the assumed 95/5. The final selected modal split was 90/10 for these counties, which resulted in a statewide 94/6 modal split. Further refinement could result in the 95/5 split; however, given the absence of supporting data, it is likely not statistically defensible to parse further.

The modal split used for the model is provided on county or COG level in **Table 12**. Note that as trains and barges are intermodal transport throughout the study area, trucks are required for waste transport to dedicated transfer stations. This creates a higher number of trips from origin to destination compared to only using trucks as the mode of transport.

Table 12. Modal split per county / COG

State	County / COG	Truck	Train	Barge	Data source
New Jersey	Bergen County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Essex County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Hudson County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Hunterdon County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Middlesex County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Monmouth County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Morris County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Ocean County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Passaic County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Somerset County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Sussex County	100%	0%	0%	NJTPA (adjusted)
New Jersey	Union County	90%	10%	0%	NJTPA (adjusted)
New Jersey	Warren County	100%	0%	0%	NJTPA (adjusted)
Pennsylvania	Lehigh	95%	5%	0%	LVPC
Pennsylvania	Northampton	95%	5%	0%	LVPC
Connecticut	Capitol Region ¹	92%	5%	0%	CRCOG
Connecticut	Lower CT River Valley	95%	5%	0%	Assumption
Connecticut	Metropolitan	91%	4%	5%	MetroCOG
Connecticut	Naugatuck Valley	95%	5%	0%	Assumption
Connecticut	South Central	95%	5%	0%	Assumption
Connecticut	Western	95%	5%	0%	WestCOG
New York	New York City ²	50%	50%	23%	DSNY
New York	Long Island	99%	1%	0%	External Research ^{3,4}
New York	Orange County	100%	0%	0%	Assumption
New York	Putnam County	100%	0%	0%	Assumption
New York	Rockland County	100%	0%	0%	Rockland County

Table 12. Modal split per county / COG

State	County / COG	Truck	Train	Barge	Data source
New York	Westchester County	100%	0%	0%	Assumption
Notes: 1. The Capitol Region has 3% of waste transported via air freight. This mode was not modeled. 2. In New York City barges are used in combination with trains, therefore the additional barge share of 23% is included with the 50% train share 3. https://messengerpapers.com/2024/06/li-life-and-politics-call-for-trains-to-haul-waste-off-long-island/ 4. https://www.brookhavenny.gov/CivicAlerts.aspx?AID=4239					

3.2.5 Waste Distribution

The data source for calculating the waste distribution split between out-of-area destinations, landfills, incinerators and processing plants (recycling) varied for each state and was calculated in different ways. The waste distribution per state is shown in **Table 13**.

In Pennsylvania, the 2022 waste data available from the Pennsylvania Department of Environmental Protection (PADEP) did not include recycled waste or waste transported out of state. Therefore, the percentage of waste leaving the study area was calculated based on the percentage of waste leaving the Pennsylvania counties in the study area to the remaining counties in the state. Recycling rates were estimated using 2021 figures, and it was assumed that the recycling rate of waste within the study area was similar to waste transferred out of the study area.

For New Jersey, as noted in the Task 5 Memorandum, waste data included recycled, landfilled and incinerated waste, as well as information about the destination of waste. This allowed the team to calculate how much waste remained in the New Jersey counties in the study area, how much was sent to other New Jersey counties outside the study area, how much waste was sent to other counties or COGs within the study area, and how much waste left the study area entirely. Rates of recycling, landfilling, and incineration were estimated for the waste remaining within the study area.

For New York, the waste distribution was based on data collected during Task 5, including 2022 data on MSW and non-MSW disposed within the state and out of state, as well as data on incineration use. The recycling rates were calculated according to the 2021 recycling rates.

In Connecticut, data from 2022 included quantities of MSW incinerated in state, disposed out of state, and recycled. MSW was not landfilled in Connecticut.

Due to lack of data, the forecasted recycling development was unknown. Therefore, the model assumed linear growth in waste generation and held recycling rates constant over time.

Table 13. Waste distribution per state

State	Out of Area	Landfill	Incineration	Recycling
New Jersey	77%	12%	0%	11%
Pennsylvania	42%	27%	0%	31%
Connecticut	23%	0%	57%	20%
New York	19%	33%	8%	40%

3.2.6 Waste Generation Forecasts for 2035 and 2050

The results from the waste generation forecast, presented in **Section 2**, were used to define the baseline for the transportation model and inform the transportation forecast for the horizon years of 2035 and 2050. Waste quantities were distributed to municipalities and transfer stations based on the projected population distribution, and waste within each municipality was distributed equally among that municipality's transfer station(s).

The waste data used did not differentiate between MSW and C&D waste. However, different waste types typically use different transport modes and are destined for facilities that may only accept one type of waste. As a result, the model was unable to account for these differences.

3.2.7 Mode Capacities

The mode capacities for trucks, trains, and barges, presented in **Table 14**, were used to inform the number of trips for each mode. Although freight trains usually carry a mix of commodities, this model represents train trips as dedicated waste-only train equivalents to simplify the analysis. The movement model did not consider rail capacity or scheduling. Finally, the model used average freight train capacity to estimate train capacity in the network. The actual amount of waste transported by train can vary.

Table 14. Mode capacities

Mode	Capacity	Source
Truck	20 tons	Task 3 Memorandum
Train	3100 tons	2020 freight average USA
Barge	2000 tons	Task 3 Memorandum

3.3 Modeled Scenarios

Movement modeling considered 11 scenarios, including the baseline and five alternatives for the 2035 and 2050 horizons (see **Table 15**) which evaluated the impact of alternative life cycle analyses, a 20% increase in rail transport, and a 10% increase or decrease in recycling rates.

Attachment V includes the data matrices read into the model, showing the changes in modal split and waste distribution across destinations and municipalities.

3.3.1 Baseline 2017-2021

The baseline scenario was based on waste generation from the 2017-2021 (2018 for New York), described in **Section 2.1.1**. In this scenario all destination landfills, incinerators, and processing facilities were assumed to be open and operating.

3.3.2 Life cycle assessment (LCA)

Constant stream and open market scenarios were considered for the 2035 and 2050 waste movement forecasts. In both scenarios, waste was directed from its origin to the nearest available landfill. In the Constant Stream scenario, once the facility closest to the waste origin reached its capacity, it was assumed that the waste was transported outside the study area. For the Open Market scenarios, once the facility closest to the waste origin reached its capacity, the waste was redirected to the closest landfill with remaining capacity. In the 2050 scenario, all landfills had reached capacity and therefore, all waste generated was assumed to be transported outside the study area. Apart from changes in landfill destinations, all other inputs remained unchanged in both scenarios.

The Constant Stream scenario was considered the baseline scenario for the forecasted years 2035 and 2050. This was chosen because it is not possible to say whether the remaining landfills in 2035 and 2050 will accept waste previously going to closed landfills due to contractual, regulatory, and political influences. Therefore, during the rail and recycling scenarios the constant stream approach was used.

3.3.3 Rail increase

This scenario considers an increase in rail use by 20% over the entire study area in both 2035 and 2050. This was not based on any rail construction plans within the region, rather it was used to investigate the impact that a region-wide strategic shift to rail would produce. This scenario resulted in an increase in intermodal transport throughout the study area due to the required waste transfer from truck to rail.

Although the construction of a new rail line or expansion of an existing one may not be feasible in the short timeframe until 2050, this modelled scenario shows how such a change could influence waste movement within the study area when compared to the baseline for 2035 and 2050.

Rail proved particularly relevant for long-distance hauls, with the greatest effect seen in the ‘Out of Area’ destination, where rail’s efficiency over long distances made it more favorable. It should be noted that while the modal split was changed in this scenario, the amount of waste going to each destination remained constant.

3.3.4 Recycling changes

Two additional scenarios considered a 10 percent increase or decrease from the current recycling rates, representing the effects of potential new waste reduction strategies and policies adopted in the study area. The model split in this scenario remained constant. These changes primarily influenced the volume of waste leaving the study area by truck.

Table 15. Modeled Waste Transport Scenario overview

Number	Scenario	Abbreviation
1	Baseline 2017-2021	Baseline
2	2035 Constant Stream Landfill	2035 CS
3	2035 Open Market Landfill	2035 OM
4	2035 Constant Stream Landfill and Decrease in Recycling (-10%)	2035 Rec De
5	2035 Constant Stream Landfill and Increase in Recycling (+10%)	2035 Rec In
6	2035 Constant Stream Landfill and Shift Road to Rail (20%)	2035 Rail
7	2050 Constant Stream Landfill	2050 CS
8	2050 Open Market Landfill	2050 OM
9	2050 Constant Stream Landfill and Decrease in Recycling (-10%)	2050 Rec De
10	2050 Constant Stream Landfill and Increase in Recycling (+10%)	2050 Rec In
11	2050 Constant Stream Landfill and Shift Road to Rail (20%)	2050 Rail

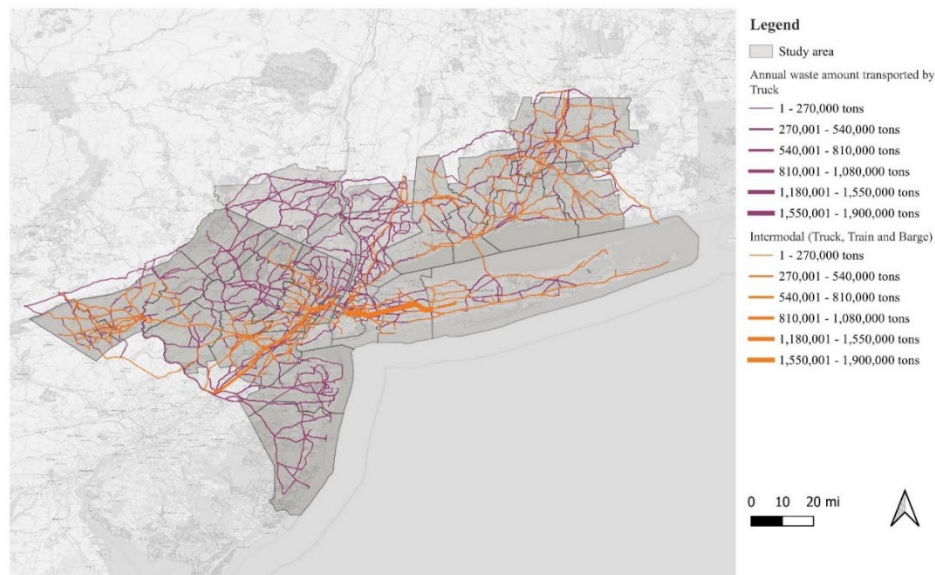
3.4 Results of the waste movement modelling

The results of the movement model offer insights into the waste dynamics within the study area, focusing on three key metrics: waste volume, number of trips, and travelled miles.

- **Waste volume** refers to the total tonnage of waste transported within and beyond the study area, reflecting how much waste is moving across the network under different conditions.
- The **number of trips** reflects the frequency of waste transportation, contingent on the mode used (i.e., truck, rail, or barge) and intermodal connections, where a single origin-destination pair might necessitate multiple trips. This metric illustrates the volume of waste vehicles traversing the area annually, shedding light on interstate movements and interactions with surrounding regions.
- **Travelled miles** serve as a proxy for traffic volume and flow influences in the study area, highlighting the benefits and drawbacks of various scenarios. This metric is critical for comparing scenarios, offering a comprehensive view of waste transport routes and distances covered and can show environmental advantages and disadvantages of each scenario.

For example, **Figure 6** presents the models output for the baseline scenario, showing waste moved throughout the study area. The map distinguishes between truck only (purple) and intermodal use (orange), which includes truck trips to intermodal stations, train trips, and barge trips. The intermodal traffic mode shows trucks traveling to the intermodal transfer stations for barges and trains. Therefore, intermodal routes can be seen outside the main rail corridors. The highest amount of waste transported by intermodal modes occurs in the Long Island counties, Manhattan, and New York City, as well as parts of New Jersey.

Figure 6: Baseline Truck and Intermodal Waste Movement in Study Area



The model visualizes waste amounts and transportation trips within, departing from, and distributed among states in the study area. Waste imports, which include all materials transported into the study area from outside, are not included. Scenario comparisons emphasize total miles traveled as a proxy for evaluating transportation efficiency and the potential environmental impacts of different waste management strategies.

The scenario evaluation is structured into four phases:

- 1: Reviewing the baseline 2017-2021 waste transport scenario, the 2035 constant stream scenario and the 2050 constant stream scenario,
- 2: Comparing the baseline with the 2035 and 2050 constant-stream forecasts,
- 3: Comparing the scenarios for 2035 and the scenarios for 2050, and
- 4: Comparing all scenarios against the baseline.

The remaining eight scenarios, including the open market, rail increase, and recycling change scenarios, are discussed in detail in **Attachment VI**.

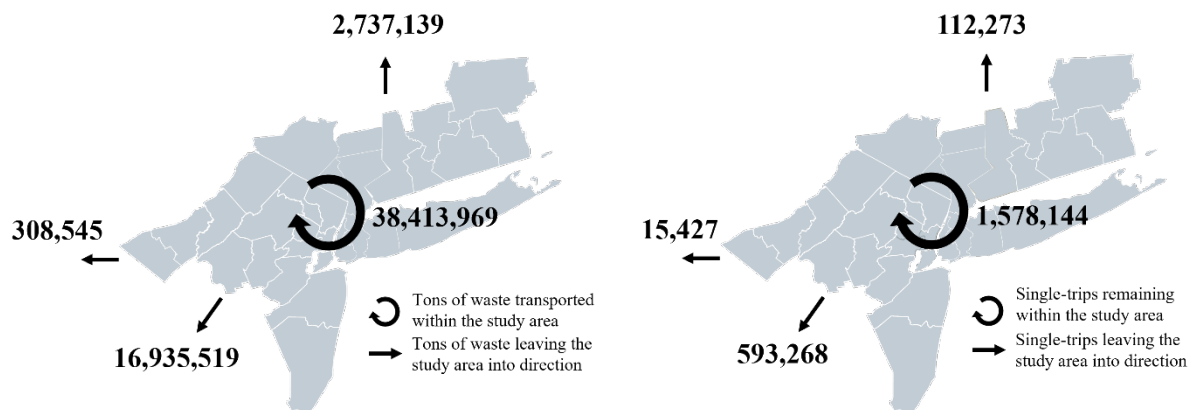
3.4.1 Constant Stream Scenarios

Baseline (2017-2021) Waste Transport

The baseline waste transport scenario analysis revealed that the largest volumes of waste and highest number of trips leaving the overall study area are directed to the southwest, followed by flows heading north and west, as shown in **Figure 7**.

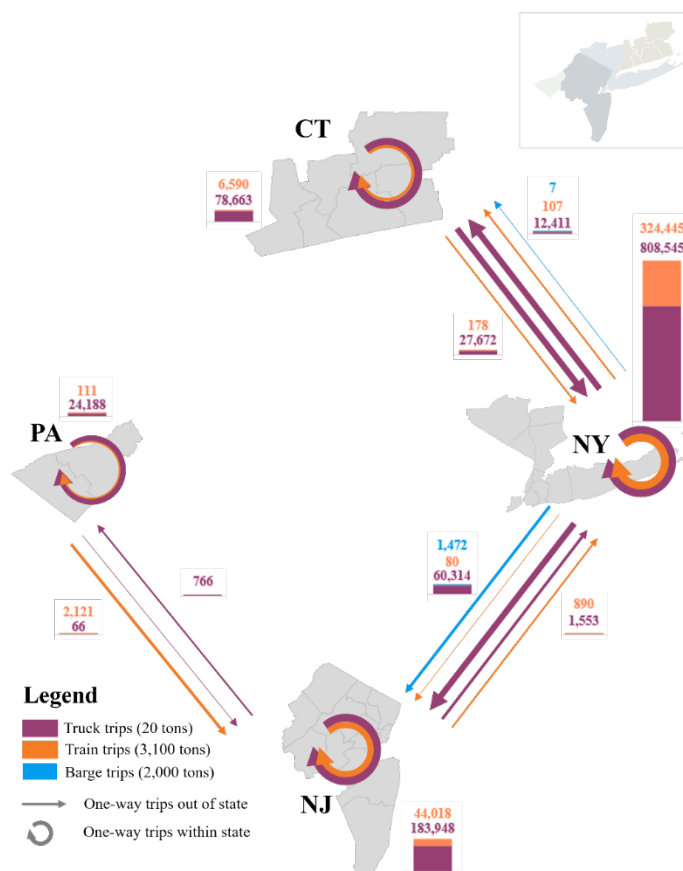
Figure 8 illustrates inter-region waste movement between the four states, displayed as one-way trips by mode (i.e., truck, barge, and train). Within the study area, the highest number of trips remained within New York State and the most significant number of trips between states occurred between New York and New Jersey, which included barge transport. Additionally, the highest number of train movements between states occurs between Pennsylvania and New Jersey.

Figure 7: Baseline 2017-2021 Annual waste amount movement in tons (left) and Annual number of trips (right) in Study Area



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2**, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

Figure 8: Baseline Waste Movement Between States in Study Area - Annual Number of Trips per Mode



Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

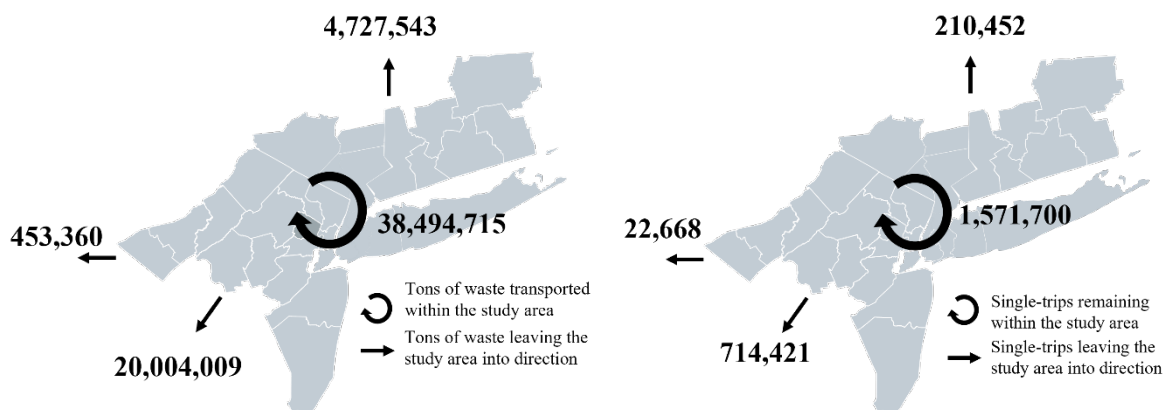
2035 Constant Stream Landfill

The 2035 Constant Stream scenario presented in

Figure 9 shows that most of the waste stays within the study area. The highest amount of waste and number of trips leaving the study area were directed southwest, followed by north, and then west, consistent with the baseline scenario.

Compared to the baseline model in **Table 16**, the number of trips leaving the study area increased to the southwest of the region by 20 percent, to the north by 87 percent and to the west by 47 percent. The number of trips within the study area remained relatively steady with a slight decrease of less than 1 percent due to changing landfill capacity.

Figure 9: 2035 CS Annual waste amount movement in tons (left) and Annual number of trips (right) in Study Area



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2**, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

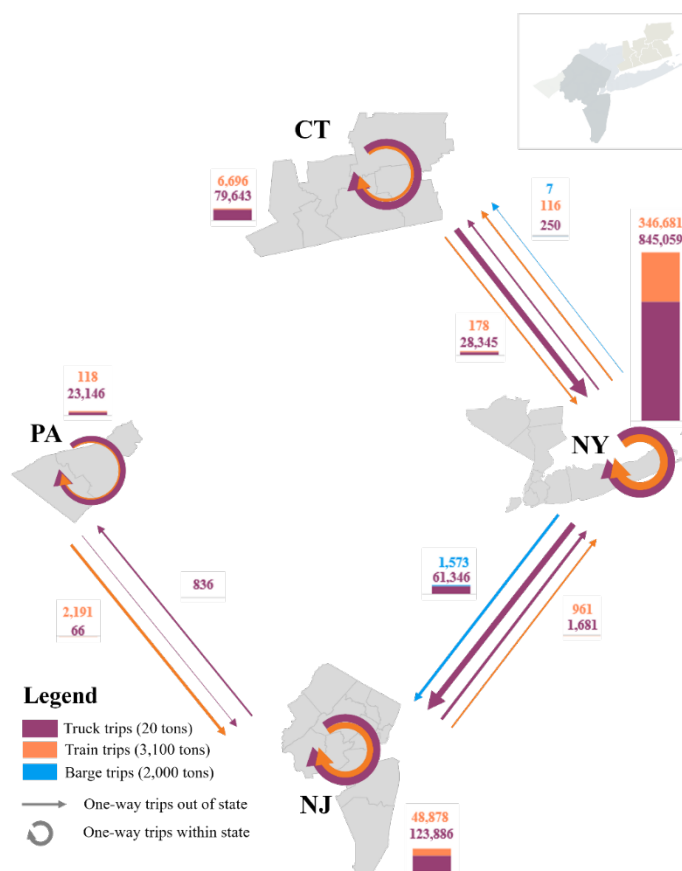
Table 16. Number of trips changes between baseline and 2035 CS scenarios

Waste Movement Direction	Baseline	2035 CS	Percentage change
North	112,273	210,452	+88%
West	15,427	22,668	+47%
South-west	593,268	714,421	+21%
Remaining within study area	1,578,144	1,571,700	0%

Figure 10 shows that, under the constant stream scenario, the highest number of trips remained within New York State. The most significant interstate movement overall was between New York and New Jersey. The most significant movement by rail was between Pennsylvania and New Jersey. Barges transported waste between New York, New Jersey and Connecticut, due their shared coastline.

Under the 2035 constant stream scenario, notable changes in trip patterns emerge in response to landfill closures. Specifically, no train trips between New York and New Jersey are observed and truck trips between New York and Connecticut decline by 98 percent. Within New Jersey, truck trips decreased by 33 percent and rail trips increased by 11 percent, suggesting a shift toward rail as landfill availability within the region changes.

Figure 10: 2035 Constant stream landfill movement between states annual number of trips

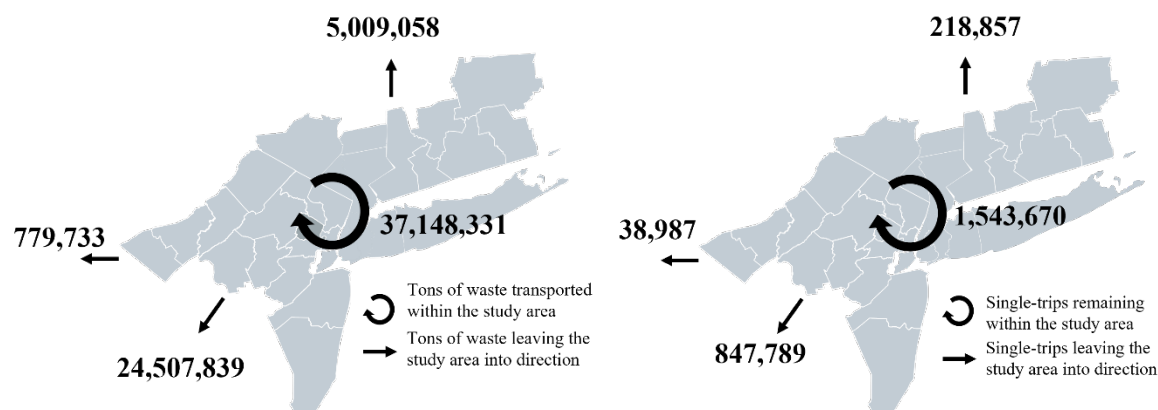


Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2050 Constant Stream Landfill

As in the baseline scenario, the 2050 constant stream analysis found that the highest volume of waste and number of trips leaving the study area were directed southwest, followed by trips north and west (refer to **Figure 11** and **Table 17**). However, compared to the baseline, the number of trips leaving the study area increased significantly: trips to the west rose by 150 percent, trips to the north doubled, and trips to the southwest increased by 43 percent. Within the study area, the total number of trips remained stable, showing a slight decrease of 2 percent.

Figure 11: 2050 CS Annual waste amount movement in tons (left) and Annual number of trips (right) in Study Area



Note: The total waste amount being moved varies to the waste amount calculated in Section 2.2, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

Table 17. Change in number of trips between baseline and 2050 CS scenarios

Waste Movement Direction	Baseline	2050 CS	Percentage change
North	112,273	218,857	+95%
West	15,427	38,987	+153%
South-west	593,268	847,789	+43%
Remaining within study area	1,578,144	1,543,670	-2%

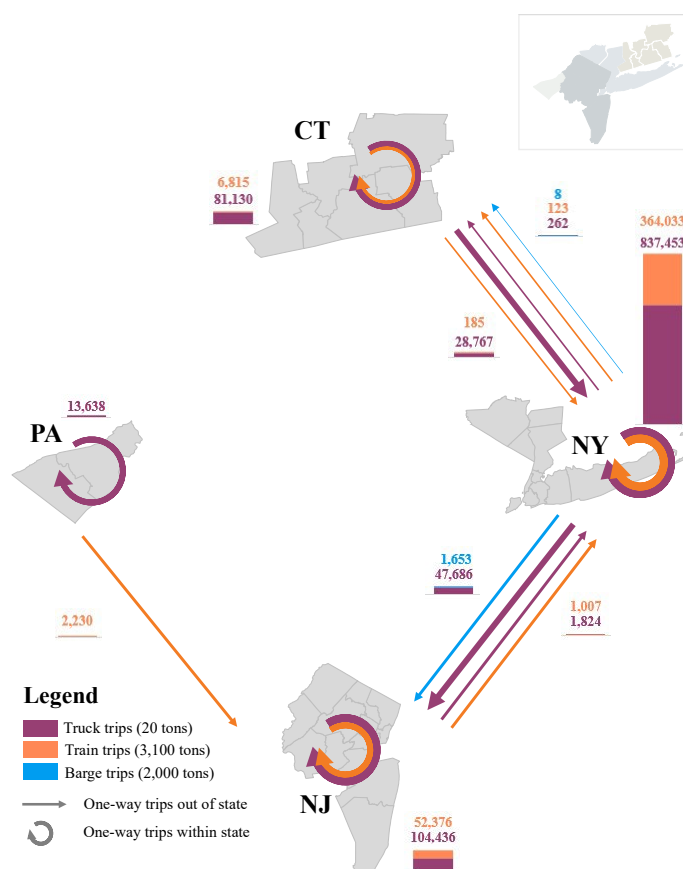
Figure 12 shows that, consistent with the previous scenarios, the largest number of trips remained within New York State. The most significant interstate movement continued to be between New York and New Jersey. However, compared to the baseline scenario, the 2050 constant stream scenario showed no train trips from New York to New Jersey due to landfill closures, a 21 percent reduction in truck trips, and a 12 percent increase in barge trips. Conversely, trips from New Jersey to New York increased by 15 percent increase for both truck and rail modes.

Between Pennsylvania and New Jersey, no truck trips were shown, and within Pennsylvania, the truck movements fell by 44 percent and train movements disappeared. Within New Jersey a 14 percent increase in rail trips was observed while truck trips decreased by 43 percent.

When compared to the 2035 constant stream scenario, no train trips occur within Pennsylvania and no truck trips between New Jersey and Pennsylvania were observed in either direction. The number of truck trips within Pennsylvania were reduced by 41 percent.

Overall, barge use increased by a modest 5 percent between New York and Connecticut, New York and New Jersey and within New Jersey. Train trips between all states increased between 2 and 7 percent.

Figure 12: 2050 Constant stream landfill movement between states annual number of trips



Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

3.4.2 Waste Movement Forecasts

As presented in **Figure 13** and **Figure 14**, the waste transport modeling projects a significant increase in both the number of trips and total miles travelled across all modes between the baseline period (2017-2021) and the forecast years of 2035 and 2050. The increases are more pronounced between 2035 and 2050 as available capacity within waste facilities within the study decrease and waste must be transported further from the point of origin.

These increases reflect the growing volume of waste generated and the longer travel distances required to process and dispose of that waste. The total number of trips increased over the

baseline by 10 percent in 2035 and 15 percent by 2050 compared to the baseline. A similar comparison for the number of miles travelled shows increases of 20 percent and 30 percent for 2035 and 2050 respectively.

Figure 13: Number of Trips Comparison - Baseline 2017-2021 versus 2035 and 2050 Forecasts

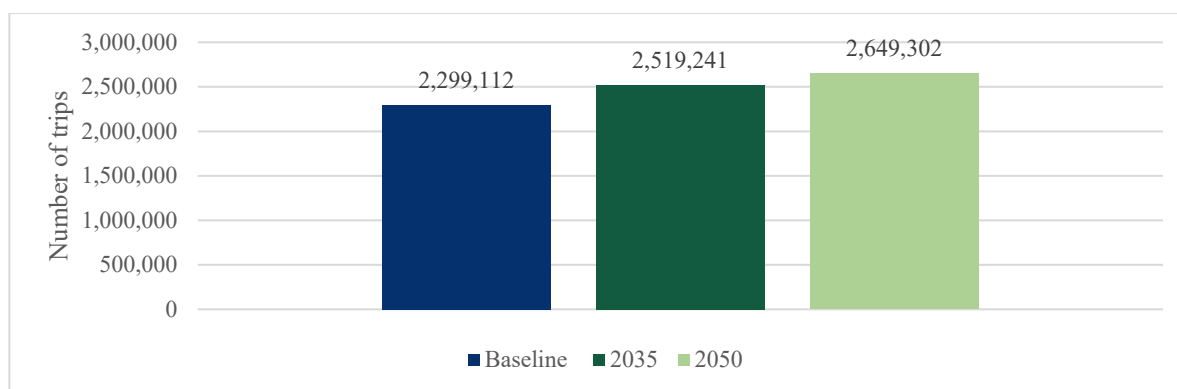
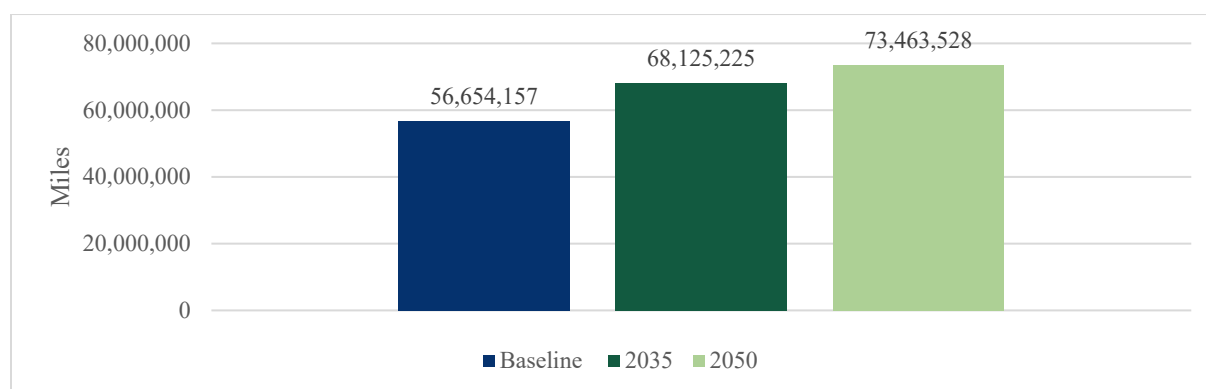


Figure 14: Travelled Miles Comparison- Baseline versus 2035 and 2050 Forecasts



Regarding waste-to-energy capacity, the Task 5 analysis found that WTE facilities currently operate at full capacity. The model further estimated that about 66 percent of the waste volume processed at these facilities originates from within the study area, while the remaining 33 percent is likely imported from surrounding states. However, the analysis did not consider contractual influences that might alter the source waste at WTEs, which could affect these proportions.

3.4.3 Waste Transport Scenario Comparisons for 2035 and 2050

This section compares five modeled waste transport scenarios across the 2035 and 2050 forecast years. Each scenario tests how system changes, such as shifts in landfill availability, increased rail usage, or variations in recycling rates, affect the number of trips and total miles traveled across the study area. Results are summarized in **Table 18** and **Table 19**.

Constant Stream (CS)

Under the Constant Stream scenario, landfills are assumed to continue accepting waste at historical rates until their projected closure years.

- Total trips increased from 2.52 million in 2035 to 2.65 million in 2050.
- Truck trips also increased modestly, while truck mileage rose from 68 million to 73 million miles, reflecting longer hauls due to facility closures.
- Train and barge use remained low and constant across both years, with around 3,300 train trips and 144,000–198,000 rail miles, and fixed barge trips at about 1,600.

This scenario illustrates the baseline trajectory for the system from 2017-2021, with gradual expansion of travel distances and limited change in modal usage.

Open Market (OM)

The Open Market scenario assumes that waste can be transported to any landfill in the region, regardless of regulatory or contractual barriers. By 2050, all in-region landfills are modeled as closed, and all waste is exported.

- In 2035, the number of total trips in OM was slightly lower than CS (2.47M vs. 2.52M), but truck mileage was 40% higher (95 million vs. 68 million), due to increased transport distance.
- In 2050, truck trips remained around 2.47 million, but truck mileage still increased to 76 million due to long outbound hauls.
- Train mileage rose from 142,000 in 2035 to 241,000 in 2050, with no change in train trips (around 3,300–3,700). This accounts for longer haul rail trips required for waste disposal.
- Barge trips stayed constant.

The OM scenario highlights how landfill availability constraints lead to major increases in truck and rail mileage, even if trip counts remain stable.

20% Rail Increase

This scenario models a system-wide shift toward greater use of rail, increasing rail usage by 20% in both 2035 and 2050.

- In 2035, rail trips nearly doubled (6,000 vs. 3,300 in CS), and train mileage jumped to 274,000 (from 144,000). Truck mileage dropped by 14 million miles, a 21% decrease from the CS baseline.
- In 2050, the pattern remained the same: rail trips rose to 6,200 and rail miles to 317,000, while truck mileage was the lowest of any scenario at about 59 million miles.
- Truck trips, however, remained relatively high in both years (about 2.5–2.6 million), due to first/last mile intermodal transfers.
- Barge use was fixed.

This scenario demonstrates that rail investment can significantly reduce mileage (and thus emissions or congestion), even if truck trips remain steady to service intermodal facilities.

-10% Recycling

This scenario simulates a 10% decrease in recycling rates, leading to greater reliance on landfilling or waste export.

- Truck trips and mileage both increased in 2035 and 2050 compared to CS. Truck mileage rose to 77 million in 2035 and 84 million in 2050—among the highest across all scenarios.
- Total trips also rose slightly, to ~2.51 million in 2035 and 2.64 million in 2050.
- Train and barge usage remained static, with train trips at 3,300 and barge trips fixed at 1,600.

This scenario shows that reductions in recycling not only increase waste volume but directly impact truck mileage and overall system strain.

+10% Recycling

A 10% increase in recycling shifts more waste to local processing facilities, reducing the need for long-haul waste transport.

- In 2035, truck mileage dropped by about 8 million miles compared to CS (to 59.7 million), while total trips remained flat (~2.52 million).
- In 2050, truck mileage remained relatively low at 66 million miles (compared to 73 million in CS).
- Rail and barge usage did not change in either year, as modal splits were held constant.

This scenario suggests that recycling programs can deliver substantial reductions in truck mileage without altering system infrastructure or trip volumes.

Table 18. 2035 Waste Transport Scenarios – Trips and Miles by Mode (with Totals)

Scenario	Trips				Miles			
	Truck	Train	Barge	Total	Truck	Train	Barge	Total
Constant Stream	2,514,354	3,307	1,580	2,519,241	67,953,798	144,273	27,154	68,125,225
Open Market	2,462,037	3,307	1,580	2,466,924	95,264,513	142,308	27,154	95,434,975
20% Rail Increase	2,499,874	6,037	1,580	2,507,491	53,544,677	274,237	27,154	53,846,068
-10% Recycling	2,505,856	3,307	1,580	2,510,743	76,756,697	144,273	27,154	76,928,124
+10% recycling	2,515,125	3,307	1,580	2,520,012	59,727,372	144,273	27,154	59,898,799

Table 18. 2035 Waste Transport Scenarios – Trips and Miles by Mode (with Totals)

Scenario	Trips				Miles			
	Truck	Train	Barge	Total	Truck	Train	Barge	Total

Table 19. 2050 Waste Transport Scenarios – Trips and Miles by Mode (with Totals)

Scenario	Trips				Miles			
	Truck	Train	Barge	Total	Truck	Train	Barge	Total
Constant Stream	2,644,009	3,632	1,660	2,649,301	73,236,298	198,701	28,530	73,463,529
Open Market	2,468,431	3,757	1,660	2,473,848	76,008,358	241,353	28,530	76,278,241
20% Rail Increase	2,632,898	6,191	1,660	2,640,749	59,619,038	317,123	28,530	59,964,691
-10% Recycling	2,635,071	3,632	1,660	2,640,363	83,746,519	198,701	28,530	83,973,750
+10% recycling	2,648,946	3,632	1,660	2,654,238	66,162,973	198,701	28,530	66,390,204

3.4.4 Overall Waste Transport Scenario Comparison

This section provides a comparative overview of all modeled waste transport scenarios across the baseline, 2035, and 2050 forecast years. Using **Figures 15 through 18**, it synthesizes how changes in policy assumptions affect overall waste flows, destination types, and modal usage.

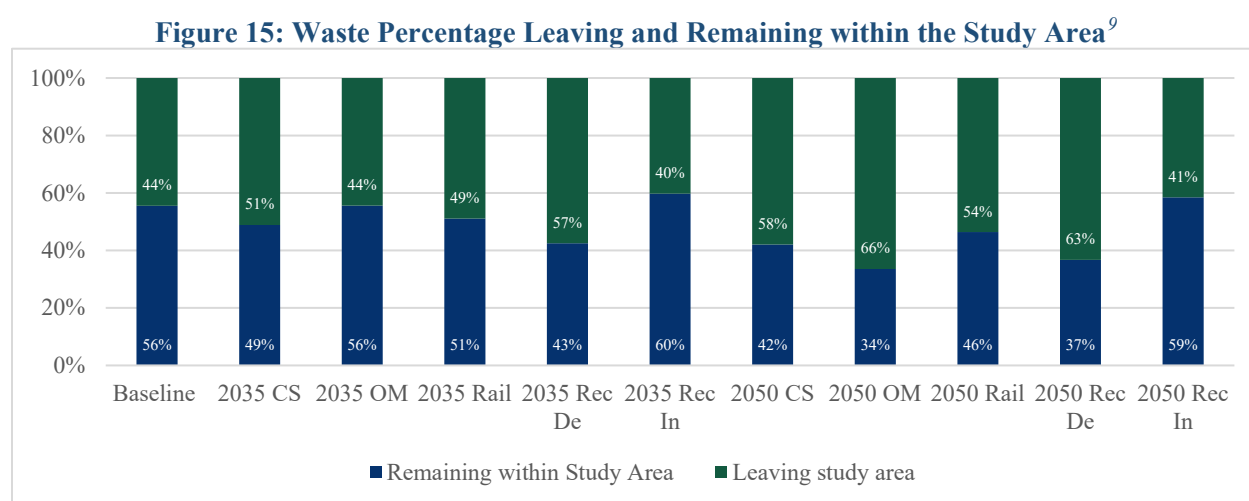
Figure 15 shows the share of waste that remains within or leaves the study area across all scenarios. Across time, most scenarios indicate a gradual increase in the percentage of waste leaving the region. This reflects the forecasted closure of regional landfills and rising disposal needs. The one major exception is the recycling increase scenario, which consistently retains a larger portion of waste within the study area by diverting it to nearby processing facilities. This demonstrates the potential for improved recycling strategies to reduce the environmental burden of long-distance waste transport.

In both 2035 and 2050, higher recycling rates reduce the share of waste transported out of the region by diverting it to nearby processing facilities. As shown in **Figure 15**, the recycling increase scenarios retained the highest proportion of waste within the study area—40% in 2035 and 41% in 2050—demonstrating the potential of recycling programs to reduce long-distance waste transport and associated environmental impacts. By contrast, the Open Market and Recycling Decrease scenarios in 2050 exhibited the highest rates of waste export, with 63–66% of waste leaving the study area.

Figure 16 further breaks down waste destinations by scenario. Landfilling declines sharply over time, from 21% in the baseline scenario to just 9% in the 2050 Constant Stream scenario, and 0% in the 2050 Open Market case, reflecting the modeled depletion of landfill capacity. These trends highlight the growing importance of alternative waste management strategies—such as recycling and intermodal transport—as in-region disposal options become more limited.

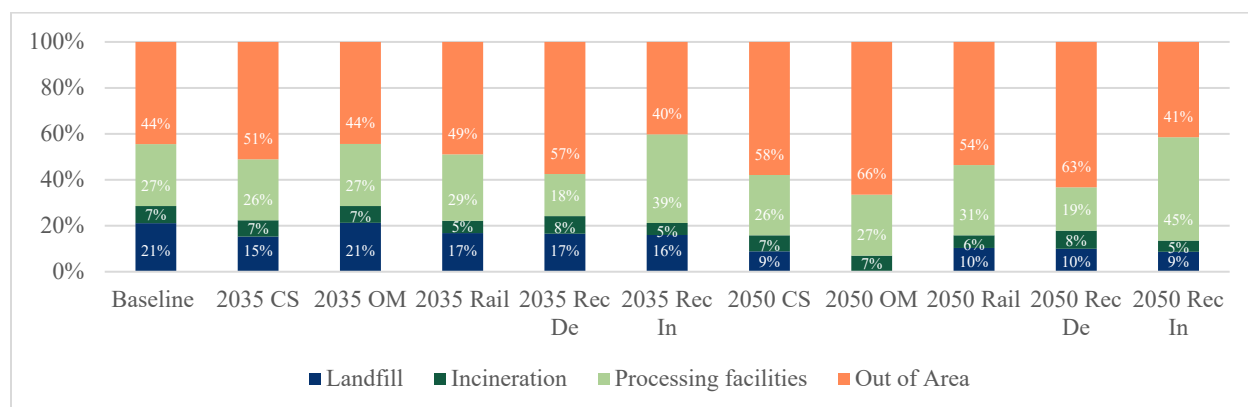
Patterns in trip movements mirror these waste destination trends. As shown in **Figure 17**, the percentage of trips leaving the study area increases in most scenarios over time. Again, the recycling increase scenarios stand out for reducing outbound trips by keeping waste closer to its source. The rail increase scenario also reduces outbound trips, not by reducing total waste export, but by enabling longer-distance hauls via higher-capacity rail, thereby concentrating more waste movement within intermodal trips.

Figure 18 summarizes trip destinations by mode, highlighting the rise of intermodal transport. In the 20% Rail Increase scenario, intermodal trips—defined as barge and truck trips to transfer stations—make up 41% of total trips, compared to just 22–23% in other scenarios. Landfill-related trips, like waste volumes, decline steadily, from 12% in the baseline to 3% in the 2050 Constant Stream scenario, and disappear entirely in the 2050 Open Market case.

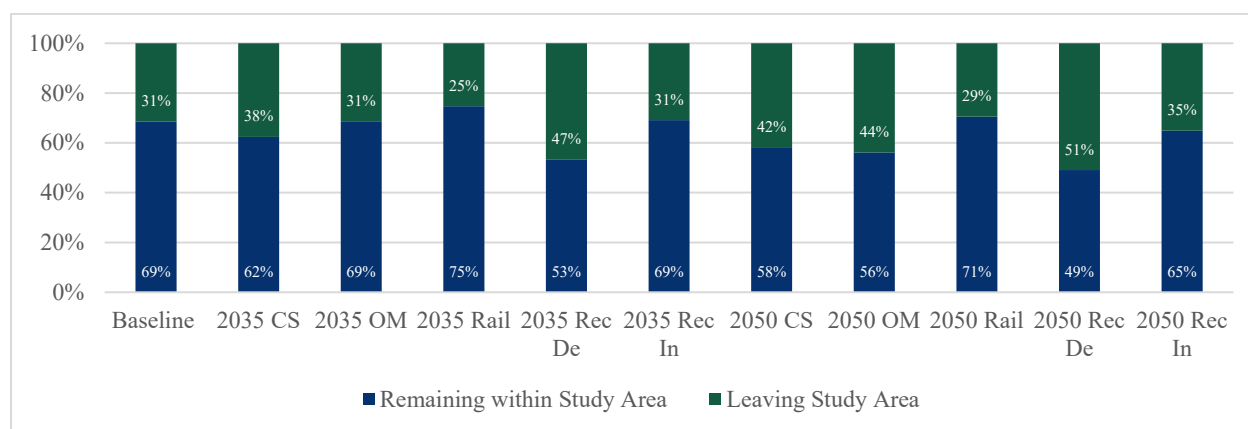
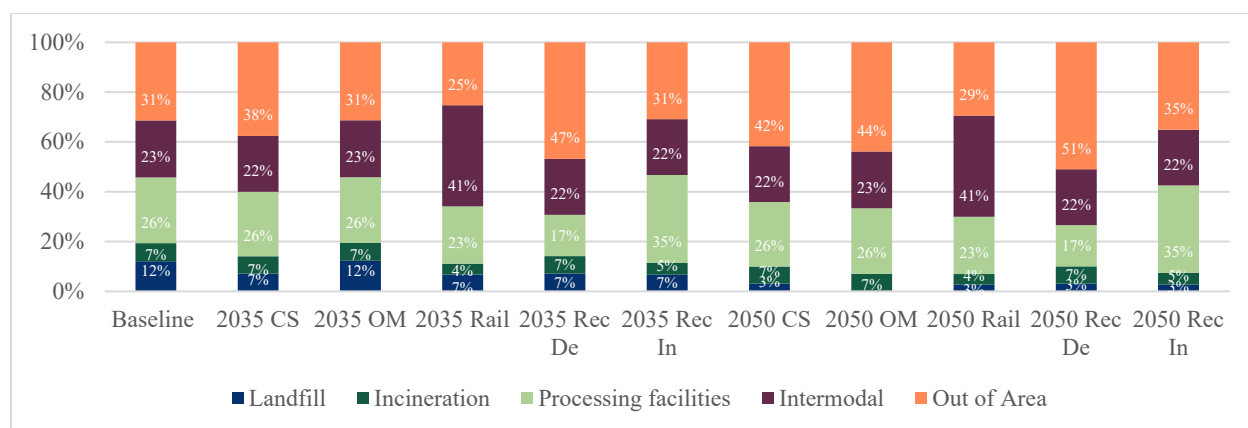


Note: Intermodal transport of waste, which shows barge and truck trips to transfer stations, was expected to visualize the actual percentage of waste remaining within the study area or leaving the study area.

⁹ CS: Constant stream; OM: Open Market; Rail: 20% rail increase; Rec De: 10% recycling decrease; Rec In: 10% recycling increase

Figure 16: Percentage waste amount per destination¹⁰

Note: Intermodal transport of waste, which shows barge and truck trips to transfer stations, was expected to visualize the actual percentage of waste remaining within the study area or leaving the study area.

Figure 17 Percentage number of trips leaving and staying within the study area¹¹**Figure 18: Percentage number of trips per destination¹²**

3.5 Conclusions and Recommendations

The underlying data used in the model lacked sufficient resolution and consistency to support corridor-level insights. In particular, fragmented data sources and inconsistent waste classifications across states limited the ability to identify specific transport corridors or analyze mode-specific routing in detail. Additionally, the use of a shortest-trip distribution methodology, while practical given data constraints, does not reflect the real-world complexity of waste movement, including contractual obligations, tipping fees, or regulatory constraints. As a result, the modeled distances and destinations may underestimate actual travel patterns.

Despite these limitations, the model offered valuable insights into projected changes in waste flows over time. Between the baseline (2017-2021) and 2050, the share of waste leaving the study area increased by about 7 percent per planning interval (2017-2021 to 2035, and again 2035 to 2050), highlighting the growing pressure on the regional waste system and the need for improved waste movement strategies to mitigate transportation impacts.

Scenario modeling showed that increased use of rail and higher recycling rates can significantly reduce miles traveled within the study area. Increasing rail utilization by 20% reduced total waste transport mileage by 18–19% in both 2035 and 2050, primarily by replacing long truck hauls with more efficient rail trips. Similarly, raising the recycling rate by 10% decreased waste-related mileage by roughly 10% and reduced the volume of waste exported from the study area by 11% in 2035 and 17% in 2050. Conversely, a 10% reduction in recycling increased total miles traveled by 14–15% and boosted waste exports by 6% in 2035 and 5% in 2050.

Differences between the constant stream and open market landfill scenarios also revealed meaningful temporal shifts. In 2035, the open market scenario resulted in 40% more miles traveled due to limited available landfills and longer haul distances. By 2050, however, with all landfills within the study area assumed closed, both scenarios involved long-distance waste exports, and the mileage gap narrowed to just 4%.

Across all modeled years and scenarios, New York–New Jersey consistently emerged as the primary corridor for interstate trips, reflecting their geographic proximity and the location of major waste transfer infrastructure.

To enhance the accuracy of future waste movement models, it is crucial to improve data collection in several areas: modal split, waste distribution, waste movement patterns, and facility capacities. Enhanced data quality will enable more precise and meaningful analyses.

¹⁰ *ibid*

¹¹ *ibid*

¹² *ibid*

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Attachment I: Multiple Linear Regression
(MLR) modelling for New
Jersey and Pennsylvania

Contents

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1. Introduction

Statistical models allow the identification of factors that affect the volume of waste generated. Statistical models are often used in planning studies that are looking for policy strategies that will impact future outcomes, providing decision-makers with potential actions available to direct future outcomes. Multiple Linear Regression (MLR) models provide a statistical methodology for predicting a future state or condition. It allows researchers to test the impact of various policies by including control variables (e.g., socio-demographic data) in the model and then adding policy variables with hypothetical values for sensitive analyses.¹ Most studies develop a base model and compare the model output with dependent variable values as a validation process.

The model development process usually employs a statistical software package (e.g., IBM's Statistical Package for Social Sciences (SPSS)) to run regression models. There are a set of assumptions required for a successful MLR model. To ensure there are no specification errors, each model needs a dependent variable (the variable to be predicted), and at least one independent variable (tested for its explanatory contribution). The relationship between the dependent and the independent variables must be linear. The regression model output includes an F-test that establishes the existence of a linear relationship, as well as an R-squared metric that reports the percent of the dependent variable that is explained by the independent variable(s). No relevant independent variables should be excluded, and no irrelevant independent variables should be included in the model specification. If a relevant variable is added, the R-squared will increase, however, if an irrelevant variable is included, it will have no effect or will decrease the R-squared metric. Each independent variable generates a coefficient that is tested for its statistical significance, using the hypothesis that there is a probability that the coefficient is actually zero (the null hypothesis test). If this hypothesis is rejected, then the coefficient is considered statistically significant at a pre-determined probability (e.g., using a 0.05 threshold that the generated coefficient occurred by chance). These statistical tests are aimed at reducing specification errors.

To avoid measurement errors, all variables must be quantitatively and accurately measured. Finally, the error terms (the difference between the predicted dependent variable value and actual value) are normally distributed with an average value of zero, a constant variance, no autocorrelation between the error terms, and no correlation between the independent variables and error terms (Lewis-beck & Lewis-beck 2015). Violations of any of these assumptions reduce the usefulness of the model output for decision-making. It should be noted that MLR models should have at least 30 cases (e.g., counties). While it is possible to run a model with fewer cases, models run with an inadequate sample size could have unstable parameters.² (Lewis-beck & Lewis-beck 2015).

The model outputs from an MLR model includes a standardized beta coefficient that provides the relative impact across independent variables in the model using the absolute value of the

¹ Lewis-Beck, C., & Lewis-Beck, M. (2015). *Applied regression: An introduction* (Vol. 22). Sage publications.

² Ibid

coefficient. This allows decision-makers to see which of the available variables has the most impact on the dependent variable to gauge their expectation for effectiveness of potential policy changes.

The research team considered using MLR modelling and conducted a series of MLR models that used counties as the unit of analysis to forecast waste for 2035 and 2050 in New Jersey and Pennsylvania. The dependent variable was the average waste generated between 2017 – 2021, with independent variables including the number of households, household size, recycling rates, and population density.

2. MLR Model Data Requirements

The data requirements for an MLR model include the determination of the unit of analysis. In academic studies, researchers develop a research design that meets all the necessary requirements for both the model and the data. Unfortunately, many planning studies often must rely upon available data, often administrative records. For this study, available waste information developed by New Jersey Department of Environmental Protection (NJDEP), Pennsylvania Department of Environmental Protection (PADEP), Connecticut Department of Energy and Environmental Protection (CTDEEP), and the Solid Waste Management Plan (SWMP) of New York State Department of Environmental Conservation (NYSDEC) were evaluated. While New Jersey and Pennsylvania had a data series of waste generation from 2017 through 2021, New York only had one year of data from 2018 for counties and towns. Further, Connecticut recently changed their governmental spatial units (counties to Council of Governments (COGs)). **Table** provides statistics for the fifteen New Jersey and Pennsylvania counties in the study area for which the required waste data was available.

Table I-1. Statistics of New Jersey and Pennsylvania Study Area Data

Statistic	Average Waste 2017 to 2021	Household Size	Housing Units 2020	Recycling Rate	Population Density
Mean	1,166,315.58	2.62	192,923.93	0.50	3,015
Median	1,246,811.00	2.58	192,847.00	0.51	1,144
Standard Deviation	783,407.48	0.13	100,468.35	0.12	4,027

Sources: NJDEP; PADEP Bureau of Waste Management Disposal Info website; U.S. Census Bureau.

3. MLR Forecasting Modeling For New Jersey and Pennsylvania

The model development process used SPSS to run a series of regressions models, adding a new independent variable to each run to determine whether that variable produces a coefficient is statistically significant (e.g., using a probability threshold). If an independent variable is found to be not statistically significant, it is normally discarded from the analysis. As each new variable is entered into the model, the R-squared metric is compared to the previous run to evaluate the contribution of the added variable. The best model is determined by the highest R-squared. Once all the available variables are tested, the best model parameters are interpreted.

Table I-20 presents the development of the MLR models using the county-level average waste from 2017 through 2021 as the dependent variable, and the number of households, household size, recycling rates, and population density as independent variables for the fifteen counties in the New Jersey and Pennsylvania Study Area. The interpretation of the statistically significant variable coefficients is the effect (positive or negative) on the dependent variable with a one unit increase in the independent variable. The R-squared indicates the overall explanatory relationship between the dependent variable and all of the independent variables used in the model. The coefficients for integer independent variables provide the individual effect of each independent variable on the dependent variable, holding all else constant. Independent variables that are ratios (e.g., recycling rates, population density) provide the effect (negative or positive) on the dependent variable, holding all else constant).

The constant is the average value of the dependent variable when the independent variable(s) equals zero. Each variable entered into the model increased the R-squared, making Model 4 the best model. The independent variables in Model 3 are all statistically significant using a 0.05 threshold, and these independent variables explain 91.5% of waste generation. Model 4 includes population density, however, it is only statistically significant using a 0.15 threshold, but has a higher R squared of 93.3%. Model 4 includes an independent variable with less statistical significance (e.g., population density is statistically significant using a 0.15 threshold ($p < 0.15$), indicating a 85% confidence in the value of the coefficient rather than the 95% confidence associated with the 0.05 threshold ($p < 0.05$)). Statistically significant regression coefficients for compound variables (e.g., percentages, ratios) can only be interpreted as having a positive or negative influence on average waste, while integer variables can provide direct increases (or decreases, if negative) impacts on average waste (e.g., number of households).

The interpretation of Model 4 is as follows:

- 93.3% of the average total waste is explained by household size, the number of households, the recycling rate, and population density.
- The constant for the model intercepts the y axis at -5,522,319.
- Household size has a positive influence on the average waste generated, controlling for other factors.
- For every additional household, the average waste tonnage generated increases by 6.6 tons, controlling for other factors.
- Recycling rates have a positive influence on the average waste tonnage, controlling for other factors.
- Population density has a negative influence on the average tons of waste, controlling for other factors.

To generate the 2035 and 2050 waste forecast using the Model 4 parameters, the number of households was defined by dividing the population forecasts for these years by the household size. **Table I-3** presents the results of the waste forecast for 2035 and 2050 for which the required waste data was available (i.e., fifteen counties of New Jersey and Pennsylvania included in the study area).

Table I-20. MLR model development

Independent Variables	Model 1	Model 2	Model 3	Model 4
Constant (intercept)	-8,188,536**	-5,445,908**	-5,974,946**	-5,522,319**
Household Size	3,568,738**	2,087,845**	2,012,205**	1,840,935**
Number of Households		5.905**	5.747**	6.585**
Recycling Rates			1,520,912**	1,387,789**
Population Density				-32.834*
R-squared	0.592	0.864	0.915	0.933

*Statistically significant using a 85% confidence level ($p < 0.15$)

**Statistically significant using a 95% confidence level ($p < 0.05$)

Table I-3. Waste forecasts using 2035 and 2050 population projections

New Jersey and Pennsylvania Counties	Average Waste 2017 - 2021	Waste 2022	Forecasted Waste 2035	Forecasted Waste 2050
Bergen County	2,179,624	2,283,973	2,467,219	2,681,162
Essex County	1,506,451	1,965,836	2,107,520	2,267,329
Hudson County	1,246,811	1,079,762	1,218,696	1,473,175
Hunterdon County	252,303	64,670	75,924	82,819
Middlesex County	2,842,557	2,492,917	2,621,471	2,724,230
Monmouth County	1,973,614	1,652,006	1,682,962	1,743,383
Morris County	1,176,039	1,316,496	1,372,336	1,410,092
Ocean County	1,259,959	1,315,877	1,561,528	1,725,221
Passaic County	1,403,129	1,380,344	1,481,155	1,574,132
Somerset County	801,233	921,502	945,887	969,479
Sussex County	260,940	373,227	371,050	377,817
Union County	1,514,182	1,569,884	1,652,890	1,784,236
Warren County	170,658	263,627	264,084	267,906
Lehigh County	445,780	398,535	525,778	573,448
Northampton County	461,454	416,077	375,043	358,049

It should be noted that the MLR model waste forecasts for Hunterdon County are far below the average waste generated as reported for the period of 2017-2021. Local representatives indicated that the Hunterdon facility charges less than surrounding counties for waste disposal and therefore attracts waste from outside the county. They also indicated that between 2017 and 2021, they managed some additional post disaster debris. This explains the discrepancy, since the MLR model is based on household-level variables and as such, only accounts for locally generated waste amounts.

4. Conclusions

Although the error terms are normally distributed and the MLR model provides sufficient output values, the fact that only fifteen counties (i.e., cases) could be modeled is problematic. As previously mentioned, the recommended number of cases is at least 30 cases. Due to the lack of data for the New York counties, which represent the most significant waste generating geography of the study, and the government unit changes made in Connecticut, it was not possible to replicate the MLR process for these two states and a statistically significant model that was representative of the entire study area could not be developed. As a result, and to use a uniform methodology across all the study area, the per capita (waste/population) methodology^{3,4,5} for the 2035 and 2050 waste forecasts was used for the entire study area. While the per capita methodology does not provide the opportunity to perform sensitivity analyses (e.g., varying policy values to see how they impact waste generation), it will provide a uniform approach across the geographies and will generate more comparable data for the transport model.

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- ³ Colvero, D. A., Feitosa, A. K., Ramalho, J. C., Gomes, A. P. D., da Cruz Tarelho, L. A., & de Matos, M. A. A. (2019). Per capita municipal solid waste generation and its relationship with socioeconomic and demographic factors in a developing country. *Revista Tecnologia e Sociedade*, 15(36).
 - ⁴ Hockett, D., Lober, D. J., & Pilgrim, K. (1995). Determinants of per capita municipal solid waste generation in the Southeastern United States. *Journal of Environmental Management*, 45(3), 205-218.
 - ⁵ Pisani, R., Alves de Castro, M. C. A., & da Costa, A. A. (2018). Influence of population, income and electricity consumption on per capita municipal solid waste generation in São Paulo State, Brazil. *Journal of Material Cycles and Waste Management*, 20, 1216-1227.

Attachment II: Waste data sources for New
Jersey, Pennsylvania,
Connecticut and New York

TABLES

Table II-1.	New Jersey counties Waste generation 2017 – 2021, MSW & Non-MSW Disposal and Recycling, ton
Table II-2.	Pennsylvania counties Waste generation, MSW & C&D waste Disposal and Recycling, 2017 – 2021, ton
Table II-3.	Pennsylvania counties Waste generation, MSW Disposal, 2017 – 2021, ton
Table II-4.	Pennsylvania counties Waste generation, MSW Recycling, 2017 – 2021, ton
Table II-5.	Pennsylvania counties Waste generation, C&D waste Disposal, 2017 – 2021, ton
Table II-6.	Pennsylvania counties Waste generation, C&D waste Recycling, 2017 – 2021, ton
Table II-7.	Connecticut COGs Waste generation, MSW & Non-MSW Disposal and Recycling, 2017 – 2021, ton
Table II-8.	New York counties Waste generation, MSW & C&D waste Disposal and Recycling, 2018, ton

The per capita forecasting methodology used the best publicly available waste generation data for each of the states in the study area. For New Jersey, Pennsylvania, and Connecticut the average annual tons of waste generated between 2017 and 2021 was used as the historical waste generation baseline. For New York, the 2018 waste generation data was the only recently available waste data. For Connecticut (CT), the unit of analysis was the Council of Governments (COGs), rather than counties.

For New Jersey, the waste data for 2017 to 2021 summarized in **Table II-1** was obtained from the following New Jersey Department of Environmental Protection. (NJDEP) sources:

- <https://www.nj.gov/dep/dshw/recycling/stats.htm>. [Accessed 11/19/24]
- https://www.nj.gov/dep/dshw/recycling/stat_links/2017disposalrates.pdf
- https://www.nj.gov/dep/dshw/recycling/stat_links/2018disposalrates.pdf
- https://www.nj.gov/dep/dshw/recycling/stat_links/2019disposalrates.pdf
- https://www.nj.gov/dep/dshw/recycling/stat_links/2020disposalrates.pdf
- https://www.nj.gov/dep/dshw/recycling/stat_links/2021disposalrates.pdf

Table II-1. New Jersey counties Waste generation 2017 – 2021, MSW & Non-MSW Disposal and Recycling, ton

New Jersey	2017	2018	2019	2020	2021	Average 2017 to 2021
Bergen County	2,124,494	2,328,648	2,217,737	2,005,320	2,221,921	2,179,624
Essex County	1,636,703	1,661,366	1,287,993	1,343,566	1,602,628	1,506,451
Hudson County	1,330,619	1,356,653	1,088,075	1,417,094	1,041,616	1,246,811
Hunterdon County	270,790	322,205	227,441	234,219	206,861	252,303
Middlesex County	2,937,187	2,873,510	2,918,634	2,672,171	2,811,284	2,842,557
Monmouth County	1,928,731	1,995,583	2,013,900	1,855,573	2,074,285	1,973,614
Morris County	1,244,464	1,115,499	1,096,122	1,260,367	1,163,741	1,176,039
Ocean County	1,378,696	1,288,625	1,242,300	1,227,627	1,162,546	1,259,959
Passaic County	1,467,436	1,344,133	1,723,868	1,217,263	1,262,944	1,403,129
Somerset County	801,878	768,467	819,893	763,762	852,165	801,233
Sussex County	267,350	271,399	259,778	243,574	262,597	260,940
Union County	1,745,309	1,551,164	1,378,270	1,395,881	1,500,288	1,514,182
Warren County	211,132	188,230	158,967	137,778	157,181	170,658

For Pennsylvania, the waste data for 2017 to 2021 summarized in **Table** was obtained from the Pennsylvania Department of Environmental Protection (PADEP) Bureau of Waste Management sources:

- Disposal Data. Solid_Waste_Disposal_Information - Power BI Report Server.
http://cedatareporting.pa.gov/reports/powerbi/Public/DEP/WM/PBI/Solid_Waste_Disposal_Information. [Accessed 11/19/24]
- Recycling Data.
<https://www.dep.pa.gov/Business/Land/Waste/Recycling/Pages/Recycling-Reports-and-Studies.aspx>. [Accessed 11/19/24]

Table II-2. Pennsylvania counties Waste generation, MSW & C&D waste Disposal and Recycling, 2017 – 2021, ton

Pennsylvania	2017	2018	2019	2020	2021	Average 2017 – 2021
Lehigh	453,494	441,033	472,600	431,659	430,113	445,780
Northampton	479,258	454,661	449,523	454,115	469,712	461,454

The waste generation data in **Table II-2** summarizes the MSW and C&D waste disposal and recycling data presented in **Table II-3** to **Table 21**.

Table II-3. Pennsylvania counties Waste generation, MSW Disposal, 2017 – 2021, ton

Pennsylvania	2017	2018	2019	2020	2021
Lehigh	273,408	291,944	283,333	250,300	266,362
Northampton	319,687	281,488	281,534	275,450	278,016

Table II-4. Pennsylvania counties Waste generation, MSW Recycling, 2017 – 2021, ton

Pennsylvania	2017	2018	2019	2020	2021
Lehigh	159,179	130,737	142,606	163,558	142,093
Northampton	110,476	131,298	127,402	135,809	138,262

Table II-5. Pennsylvania counties Waste generation, C&D waste Disposal, 2017 – 2021, ton

Pennsylvania	2017	2018	2019	2020	2021
Lehigh	20,879	18,318	45,630	17,251	21,183
Northampton	49,027	41,569	40,377	42,753	53,388

Table 21. Pennsylvania counties Waste generation, C&D waste Recycling, 2017 – 2021, ton

Pennsylvania	2017	2018	2019	2020	2021
Lehigh	28	34	1,031	549	475
Northampton	68	306	211	103	46

For Connecticut, the Connecticut Department of Energy and Environmental Protection (CTDEEP) provided¹ the research team with waste generation data files for the period of 2017 to 2021. The data, which was available by town, was aggregated to COG level for those COGs that are included in the study area. The waste generation data is summarized in

Table 22.**Table 22. Connecticut COGs Waste generation, MSW & Non-MSW Disposal and Recycling, 2017 – 2021, ton**

Connecticut	2017	2019	2020	2021	Average 2017 – 2021
Capitol Region	836,668	763,444	774,037	953,457	831,901
Lower CT River Valley	145,133	139,451	136,312	132,966	138,465
Metropolitan	290,732	251,008	302,397	315,234	289,843
Naugatuck Valley	296,026	307,237	291,502	324,830	304,899
South Central	516,318	493,629	454,435	460,658	481,260
Western	549,336	739,219	866,412	690,418	711,346

For the New York counties of the study area, recent historical waste generation data was only available from the December 2023 New York State Solid Waste Management Plan (SWMP) for the year 2018 (NYSDEC 2023), which was used as the baseline waste generation. The SWMP provides waste generation data for both MSW and C&D waste. As presented in Table II-8, Appendix E of the SWMP provides the detailed waste generation quantities for MSW and C&D waste disposed and recycled (“recovered”) respectively for the counties of New York.

Table II-8. New York counties Waste generation, MSW & C&D waste Disposal and Recycling, 2018, ton

New York	2018 Total	MSW disposal	MSW recovered	C&D waste disposal	C&D waste recovered
New York City	14,120,606	5,413,000	1,254,606	2,523,000	4,930,000
Long Island	6,983,966	2,330,000	573,966	1,650,000	2,430,000

¹ Personal communications with Brenna Giannetti of CTDEEP for waste volumes for 2015, 2017, 2019, 2020, 2021, 2022, and June through August 2024.

Table II-8. New York counties Waste generation, MSW & C&D waste Disposal and Recycling, 2018, ton

New York	2018 Total	MSW disposal	MSW recovered	C&D waste disposal	C&D waste recovered
Orange County	586,200	288,400	33,200	65,600	199,000
Putnam County	212,900	82,000	1,600	1,800	127,500
Rockland County	485,000	256,200	43,000	118,800	67,000
Westchester County	1,432,500	666,200	157,500	270,300	338,500

Attachment III: Population forecasts for Connecticut 2035 and 2050

TABLES

- Table III-1. Population projections for Connecticut COGs
- Table III-2. Growth rates of the population projections for Connecticut COGs
- Table III-3. Projected population numbers 2035 – 2050 for COGs of Connecticut

In consultation with NYMTC, it was decided that the study should apply the NYMTC population forecast for counties and COGs to calculate the waste generation forecast for the study area. However, the NYMTC population forecast does not include the population forecast for the Connecticut COGs. Thus, the Connecticut Population Projections were used to complement the missing population forecasts.¹ However, these projections only extend until 2040. Therefore, the population forecast for 2050 was calculated by estimating projections from 2040 to 2050 based on the increase or decrease of the projected population in the years 2015 through 2040 for the individual COGs.

From population projections for 2015 to 2040 (refer to **Table III-1**), growth rates for each 5-year interval were created (refer to **Table III-2**). As presented in **Table III-23**, these growth rates were then applied to the last two 5-year intervals from 2040 to 2045 and 2045 to 2050 to calculate the population forecast for the year 2050. Specifically, the population forecast for 2050 was estimated by first multiplying the population forecast for 2040 by the growth rate for the 5-year interval for 2040 to 2045 resulting in the population forecast for 2045, and then multiplying this population forecast by the growth rate for the 5-year interval for 2045 to 2050.

Table III-1. Population projections for Connecticut COGs

COG	2015	2020	2025	2030	2035	2040
Capitol Region	984,015	994,214	1,004,748	1,015,557	1,025,364	1,035,084
Lower CT River Valley	176,675	176,940	176,339	175,849	174,107	172,144
Metropolitan	318,303	318,379	319,106	320,757	324,081	327,656
Naugatuck Valley	450,232	451,413	452,627	452,712	450,600	447,275
South Central	571,752	575,652	581,671	588,205	593,319	596,050
Western	588,529	579,083	571,213	566,204	564,567	566,677
Total	3,089,506	3,095,681	3,105,704	3,119,284	3,132,038	3,144,886

¹ Connecticut Council of Governments. Connecticut Population Projections – State, County, and Regional Councils of Governments Level, 2015-2040 https://data.ct.gov/Government/Connecticut-Population-Projections-State-County-an/pv2w-k7qu/about_data. [Accessed 11/19/24]

Table III-2. Growth rates of the population projections for Connecticut COGs

Population Growth rates in 5 years intervals						Estimated Population Growth - 2040-2050	
COG	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
Capitol Region	1.010	1.011	1.011	1.010	1.009	1.009	1.009
Lower CT River Valley	1.001	0.997	0.997	0.990	0.989	0.988	0.987
Metro-politan	1.000	1.002	1.005	1.010	1.011	1.012	1.013
Naugatuck Valley	1.003	1.003	1.000	0.995	0.993	0.992	0.991
South Central	1.007	1.010	1.011	1.009	1.005	1.001	0.996
Western	0.984	0.986	0.991	0.997	1.004	1.012	1.021

Table III-23. Projected population numbers 2035 – 2050 for COGs of Connecticut

COG	2035	2040	2045	2050
Capitol Region	1,025,364	1,035,084	1,044,400	1,053,799
Lower CT River Valley	174,107	172,144	170,078	167,867
Metropolitan	324,081	327,656	331,588	335,899
Naugatuck Valley	450,600	447,275	443,697	439,704
South Central	593,319	596,050	596,646	594,259
Western	564,567	566,677	573,477	585,520
Total	3,132,038	3,144,886	3,159,886	3,177,048

Attachment IV: Expected/reported future
changes in the population
forecast

Considering that the waste generation model is population based (i.e., per capita forecasting model), expected changes in the population forecast could affect waste generation projections. The Cornell Program on Applied Demographics recently published projections of the New York State and Counties population for at least 25 years (through 2050)^{1,2}. (Giles Morris 2024; New York State projections, accessed 12/5/24). The new publication only contains statewide projections that will be used as a control for county projections presumably in the end 2024 and Q1 2025.

There were three scenarios developed, a middle series with a set of assumptions that correspond with demographic change during the last decade and a high and a low scenario that assumes changes more towards population increase and more towards population decrease. The 2050 population is projected to be between 17 and 19.5 million, compared to an estimated 19.6 million in 2023.

The number of people aged 0 to 17 is projected to decline between 10% and 25% over the coming 25 years amidst a decline in the number of births. The number of 65 and over is projected to increase by 15 to 20% over the next 10 years but slightly decrease afterwards.

The prime working age population (age 25-44) is around 7.7 million now and is projected to be between 7.2 and 7.7 million in 10 years and between 6.5 and 7.4 million in 25 years.

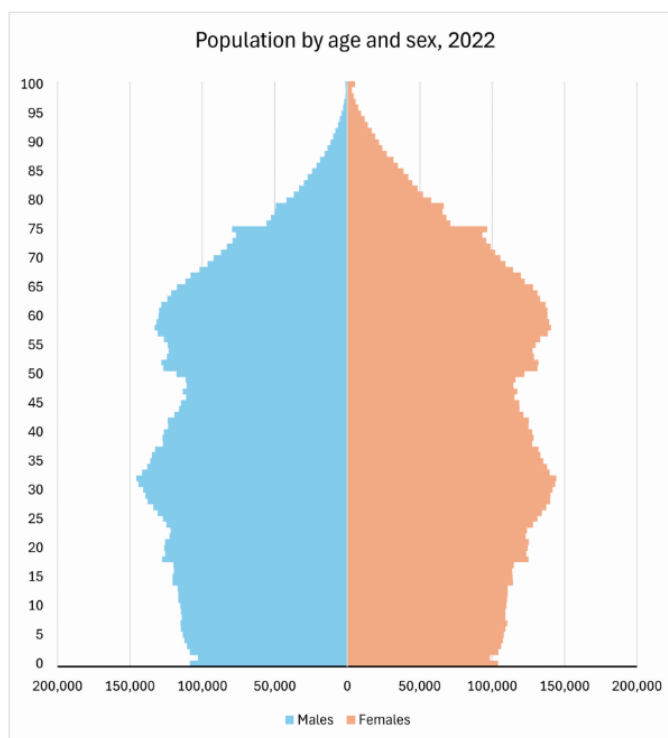
The number of births has been declining in New York and the number of deaths has been increasing. These projections expect that the number of deaths outnumber the number of births sometime during the next decade (i.e., 2035).

Domestic migration flows are the biggest driver of population change in New York and also the hardest to project. The population pyramids below illustrate the projected development of the demographic changes in 2035 and 2050 respectively:

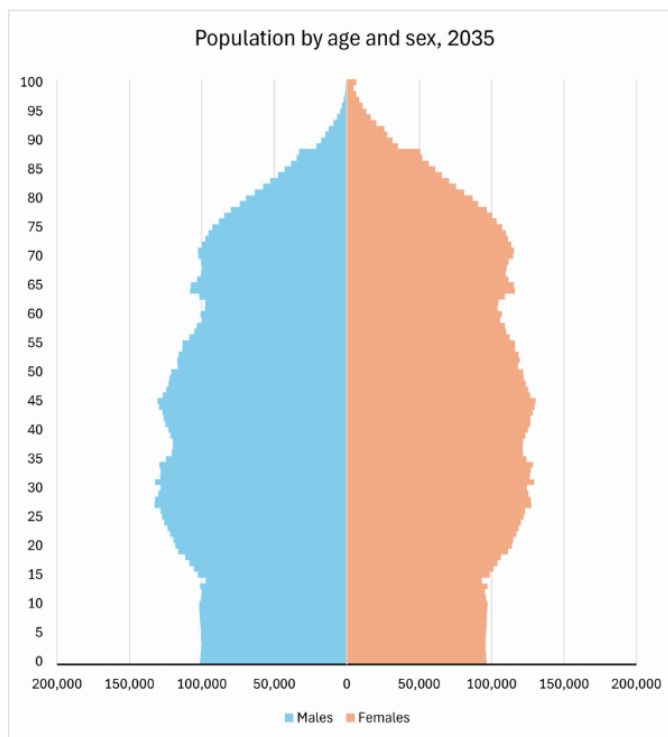
¹ Giles Morris (2024). Stark population decline projected for NYS. Cornell Chronicle. November 13, 2024. <https://news.cornell.edu/stories/2024/11/stark-population-decline-projected-nys> (last accessed December 5, 2024).

² New York State projections. https://pad.human.cornell.edu/state_projections. [Accessed 12/5/24]

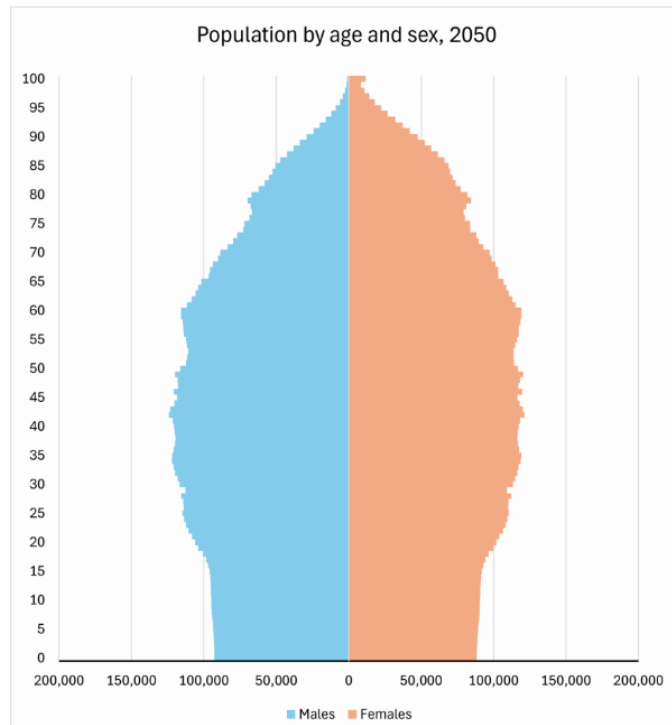
Population pyramids



Population pyramids



Population pyramids



Attachment V: Data matrices for waste movement

TABLES

Table V-1.	Baseline input
Table V-2.	Recycling decrease years 2035 and 2050
Table V-3.	Recycling increase years 2035 and 2050
Table V-4.	Rail increase years 2035 and 2050

Table V-1. Baseline input

State	County/COG	OoA Truck	OoA Train	OoA Barge	Landfill Truck	Landfill Train	Landfill Barge	Incineration Truck	Incineration Train	Incineration Barge	Recycling Truck	Recycling Train	Recycling Barge
NJ	Bergen	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Essex	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Hudson	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Hunterdon	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Middlesex	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Monmouth	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Morris	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Ocean	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Passaic	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Somerset	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Sussex	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Union	67%	10%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Warren	77%	0%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
PA	Lehigh	37%	5%	0%	27%	0%	0%	0%	0%	0%	31%	0%	0%
PA	Northampton	37%	5%	0%	27%	0%	0%	0%	0%	0%	31%	0%	0%
CT	Capitol Region	18%	5%	0%	0%	0%	0%	57%	0%	0%	20%	0%	0%
CT	Lower CT River Valley	18%	5%	0%	0%	0%	0%	57%	0%	0%	20%	0%	0%
CT	Metropolitan	19%	4%	5%	0%	0%	0%	57%	0%	0%	20%	0%	0%
CT	Naugatuck Valley	18%	5%	0%	0%	0%	0%	57%	0%	0%	20%	0%	0%
CT	South Central	18%	5%	0%	0%	0%	0%	57%	0%	0%	20%	0%	0%
CT	Western	18%	5%	0%	0%	0%	0%	57%	0%	0%	20%	0%	0%
NY	New York City	0%	19%	19%	2%	31%	4%	8%	0%	0%	40%	0%	0%
NY	Long Island	18%	1%	0%	33%	0%	0%	8%	0%	0%	40%	0%	0%
NY	Orange	19%	0%	0%	33%	0%	0%	8%	0%	0%	40%	0%	0%
NY	Putnam	19%	0%	0%	33%	0%	0%	8%	0%	0%	40%	0%	0%
NY	Rockland	19%	0%	0%	33%	0%	0%	8%	0%	0%	40%	0%	0%
NY	Westchester	19%	0%	0%	33%	0%	0%	8%	0%	0%	40%	0%	0%

Table V-2. Recycling decrease years 2035 and 2050

State	County/COG	OoA Truck	OoA Train	OoA Barge	Landfill Truck	Landfill Train	Landfill Barge	Incineration Truck	Incineration Train	Incineration Barge	Recycling Truck	Recycling Train	Recycling Barge
NJ	Bergen	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Essex	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Hudson	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Hunterdon	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Middlesex	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Monmouth	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Morris	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Ocean	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Passaic	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Somerset	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Sussex	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Union	77%	10%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
NJ	Warren	87%	0%	0%	12%	0%	0%	0%	0%	0%	1%	0%	0%
PA	Lehigh	47%	5%	0%	27%	0%	0%	0%	0%	0%	21%	0%	0%
PA	Northampton	47%	5%	0%	27%	0%	0%	0%	0%	0%	21%	0%	0%
CT	Capitol Region	28%	5%	0%	0%	0%	0%	57%	0%	0%	10%	0%	0%
CT	Lower CT River Valley	28%	5%	0%	0%	0%	0%	57%	0%	0%	10%	0%	0%
CT	Metropolitan	29%	4%	5%	0%	0%	0%	57%	0%	0%	10%	0%	0%
CT	Naugatuck Valley	28%	5%	0%	0%	0%	0%	57%	0%	0%	10%	0%	0%
CT	South Central	28%	5%	0%	0%	0%	0%	57%	0%	0%	10%	0%	0%
CT	Western	28%	5%	0%	0%	0%	0%	57%	0%	0%	10%	0%	0%
NY	New York City	10%	19%	19%	2%	31%	4%	8%	0%	0%	30%	0%	0%
NY	Long Island	28%	1%	0%	33%	0%	0%	8%	0%	0%	30%	0%	0%
NY	Orange	29%	0%	0%	33%	0%	0%	8%	0%	0%	30%	0%	0%
NY	Putnam	29%	0%	0%	33%	0%	0%	8%	0%	0%	30%	0%	0%
NY	Rockland	29%	0%	0%	33%	0%	0%	8%	0%	0%	30%	0%	0%
NY	Westchester	29%	0%	0%	33%	0%	0%	8%	0%	0%	30%	0%	0%

Table 24. Recycling increase years 2035 and 2050

State	County/COG	OoA Truck	OoA Train	OoA Barge	Landfill Truck	Landfill Train	Landfill Barge	Incineration Truck	Incineration Train	Incineration Barge	Recycling Truck	Recycling Train	Recycling Barge
NJ	Bergen	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Essex	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Hudson	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Hunterdon	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Middlesex	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Monmouth	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Morris	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Ocean	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Passaic	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Somerset	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Sussex	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Union	57%	10%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
NJ	Warren	67%	0%	0%	12%	0%	0%	0%	0%	0%	21%	0%	0%
PA	Lehigh	27%	5%	0%	27%	0%	0%	0%	0%	0%	41%	0%	0%
PA	Northampton	27%	5%	0%	27%	0%	0%	0%	0%	0%	41%	0%	0%
CT	Capitol Region	8%	5%	0%	0%	0%	0%	57%	0%	0%	30%	0%	0%
CT	Lower CT River Valley	8%	5%	0%	0%	0%	0%	57%	0%	0%	30%	0%	0%
CT	Metropolitan	9%	4%	5%	0%	0%	0%	57%	0%	0%	30%	0%	0%
CT	Naugatuck Valley	8%	5%	0%	0%	0%	0%	57%	0%	0%	30%	0%	0%
CT	South Central	8%	5%	0%	0%	0%	0%	57%	0%	0%	30%	0%	0%
CT	Western	8%	5%	0%	0%	0%	0%	57%	0%	0%	30%	0%	0%
NY	New York City	0%	19%	19%	0%	31%	4%	0%	0%	0%	50%	0%	0%
NY	Long Island	8%	1%	0%	33%	0%	0%	8%	0%	0%	50%	0%	0%
NY	Orange	9%	0%	0%	33%	0%	0%	8%	0%	0%	50%	0%	0%
NY	Putnam	9%	0%	0%	33%	0%	0%	8%	0%	0%	50%	0%	0%
NY	Rockland	9%	0%	0%	33%	0%	0%	8%	0%	0%	50%	0%	0%
NY	Westchester	9%	0%	0%	33%	0%	0%	8%	0%	0%	50%	0%	0%

Table 25. Rail increase years 2035 and 2050

State	County/COG	OoA Truck	OoA Train	OoA Barge	Landfill Truck	Landfill Train	Landfill Barge	Incineration Truck	Incineration Train	Incineration Barge	Recycling Truck	Recycling Train	Recycling Barge
NJ	Bergen	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Essex	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Hudson	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Hunterdon	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Middlesex	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Monmouth	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Morris	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Ocean	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Passaic	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Somerset	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Sussex	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Union	47%	30%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
NJ	Warren	57%	20%	0%	12%	0%	0%	0%	0%	0%	11%	0%	0%
PA	Lehigh	17%	25%	0%	27%	0%	0%	0%	0%	0%	31%	0%	0%
PA	Northampton	17%	25%	0%	27%	0%	0%	0%	0%	0%	31%	0%	0%
CT	Capitol Region	0%	23%	0%	0%	0%	0%	55%	2%	0%	20%	0%	0%
CT	Lower CT River Valley	0%	23%	0%	0%	0%	0%	55%	2%	0%	20%	0%	0%
CT	Metropolitan	0%	23%	5%	0%	0%	0%	56%	1%	0%	20%	0%	0%
CT	Naugatuck Valley	0%	23%	0%	0%	0%	0%	55%	2%	0%	20%	0%	0%
CT	South Central	0%	23%	0%	0%	0%	0%	55%	2%	0%	20%	0%	0%
CT	Western	0%	23%	0%	0%	0%	0%	55%	2%	0%	20%	0%	0%
NY	New York City	0%	19%	19%	0%	33%	4%	0%	8%	0%	30%	10%	0%
NY	Long Island	0%	19%	0%	33%	0%	0%	6%	2%	0%	40%	0%	0%
NY	Orange	0%	19%	0%	33%	0%	0%	7%	1%	0%	40%	0%	0%
NY	Putnam	0%	19%	0%	33%	0%	0%	7%	1%	0%	40%	0%	0%
NY	Rockland	0%	19%	0%	33%	0%	0%	7%	1%	0%	40%	0%	0%
NY	Westchester	0%	19%	0%	33%	0%	0%	7%	1%	0%	40%	0%	0%

Attachment VI: Waste Transport Scenarios

FIGURES

- Figure VI-1: 2035 Open Market landfill waste amount (left) and number of trips (right)
- Figure VI-2: 2035 Open market landfill movement between states annual number of trips
- Figure VI-3: 2035 Constant Stream Landfill and Decrease in Recycling waste amount (left) and number of trips (right)
- Figure VI-4: 2035 Constant stream landfill and decrease in recycling (-10%) movement between states annual number of trips
- Figure VI-5: 2035 Constant Stream Landfill and Increase in Recycling waste amount (left) and number of trips (right)
- Figure VI-6: 2035 Constant stream landfill and increase in recycling (+10%) movement between states annual number of trips
- Figure VI-7: 2035 Constant stream landfill and shift road to rail waste amount (left) and number of trips (right)
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- Figure VI-9: 2050 Open Market landfill waste amount (left) and number of trips (right)
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- Figure VI-13: Constant Stream Landfill and Increase in Recycling waste amount (left) and number of trips (right)
- Figure VI-14: 2050 Constant stream landfill and increase in recycling (+10%) movement between states annual number of trips
- Figure VI-15: 2050 Constant stream landfill and shift road to rail waste amount (left) and number of trips (right)
- Figure VI-16: 2050 Constant stream landfill and shift road to rail (20%) movement between states annual number of trips

TABLES

- Table VI-1. Number of trips changes between 2035 CS and 2035 OM scenarios
- Table VI-2. Number of trips changes between 2035 CS and 2035 Rec De scenarios
- Table VI-3. Number of trips changes between 2035 CS and 2035 Rec In scenarios
- Table VI-4. Number of trips changes between 2035 CS and 2035 Rail scenarios

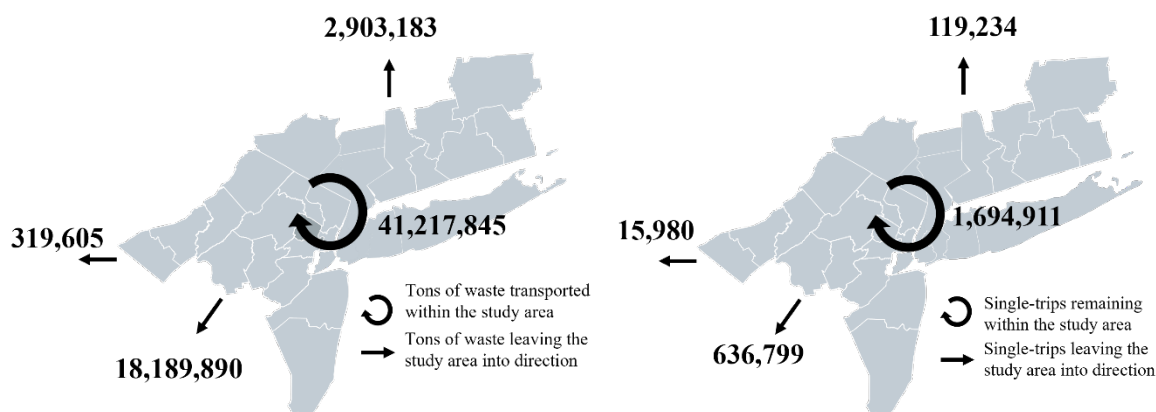
- Table VI-5. Number of trips changes between 2050 CS and 2050 OM scenarios
- Table VI-6. Number of trips changes between 2050 CS and 2050 Rec De scenarios
- Table VI-7. Number of trips changes between 2050 CS and 2050 Rec In scenarios
- Table VI-8. Number of trips changes between 2050 CS and 2050 Rail scenarios

2035 Open Market Landfill

An analysis of the 2035 open market scenario shown in **Figure VI-1** that most of the waste stays within the study area. The highest amount of waste and number of trips leaving the study area were directed southwest, followed by north, and west.

Compared to the 2035 constant stream scenario in **Table** , the number of trips leaving the study area decreased to the north of the region by 43%, to the west by 29% and to the south-west by 11%. The number of trips within the study area increase by 8%. This is showing the shift from the constant stream scenario, where waste from closed landfills leaves the study area, to the open market scenario, where waste is moved to the remaining open landfills within the study area

Figure VI-1: 2035 Open Market landfill waste amount (left) and number of trips (right)



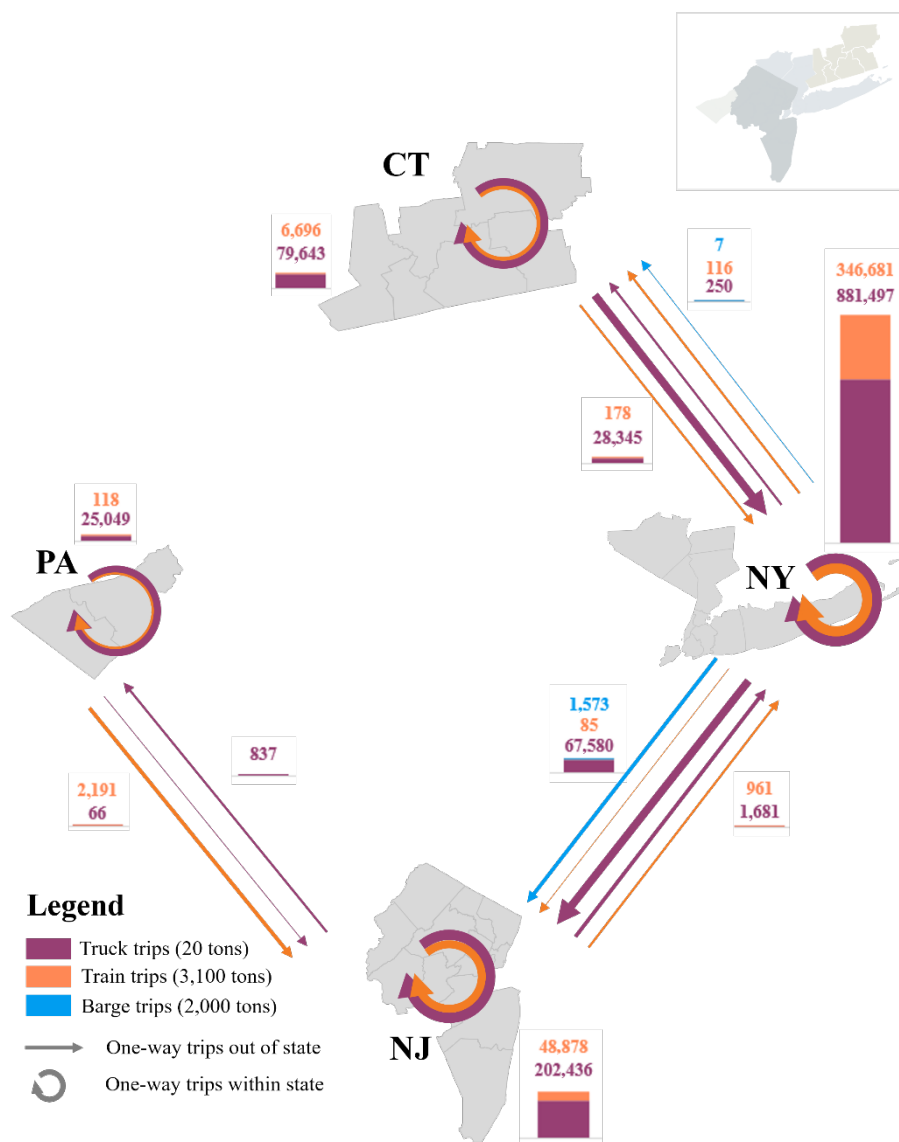
Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2**, of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

Table VI-1. Number of trips changes between 2035 CS and 2035 OM scenarios

	2035 CS	2035 OM	Percentage change
North	210,452	119,234	-43%
West	22,668	15,980	-30%
South-west	714,421	636,799	-11%
Remaining within study area	1,571,700	1,694,911	+8%

Within the study area shown in **Figure** , the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2035 CS stream scenario, the 2035 open market scenario shows train trips between New York and New Jersey and a 10% increase of truck trips. Truck trips within New Jersey increased by 63% as well as a slight increase in truck trips within New York and Pennsylvania.

Figure VI-2: 2035 Open market landfill movement between states annual number of trips



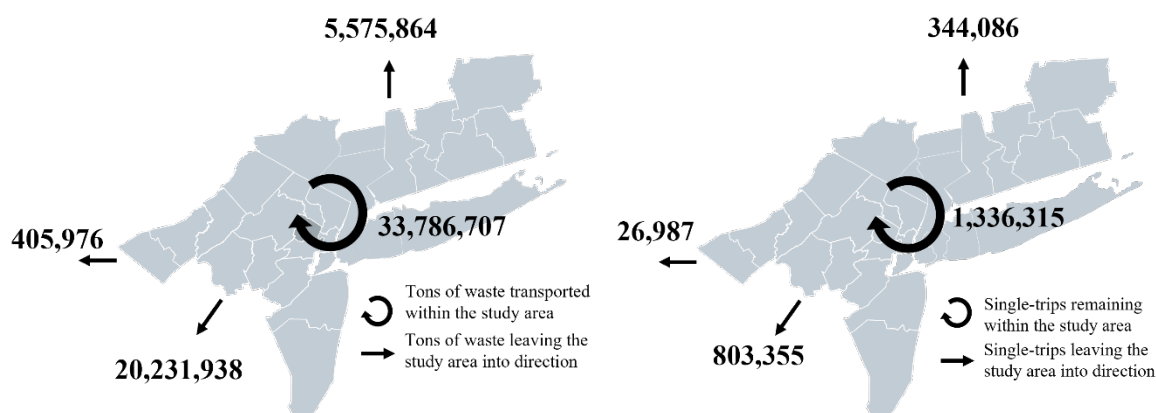
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2035 Constant Stream Landfill and Decrease in Recycling (-10%)

The analysis of the 2035 Recycling decrease scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2035 CS scenario in **Table** , the number of trips leaving the study area increased to the north of the region by 64%, to the west by 19% and to the south-west by 12%. The number of trips within the study area decreased by 15%. This is showing the effect of waste not being recycled and instead being transported out of area.

Figure VI-3: 2035 Constant Stream Landfill and Decrease in Recycling waste amount (left) and number of trips (right)



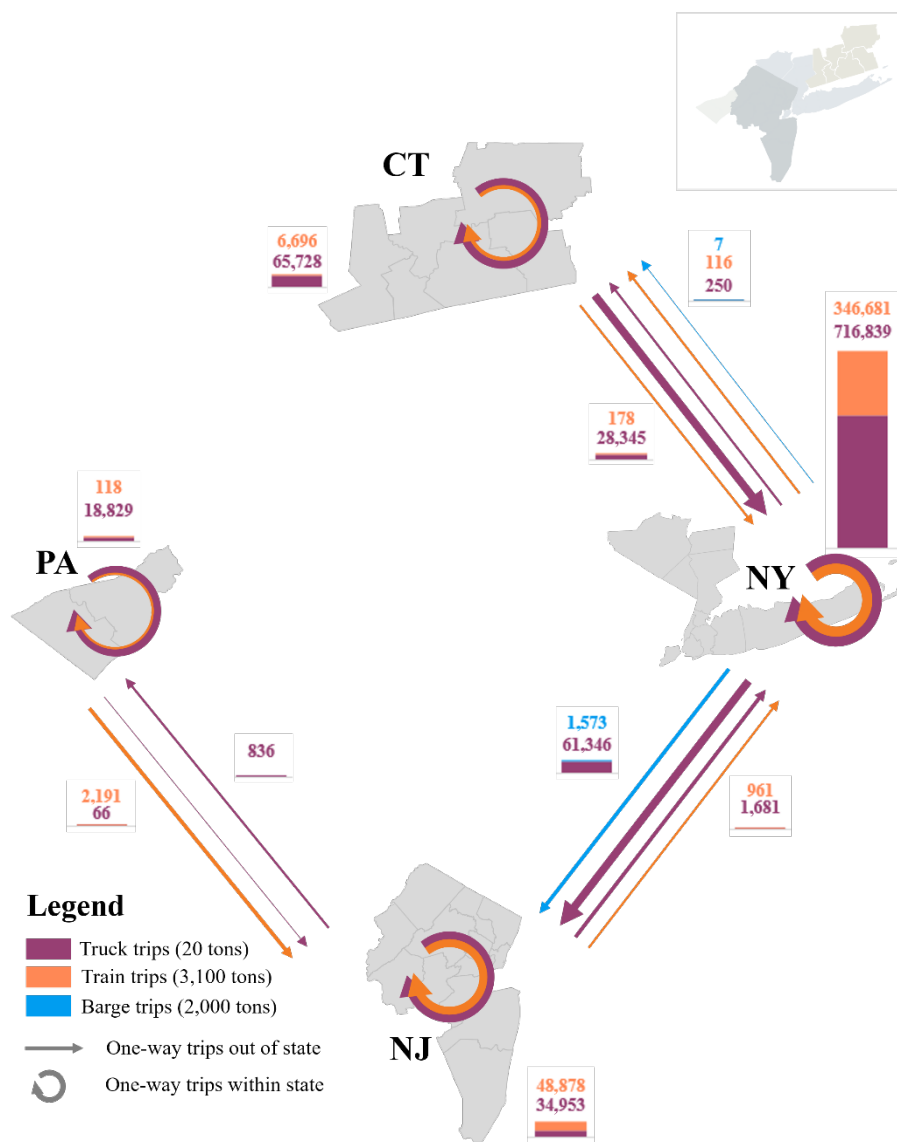
Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

Table V-2. Number of trips changes between 2035 CS and 2035 Rec De scenarios

	2035 CS	2035 Rec De	Percentage change
North	210,452	344,086	+63%
West	22,668	26,987	+19%
South-west	714,421	803,355	+12%
Remaining within study area	1,571,700	1,336,315	-15%

Within the study area shown in **Figure** , the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2035 CS stream scenario, the 2035 recycling decrease scenario shows a reduction in truck trips within all four states. The highest reduction occurred within New Jersey, by 72%. Truck trips within New York, Connecticut and Pennsylvania reduced by 17-19%. This reflects the trip reduction within the study area in **Table** and a change to trips going outside the study area. As trips to processing facilities were taken by trucks, only a change in truck trip destinations is shown.

Figure VI-4: 2035 Constant stream landfill and decrease in recycling (-10%) movement between states annual number of trips



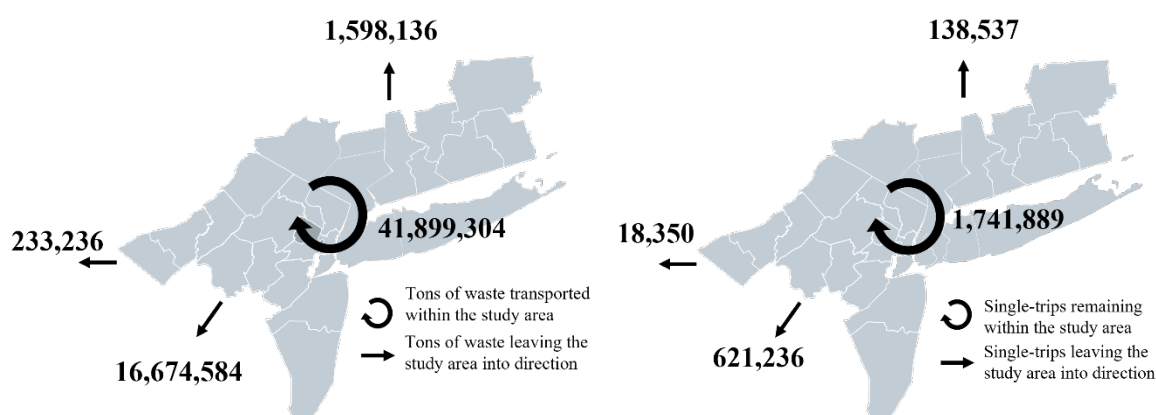
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2035 Constant Stream Landfill and Increase in Recycling (+10%)

The analysis of the 2035 Recycling increase scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2035 CS scenario in **Table** , the number of trips leaving the study area decreased to the north of the region by 34%, to the west by 19% and to the south-west by 13%. The number of trips within the study area increased by 11%, showing the change from trips going out of study area to processing facilities.

Figure VI-5: 2035 Constant Stream Landfill and Increase in Recycling waste amount (left) and number of trips (right)



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

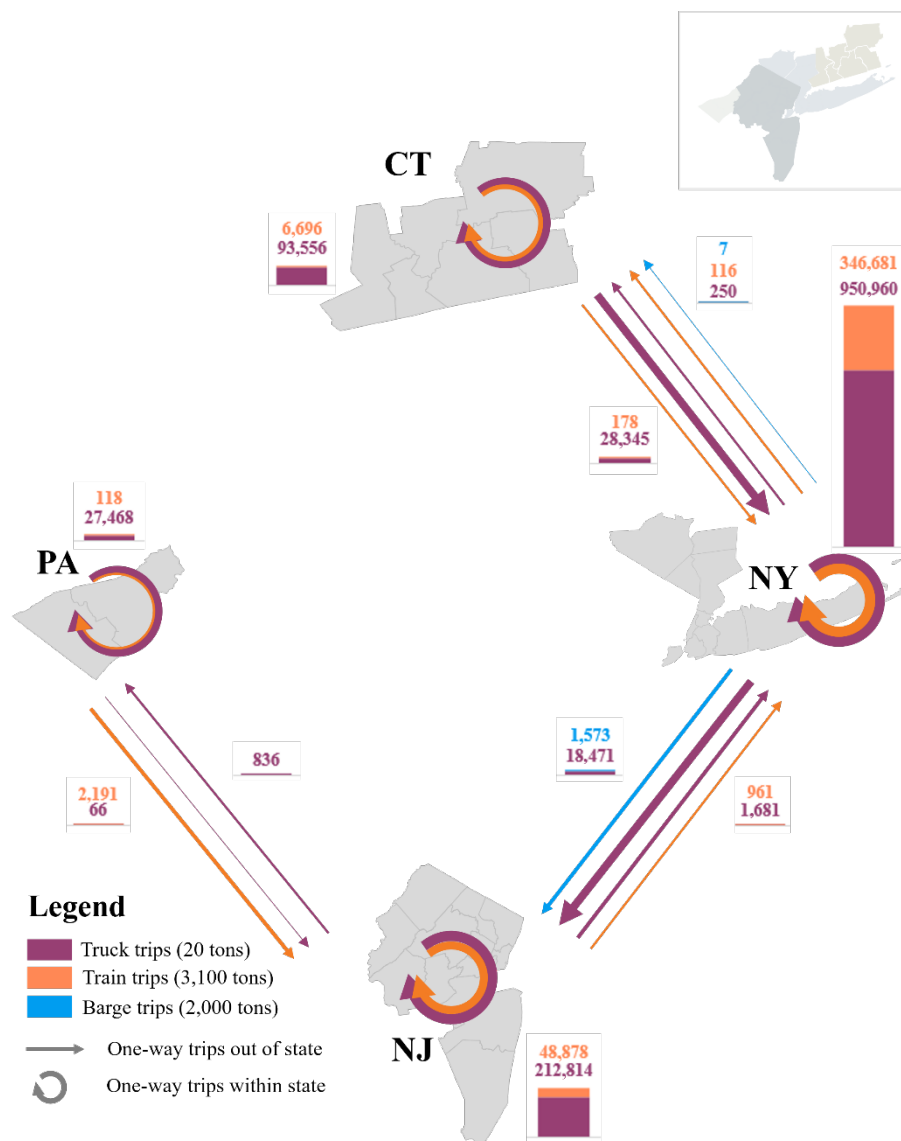
Table VI-3. Number of trips changes between 2035 CS and 2035 Rec In scenarios

	2035 CS	2035 Rec In	Percentage change
North	210,452	138,537	-34%
West	22,668	18,350	-19%
South-west	714,421	621,236	-13%
Remaining within study area	1,571,700	1,741,889	+11%

Within the study area shown in **Figure** , the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2035 CS stream scenario, the 2035 recycling increase scenario shows an increase in truck trips within all four states. The highest increase occurred within New Jersey, by 72%. Truck trips within New York, Connecticut and Pennsylvania increased by 15-19%. Additionally, a truck trip reduction of 70% from New York to New Jersey can be traced back to a change of waste amount transported to incinerators by truck. This reflects the trip increase within the study area in **Table** and a change from trips going

outside the study area. As trips to processing facilities were taken by trucks, only a change in truck trip destinations is shown, including out of area and incineration destinations.

Figure VI-6: 2035 Constant stream landfill and increase in recycling (+10%) movement between states annual number of trips



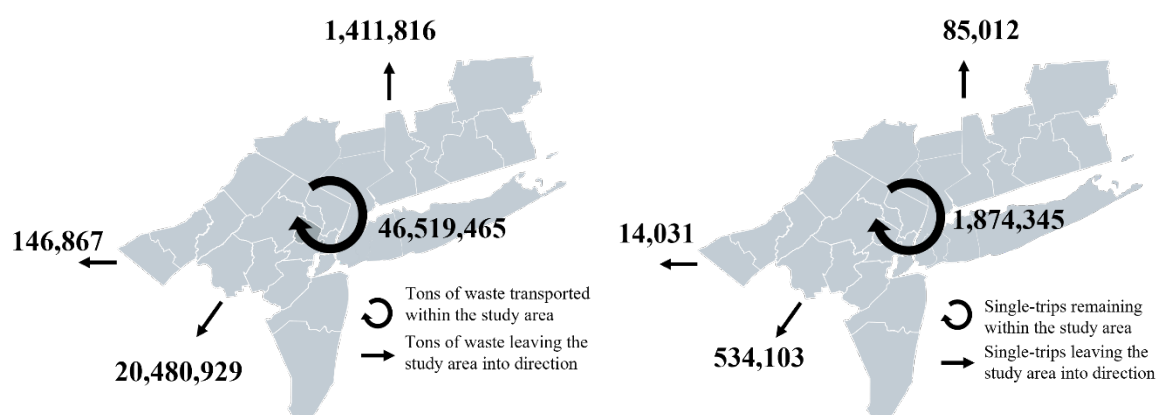
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2035 Constant Stream Landfill and Shift Road to Rail (20%)

The analysis of the 2035 Rail scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2035 CS scenario in **Table VI-4**, the number of trips leaving the study area decreased to the north of the region by 60%, to the west by 38% and to the south-west by 25%. The number of trips within the study area increased by 19%, due to intermodal use of trucks, train and barge.

Figure VI-7: 2035 Constant stream landfill and shift road to rail waste amount (left) and number of trips (right)



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

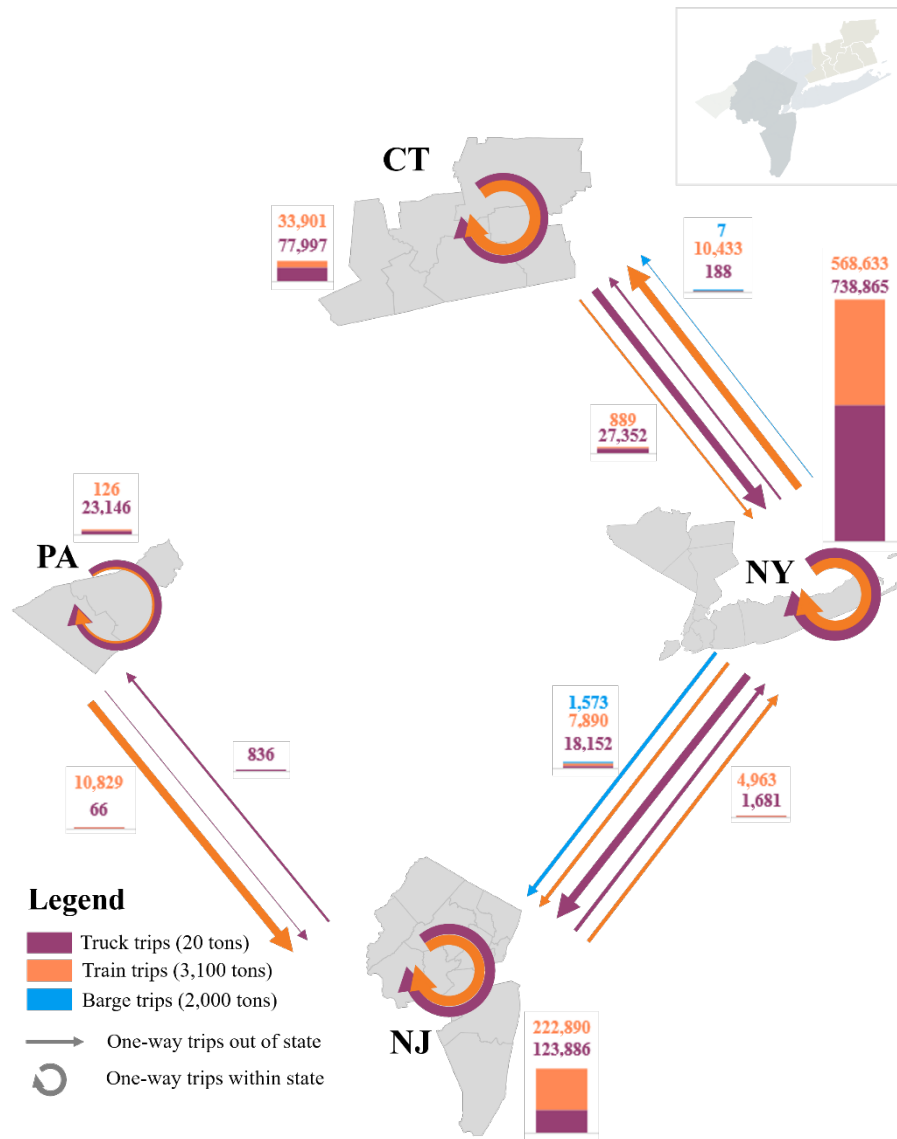
Table VI-4. Number of trips changes between 2035 CS and 2035 Rail scenarios

	2035 CS	2035 Rail	Percentage change
North	210,452	85,012	-60%
West	22,668	14,031	-38%
South-west	714,421	534,103	-25%
Remaining within study area	1,571,700	1,874,345	+19%

Within the study area shown in **Figure**, the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2035 CS stream scenario, the 2035 rail scenario shows an increase in train trips within all four states and between all previously connected states. The highest increase occurred between New York and Connecticut. A reduction of truck trips is shown between New York and New Jersey by 70%, New York and Connecticut by 25%, Connecticut and New York by 4% and within New York by 15% and Connecticut by 2%. However, between several states, the truck trips remained steady, showing

the intermodal use of train trips. This reflects the trip increase within the study area in **Table VI-4** and a decrease in trips going outside the study area, due to higher mode capacities of trains.

Figure VI-8: 2035 Constant stream landfill and shift road to rail (20%) movement between states annual number of trips



Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2050 Open Market Landfill

The analysis of the 2050 open market scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2050 CS scenario in **Table VI-5**, the number of trips leaving the study area increased to the north of the region by 45% and decreased to the west and south-west of the region as well as the trips within the study area. The decrease of trips ranged between 5% (south-west and within study area) and 28% (west). This change compared to the constant stream scenario, shows the complete closure of all landfills within the study area.

Figure VI-9: 2050 Open Market landfill waste amount (left) and number of trips (right)

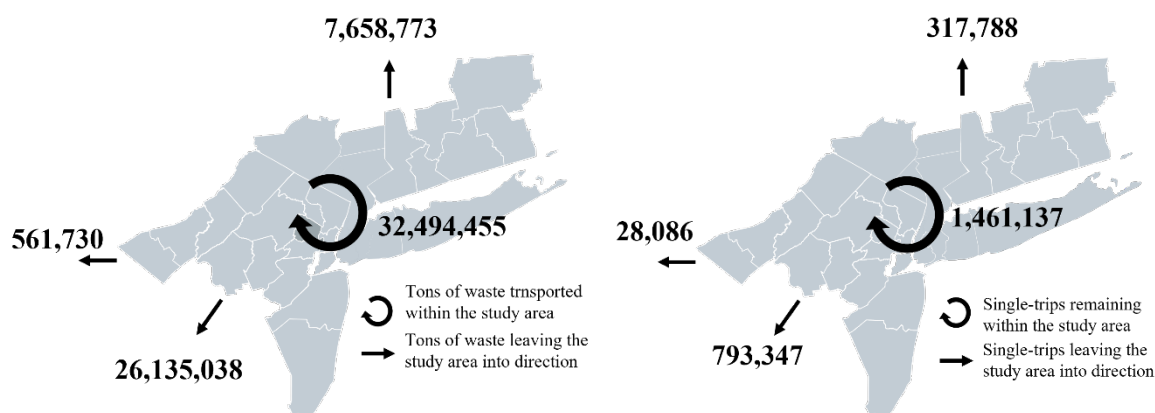
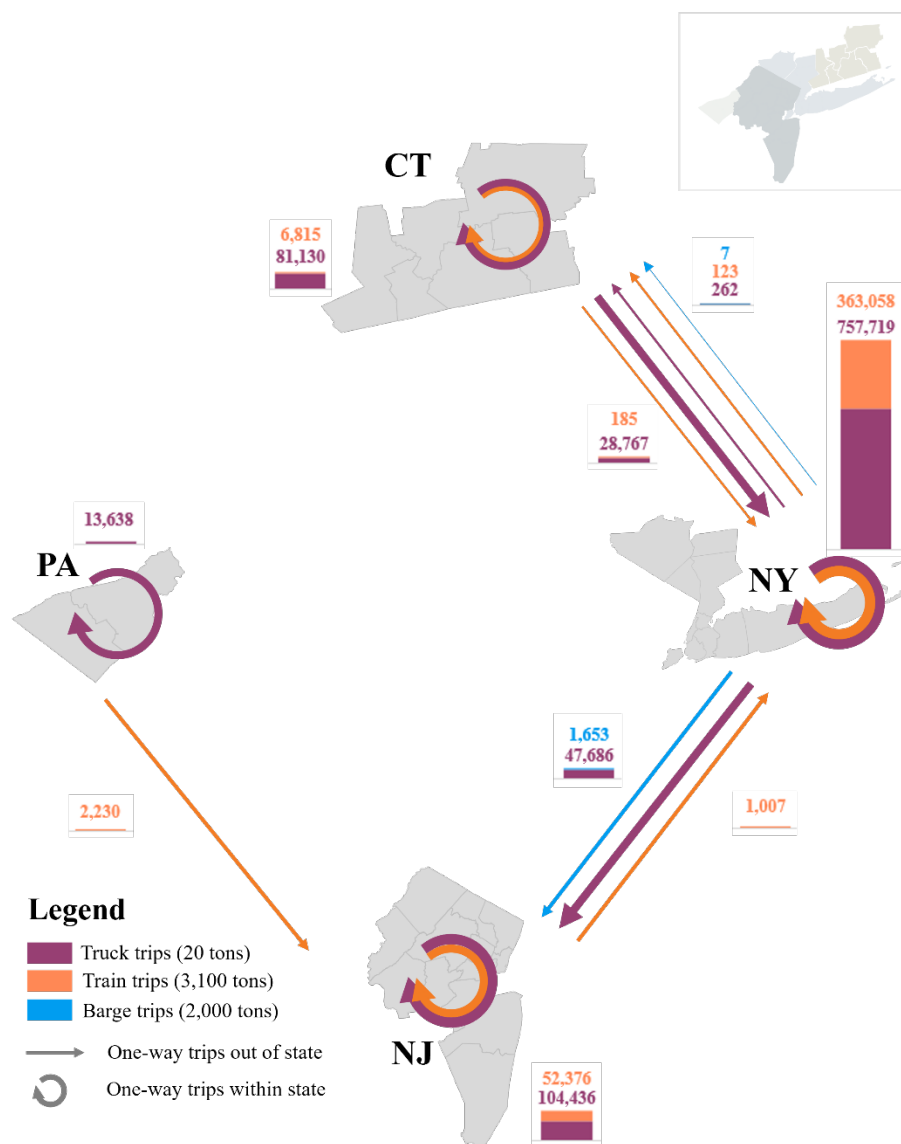


Table VI-5. Number of trips changes between 2050 CS and 2050 OM scenarios

	2050 CS	2050 OM	Percentage change
North	218,857	317,788	+45%
West	38,987	28,086	-28%
South-west	847,789	793,347	-6%
Remaining within study area	1,543,670	1,461,137	-5%

Within the study area shown in **Figure** , the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2050 CS stream scenario, the 2050 open market scenario shows an 11% decrease in truck trips within New York and no more truck trips between New Jersey and New York. This reflects the slight trip decrease within the study area in **Table VI-5** and reflecting the closure of all landfills.

Figure VI-10: 2050 Open market landfill movement between states annual number of trips



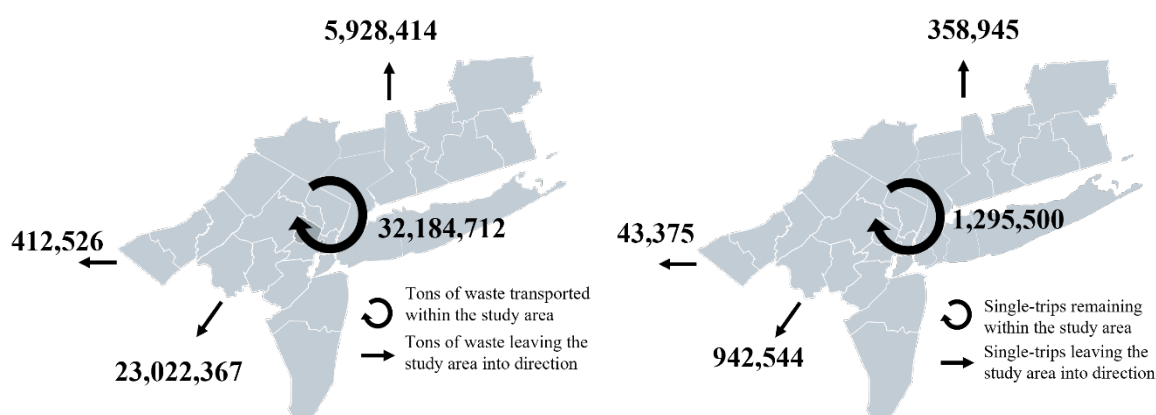
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2050 Constant Stream Landfill and Decrease in Recycling (-10%)

The analysis of the 2050 Recycling decrease scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2050 CS scenario in **Table VI-6**, the number of trips leaving the study area increased to the north of the region by 64%, and to the west and south-west by 11%. The number of trips starting and ending within the study area decreased by 16%. This is showing the effect of waste not being recycled and instead being transported out of area.

Figure VI-11: 2050 Constant Stream Landfill and Decrease in Recycling waste amount (left) and number of trips (right)



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

Table VI-6. Number of trips changes between 2050 CS and 2050 Rec De scenarios

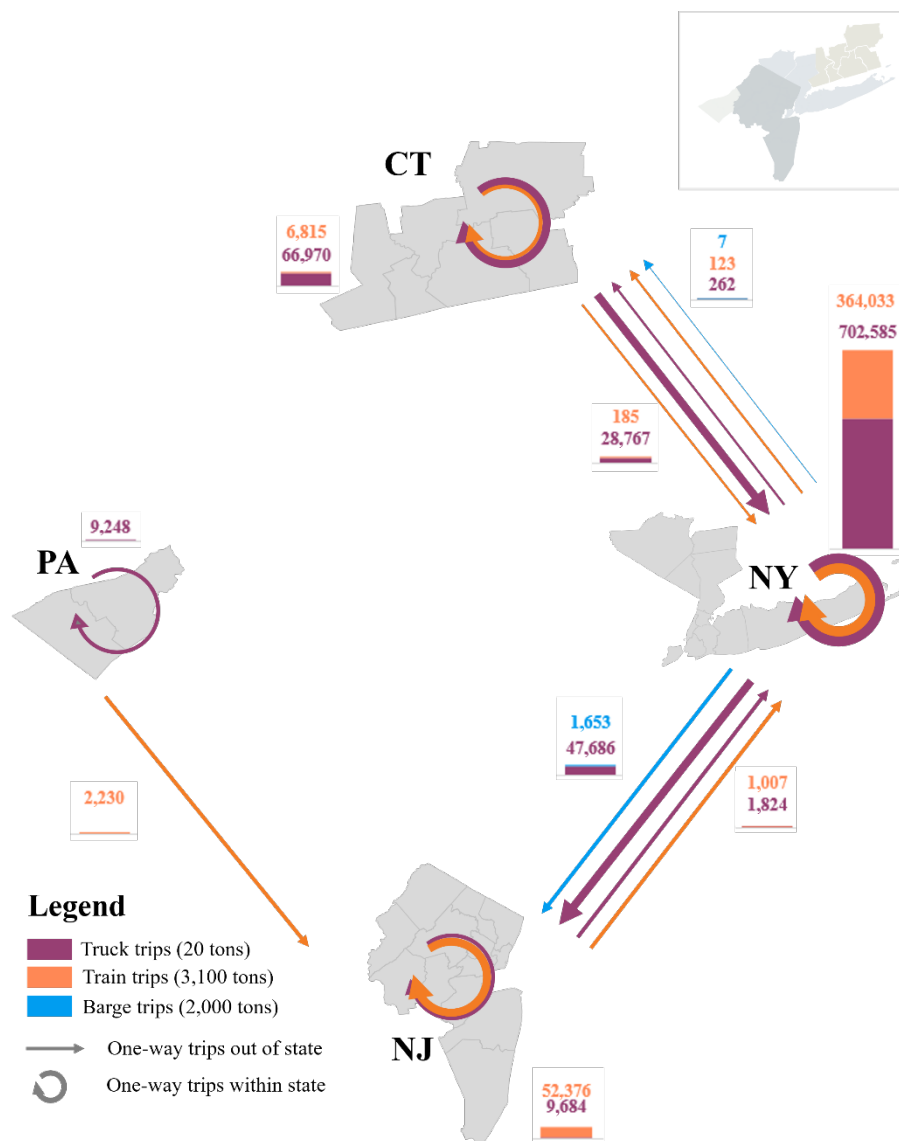
	2050 CS	2050 Rec De	Percentage change
North	218,857	358,945	+64%
West	38,987	43,375	+11%
South-west	847,789	942,544	+11%
Remaining within study area	1,543,670	1,295,500	-16%

Within the study area shown in Compared to the 2050 CS stream scenario, the 2050 recycling decrease scenario shows a reduction in truck trips within all four states. The highest reduction occurred within New Jersey, by 91%. Truck trips within New York, Connecticut and Pennsylvania reduced by 17-32%. This reflects the trip reduction within the study area in **Table VI-6** and a change to trips going outside the study area. As trips to processing facilities were taken by trucks, only a change in truck trip destinations is shown.

Figure, the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge

transportation. Compared to the 2050 CS stream scenario, the 2050 recycling decrease scenario shows a reduction in truck trips within all four states. The highest reduction occurred within New Jersey, by 91%. Truck trips within New York, Connecticut and Pennsylvania reduced by 17-32%. This reflects the trip reduction within the study area in **Table VI-6** and a change to trips going outside the study area. As trips to processing facilities were taken by trucks, only a change in truck trip destinations is shown.

Figure VI-12: 2050 Constant stream landfill and decrease in recycling (-10%) movement between states annual number of trips



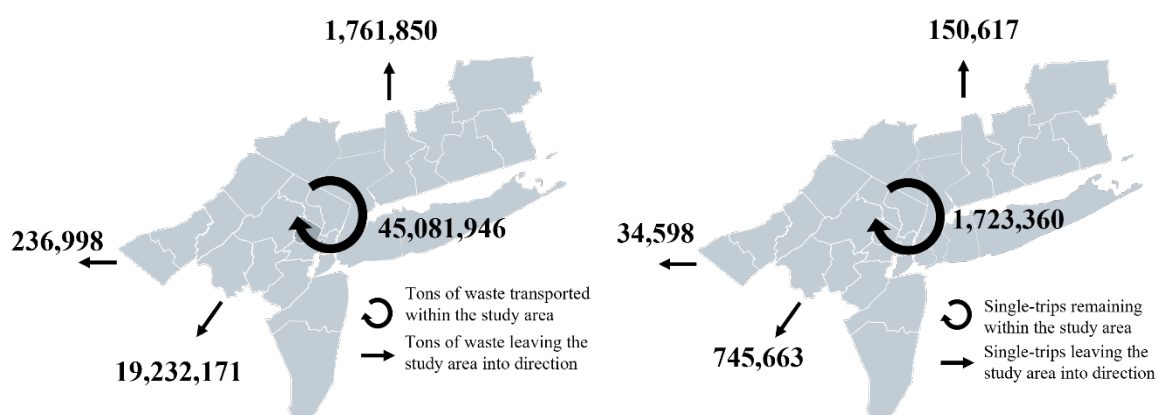
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2050 Constant Stream Landfill and Increase in Recycling (+10%)

The analysis of the 2050 Recycling increase scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2050 constant stream model in **Table** , the number of trips leaving the study area decreased by 31% to the north of the region, 11% to the west and 12% to the south-west of the region. In contrast, the number of trips within the study area increased by 12%, showing the change from trips going out of study area to processing facilities.

Figure VI-13: Constant Stream Landfill and Increase in Recycling waste amount (left) and number of trips (right)



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

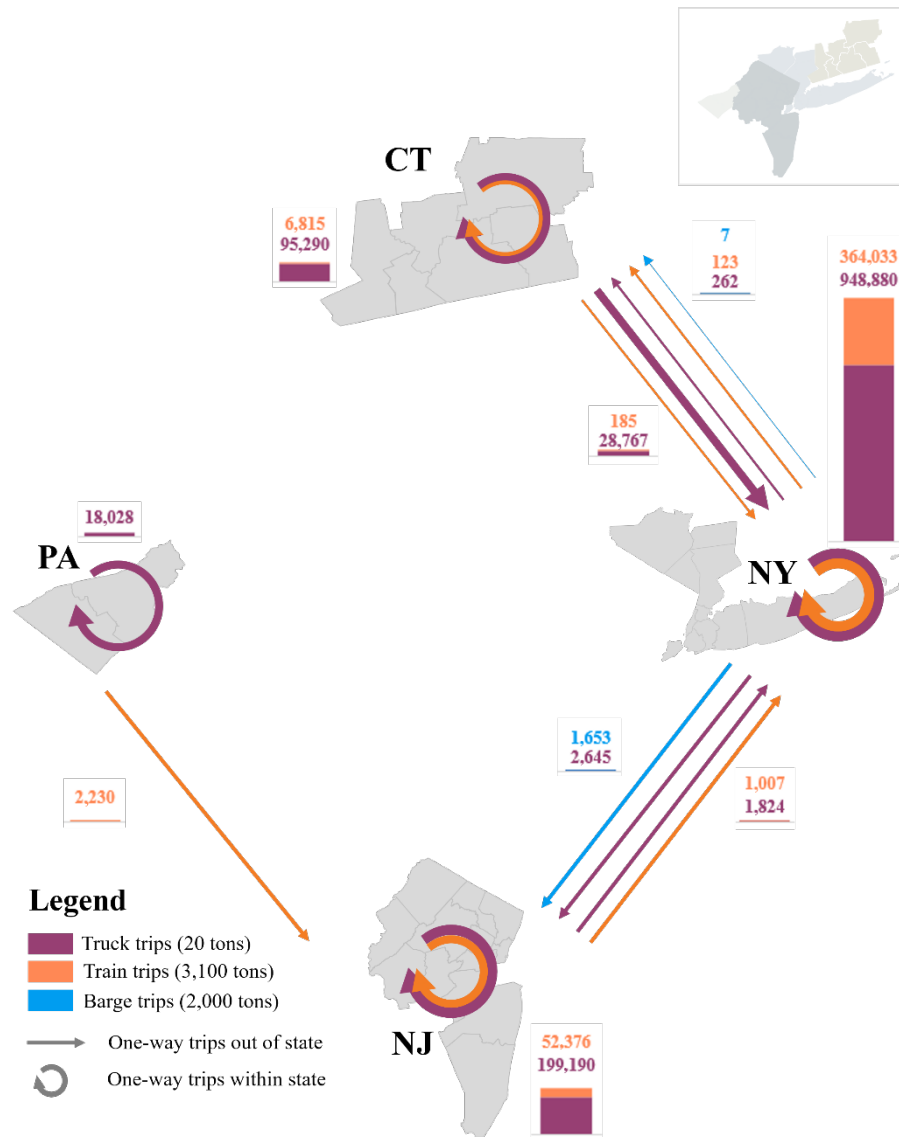
Table VI-7. Number of trips changes between 2050 CS and 2050 Rec In scenarios

	2050 CS	2050 Rec In	Percentage change
North	218,857	150,617	-31%
West	38,987	34,598	-11%
South-west	847,789	745,663	-12%
Remaining within study area	1,543,670	1,723,360	+12%

Within the study area shown in **Figure** , the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2050 CS stream scenario, the 2050 recycling increase scenario shows an increase in truck trips within all four states. The highest increase occurred within New Jersey, by 91%. Truck trips within New York, Connecticut and Pennsylvania increased by 16-32%. Additionally, a truck trip reduction of 94% from New York to New Jersey can be traced back to a change of waste amount transported to incinerators by truck. This reflects the trip increase within the study area in **Table** and a change from trips going

outside the study area. As trips to processing facilities were taken by trucks, only a change in truck trip destinations is shown, including out of area and incineration destinations.

Figure VI-14: 2050 Constant stream landfill and increase in recycling (+10%) movement between states annual number of trips



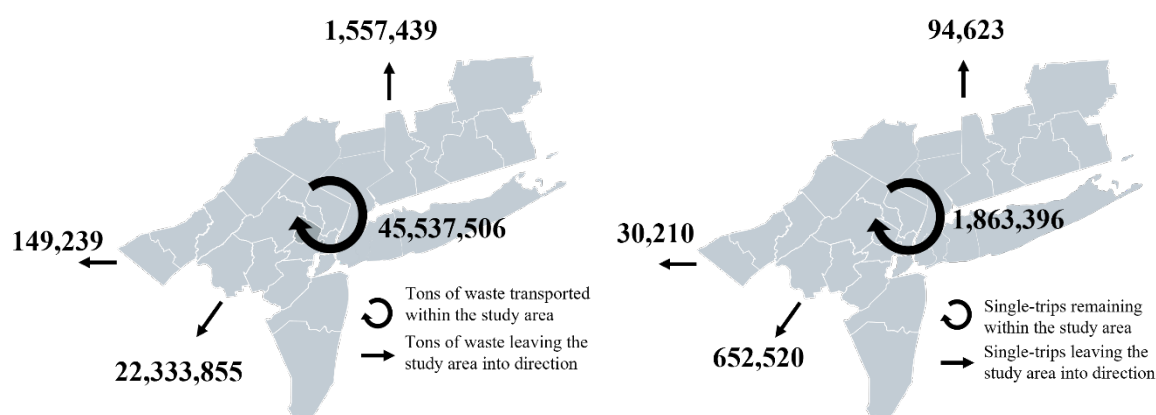
Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.

2050 Constant Stream Landfill and Shift Road to Rail (20%)

The analysis of the 2050 Rail scenario revealed in **Figure** that most of the waste is staying within the study area. The highest amount of waste and number of trips leaving the study area were directed south-west, followed by north, and west.

Compared to the 2050 constant stream scenario in **Table VI-8**, the number of trips leaving the study area decreased to the south-west and west of the region by 23%, and to the north by 57%, showing the shift from road to rail on long distance trips. In contrast, the number of trips within the study area increased by 21%, due to intermodal use of trucks, train and barge.

Figure VI-15: 2050 Constant stream landfill and shift road to rail waste amount (left) and number of trips (right)



Note: The total waste amount being moved varies to the waste amount calculated in **Section 2.2** of the report, due to double or even triple counting waste which is moved by intermodal transport (truck and barge to transfer stations). This specifically has an impact on the amount of waste remaining within the study area.

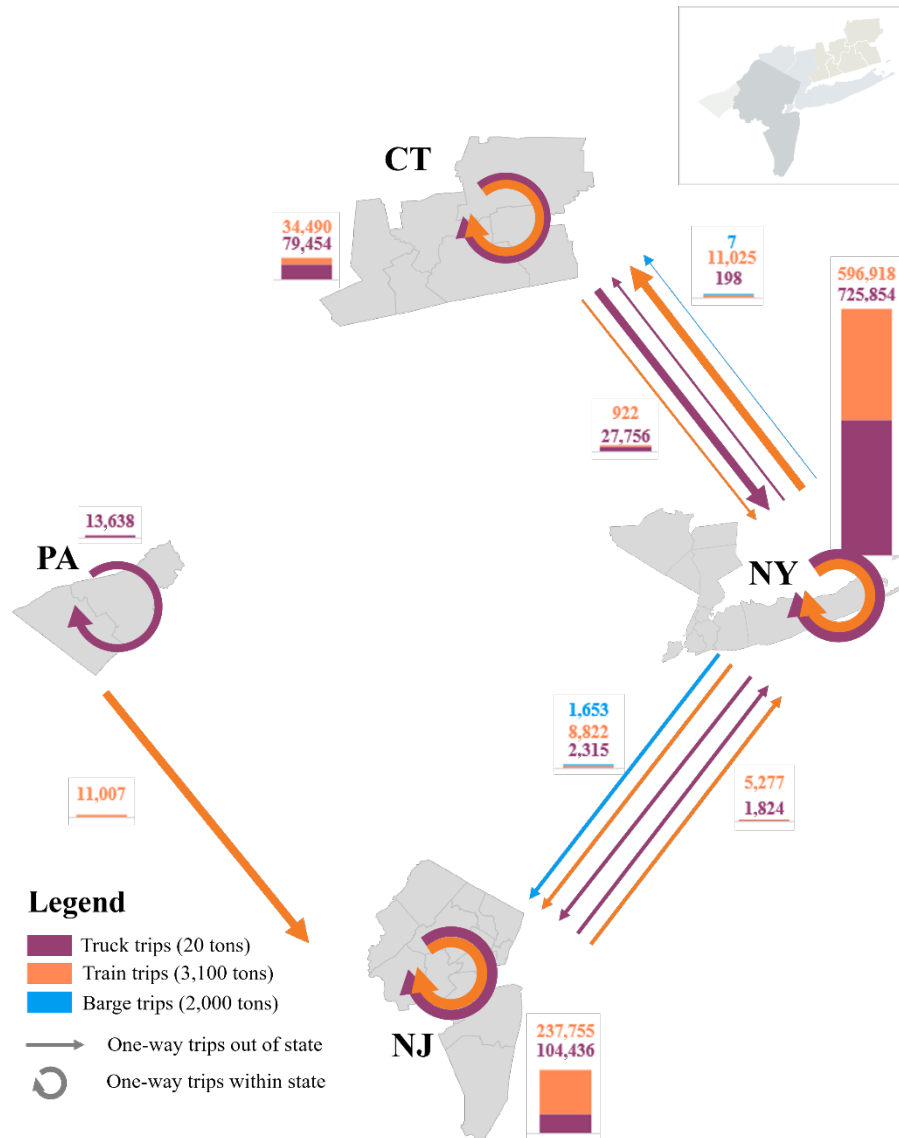
Table VI-8. Number of trips changes between 2050 CS and 2050 Rail scenarios

	2050 CS	2050 Rail	Percentage change
North	218,857	94,623	-57%
West	38,987	30,210	-23%
South-west	847,789	652,520	-23%
Remaining within study area	1,543,670	1,863,396	+23%

Within the study area shown in **Figure**, the highest number of trips remained within New York State and the biggest trip movement between states occurred between New York and New Jersey, which included barge transportation. Compared to the 2050 CS stream scenario, the 2050 rail scenario shows a high increase in train trips within all four states and between all previously connected states. The highest increases occurred between New York and Connecticut by nearly 9000%, followed by Pennsylvania to New Jersey (425%), within Connecticut (400%), and Connecticut to New York (394%). A reduction of truck trips is shown between New York and New Jersey by 95%, New York and Connecticut by 24%, Connecticut and New York by 4% and within New York by 16% and Connecticut by 2%. However, between several states, the truck

trips remained steady, showing the intermodal use of train trips. This reflects the trip increase within the study area in **Table VI-8** and a decrease in trips going outside the study area, due to higher mode capacities of trains.

Figure VI-16: 2050 Constant stream landfill and shift road to rail (20%) movement between states annual number of trips



Note: Overall, there were no waste trips between New Jersey and Connecticut, Pennsylvania and Connecticut, and Pennsylvania and New York due to the chosen methodology. As New Jersey is located between New York and Pennsylvania and the waste is moved to a destination located closest to its origin. Therefore, waste movement between the previously named states could not be identified.