Appendix E

SMTC Energy and Greenhouse Gas Analysis Process

SMTC ENERGY and GREENHOUSE GAS ANALYSIS PROCESS

Detailed below are the steps that were taken in an effort to complete the energy and greenhouse gas analysis required for the Syracuse Metropolitan Transportation Council's (SMTC) Long-Range Transportation Plan (LRTP) 2007 Update and the 2007 – 2012 Transportation Improvement Program (TIP).

The detailed results of the analysis can be found in the following steps. The steps that were followed are consistent with the guidance documents listed below, as amended through consultation with the New York State Department of Transportation's Environmental Analysis Bureau (NYSDOT-EAB).

- *Air Quality Analysis of Transportation Improvement Programs, Regional Transportation Plans, and Capital Project programs – Technical Guidance to Assist Metropolitan Planning Organizations and Department of Transportation Regional Offices Meet the Objectives of the 2002 New York State Energy Plan* (January 21, 2003);
- *Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12a: Energy Analysis Guidelines for TIPs and Plans* (June 21, 2002); and
- *Development of Revised NYSDOT Energy Analysis Guidelines (Draft), Subtask 12b: Greenhouse Gases (CO_2) Emissions Estimates for TIPs and Plans* (June 21, 2002)

Step #1 – Identification of all Non-Exempt and Regionally Significant Projects

The first step in this process was determining which projects would be subject to analysis. All of the projects included in the 2007-2012 TIP and the LRTP 2007 Update were reviewed for their significance in affecting energy consumption as per the guidance provided in 6 NYCRR Part 240.6 (h)(2). In general, projects that maintain current levels of service or capacity, such as safety improvements, resurfacing, bridge repair, or bus replacements were considered exempt from the analysis. Similarly, projects that result in operations improvements, but without an increase in capacity (such as intersection widening) were also considered exempt and excluded from the analysis.

A Regionally Significant project is, according to 6 NYCRR Part 240.2 (38)**,** "a transportation project (other than an exempt project) that is on a facility which serves regional transportation needs (such as access to and from an area outside the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network, including, at a minimum, all principal arterial highways and all fixed guideway transit facilities that offer an alternative to regional highway travel."

Non-exempt projects include highway and road projects that increase capacity by at least one travel lane, and transit projects that change capacity on a fixed route system. The non-exempt determination was made if the project type is not found in the list of exempt projects derived from “Table 2- Exempt Projects” in 40 CFR Part 93.126, 93.127 and NYCRR Part 240.27.

As mentioned above, the project list for the SMTC’s energy and greenhouse gas analysis consisted of the projects included in the 2007-2012 TIP and the LRTP 2007 Update. Three projects from the 2007-2012 TIP, noted below, were categorized as non-exempt projects. However, these projects were unable to be analyzed utilizing the indirect energy lane-mile approach, consistent with *Subtask 12a: Energy Analysis Guidelines for Tips and Plans* because the projects entail signal improvements only, with no additional lane miles of construction.

- Geddes/Genesee Streets Signal Interconnection – Update signals and inclusion in existing traffic interconnect system.

- Lodi/North Salina Streets Signal Improvements – Update signals and inclusion in existing traffic interconnect system.

- N, S, E, W Signal Interconnect Expansion - Update signals and inclusion in existing traffic interconnect system.

The LRTP 2007 Update includes four projects that are considered essential to the region’s transportation system in order to service anticipated future development, although these projects are not programmed on the current TIP. One of these projects is a pavement rehabilitation and streetscaping project, one is a new construction project, and the remaining two are widening projects, as noted in the list below. All four of these projects were included in the energy and greenhouse gas analysis.

- North Salina Street Lane Reduction – Reduce North Salina Street between East Division Street and Isabella Street from two lanes in each direction to one lane in each direction with a center left turn lane. The project is expected to include new pavement overlay but maintain the current pavement width.

- Bear Street Extension – Extend Bear Street from the Interstate 81 bridge to Hiawatha Boulevard, intersecting Hiawatha Boulevard at its current intersection with North Salina Street. The extension will consist of four travel lanes.

- Third Lane of Frontage Road – Add a third travel lane to the Interstate 81 Frontage Road (SR 936F) from Exit 23B to Bear Street.

- Additional Travel Lane on NY 31 – Add a second travel lane in each direction plus a center left-turn lane on NY 31 from Morgan Road to Henry Clay Boulevard.

Step #2 – Travel Demand Modeling

To determine the impact of future projects in the Syracuse Metropolitan Planning Area (MPA), the SMTC uses TransCAD travel simulation software. Like most other programs of this type, the model consists of a road network, land-use and employment data, trip generation, trip distribution, and trip assignment. The results generated by the program are then compared to known travel counts to calibrate the model. The SMTC travel demand model is calibrated based on 2003 base year traffic conditions and 2000 Census information that was forecasted for 2003 (base year) and 2027 (horizon year). Background documentation and technical information related to the SMTC Model are available at the SMTC.

The analysis includes a year 2027 No-Build scenario and a year 2027 Build scenario (as 2027 is the horizon year of the SMTC LRTP). The No-Build scenario includes the 2003 roadway network with 2027 land-use characteristics, while the Build scenario consists of the 2027 network and 2027 land-use characteristics.

Step #3 – Off-Line Model Analysis

A quantitative analysis was also undertaken to account for the visions of the 2027 LRTP that could not be modeled in TransCAD. Inclusion of transit and bicycle/pedestrian transportation modes is beyond the capabilities of the software. Using information developed by the SMTC and its member agencies, the SMTC calculated the reduction of vehicle miles traveled (VMT) as a result of transit and bicycle and pedestrian system improvements envisioned in the LRTP. Additionally, the SMTC accounted for reductions of volatile organic compounds, carbon monoxide, and oxides of nitrogen as a result of converting Centro's existing compressed natural gas (CNG) buses to diesel-electric hybrid buses. These calculations incorporated emission factors provided by Cummins, Inc., the manufacturer of the hybrid propulsion systems.

These off-model VMT reductions were then factored into the TransCAD outputs to better demonstrate the Build scenario provided for in the LRTP. This process differed from that used in the Air Quality Conformity determination where only the results of VMT from TransCAD were utilized. VMT reductions were included to account for expected increases in bicycle and pedestrian trips (VMT reduction of 0.2% in 2027) and in transit ridership (increase of approximately 33,000 daily riders with an average trip length of 5 miles in 2027). The results can be found in Table 1.

Step #4 - Regional Emissions Modeling

As stated earlier, TransCAD estimates the number of vehicle miles traveled (VMT) for various scenarios provided for in the planning process. To calculate the regional emissions that will result from the transportation system envisioned in the LRTP Build scenario, this VMT information is utilized in conjunction with the latest MOBILE6 emission factors. MOBILE6 was developed by the US Environmental Protection Agency (EPA).

Emission estimates were determined using the VMT data and MOBILE6 emission factors. This process involves the utilization of traffic volume and speed data provided by the SMTC, the most recent vehicle fleet characteristics, and other traffic and meteorological parameters established by NYSDOT in cooperation with the New York State Department of Environmental Conservation (NYSDEC). MOBILE6 incorporates these parameters to develop estimated emission factors.

For this analysis the SMTC utilized emissions factors by road type and speed for Volatile Organic Compounds (VOC), Nitrogen Oxides (NO_x) and Carbon Monoxide (CO) for both the Build and No-Build scenarios. The SMTC then calculated the number of grams of pollutant produced for each scenario. An additional emissions reduction was included to account for the conversion of Centro's compressed natural gas (CNG) fleet to hybrid diesel-electric buses by 2027 (emissions data for CNG and hybrid buses were provided by Centro). These results can be found in Table 1.

Step #5 – Direct Energy Analysis

Direct energy represents the energy consumed by vehicles using a transportation facility (for this analysis, "facility" is defined as the roadway segments in the SMTC's regional travel demand model). Direct vehicle energy was calculated using the VMT Fuel Consumption Method as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. The calculations were based on VMT (not seasonally-adjusted) reported by the 2027 No-Build and Build scenarios and a calculated vehicle type. Vehicle classification data were based on aggregating data obtained from NYSDOT's *Mobile 6 Region 3 1999 Summer Time Emissions Factors*. NYSDOT Region 3 includes the majority of the Syracuse MPA. Therefore, it was determined those factors would accurately reflect vehicle distribution for the model. The classification data in the MOBILE6 table is based on 28 vehicle classifications, determined by EPA, which is not directly comparable to the three vehicle types used in the direct energy analysis guidance. For this analysis, it was assumed that, taken together, vehicle classifications 1-5, 14-16, and 28 are equivalent to "light duty vehicles", classifications 6-9 and 17-20 are equivalent to "medium trucks", and classifications 10-13 and 21-27 represent "heavy trucks". Since the table lists percentages of type of vehicle by functional class, an average of all functional classes was calculated and then summarized to represent the percentage by the three vehicle types required for energy analysis. Each of the three vehicle types have a fuel economy rate per year based on the fuel type used.

For each scenario, the total VMT was multiplied by the percentage of each vehicle type to determine vehicle type VMT. That vehicle type VMT was then divided by the fuel economy rate to calculate the number of gallons of fuel used. These fuel consumption values were then converted to British Thermal Units (BTUs) by multiplying each gallon by 125,000. Finally, the total direct energy consumption (in BTUs) was summarized for all vehicles in each scenario. These results can be found in Table 2.

Step #6 – Indirect Energy Analysis

Indirect energy represents the energy required to construct and maintain the transportation system. For this analysis, per EAB guidelines, only the energy used in construction activities for Regionally Significant or Non-Exempt projects, including new construction, reconstruction, rehabilitation, and widening was analyzed. Certain non-exempt projects, such as ridesharing, include no energy-consuming construction or maintenance activities, and therefore, an indirect energy calculation is not applicable. The intent of the indirect energy calculations is to measure the energy used in the construction of the projects included in the 2027 Build scenario. The indirect energy value of the 2027 No-Build scenario is zero; therefore, it is not possible to compute the percentage difference between the two scenarios.

Indirect vehicle energy was calculated using the Lane Mile Approach as described in *Subtask 12a: Energy Analysis Guidelines for TIPs and Plans*. As previously mentioned, the three non-exempt projects on the 2007-2012 TIP are signal interconnect projects that do not lend themselves to analysis using the lane mile approach. However, one rehabilitation project, two road widening projects, and one new construction project from the LRTP 2007 Update were included in the indirect energy analysis. The number of lane miles for each project was multiplied by a rate of Construction Energy Consumed per lane mile (from Table 4 of *Subtask 12a*) and the total Construction Energy Consumed, in BTU's, was calculated. Results of this analysis are shown in Table 3.

Step #7 – CO_2 Emissions Estimates from Direct Energy Consumption

Carbon dioxide (CO_2) is a product of fossil fuel combustion, as well as other processes. It is considered a greenhouse gas, as it traps heat radiated by the Earth into the atmosphere and thereby contributes to the potential for global warming. Carbon dioxide emissions were calculated as described in *Subtask 12b: Greenhouse Gases (CO_2) Emissions Estimates Guidelines for TIPs and Plans*. The carbon dioxide emissions from direct energy consumption were based on the results calculated previously in Step 5.

Subtask 12b, Table 1 lists Carbon Emission coefficients based on vehicle type. The Direct Energy consumed (by vehicle type) was multiplied by the Carbon Emission Coefficients for both gasoline and diesel engines and then by a factor representing the amount of carbon that is oxidized. This process created a value representing total tons of carbon dioxide emitted. The results can be found in Table 4.

Step #8 – CO_2 Emissions Estimates from Indirect Energy Consumption

The indirect energy consumed as a result of the Build scenario was determined in Step 6 above. *Subtask 12b, Table 1* lists Carbon Emission coefficients based on vehicle type. Similar to Step 7 above, the indirect energy consumed was multiplied by the Carbon Emission Coefficients for diesel vehicles and then by a factor representing the amount of carbon that is oxidized, resulting in the total tons of Carbon emitted. The results can be found in Table 5.

Step #9 - Documentation

A summary of the results of the quantitative analyses is presented in Table 6. These results indicate that the Build scenario of the LRTP 2007 Update and supporting TIP will result in a decrease in VMT and associated decreases in VOC, NO_x, CO, CO_2, and the amount of direct energy used by vehicles in the Syracuse MPA over the No-Build scenario.

VMT Calculations

2027 No Build

Functional Classification		Daily VMT	Avg speed (mph)	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)
11/12	Interstate/ Freeway	4,768,316.12	46.25	11.06	52,713,955.68	0.21	989,418.23	0.23	1,108,640.86
14	Principal arterial	1,429,353.54	31.21	10.71	15,315,285.08	0.23	325,296.98	0.20	282,416.37
16	Minor arterial	2,081,040.01	29.58	10.72	22,308,777.24	0.23	482,112.33	0.20	416,208.00
17	Urban collector	871,021.20	32.42	10.88	9,480,673.49	0.23	196,110.52	0.18	156,783.82
19	Local roads	428,289.06	27.22	10.93	4,681,728.65	0.24	103,274.95	0.19	79,476.26
14	Low capacity ramp	47,102.81	14.47	11.86	558,452.23	0.38	18,024.25	0.25	11,553.09
11/12	High capacity ramp	304,846.39	32.03	10.42	3,176,499.40	0.24	71,924.88	0.22	67,066.21
1	Interstate	884,273.17	46.83	10.26	9,074,703.21	0.22	191,308.39	0.31	271,745.37
2	Principal arterial	357,747.90	42.36	10.93	3,909,079.79	0.21	73,438.10	0.21	76,816.02
6	Minor arterial	208,543.40	46.21	11.16	2,326,347.74	0.20	41,202.65	0.22	46,385.58
7	Major Collector	464,425.85	40.50	10.89	5,057,631.85	0.21	97,063.86	0.20	93,350.74
8	Minor collector	345,600.85	40.93	10.92	3,772,568.29	0.21	71,931.41	0.20	69,764.94
9	Local roads	604,428.52	41.98	10.98	6,636,049.31	0.21	124,531.47	0.20	123,284.22
2	Low capacity ramp	5,911.31	12.19	12.28	72,572.27	0.44	2,618.61	0.28	1,669.69
1	High capacity ramp	19,109.86	34.98	9.70	185,369.31	0.24	4,587.58	0.28	5,350.76
	TOTAL	**12,820,010.01**			**139,269,693.53**	**g/day**	**2,792,844.20**	**g/day**	**2,810,511.93 g/day**
					153.52	**tons/day**	**3.08**	**tons/day**	**3.10 tons/day**

2027 Build

Functional Classification		Daily VMT	Avg speed (mph)	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)
11/12	Interstate/ Freeway	4,762,237.40	46.26	11.06	52,649,716.08	0.21	988,058.21	0.23	1,107,326.25
14	Principal arterial	1,435,232.69	31.37	10.72	15,379,181.66	0.23	326,183.73	0.20	283,126.75
16	Minor arterial	2,085,979.47	29.60	10.72	22,361,009.99	0.23	483,136.92	0.20	417,195.89
17	Urban collector	869,968.44	32.49	10.88	9,469,561.51	0.23	195,757.88	0.18	156,594.32
19	Local roads	424,441.95	27.20	10.93	4,639,815.05	0.24	102,372.75	0.19	78,775.10
14	Low capacity ramp	47,104.25	14.56	11.84	557,554.61	0.38	17,925.02	0.24	11,511.87
11/12	High capacity ramp	305,760.73	32.02	10.42	3,186,026.81	0.24	72,144.52	0.22	67,267.36
1	Interstate	885,156.09	46.84	10.26	9,084,556.43	0.22	191,471.11	0.31	272,073.29
2	Principal arterial	357,483.89	42.35	10.93	3,905,886.23	0.21	73,394.55	0.21	76,748.69
6	Minor arterial	209,956.43	46.17	11.15	2,341,552.29	0.20	41,499.83	0.22	46,681.87
7	Major Collector	463,955.17	40.53	10.89	5,053,413.55	0.21	96,935.24	0.20	93,286.38
8	Minor collector	344,918.82	40.93	10.92	3,765,121.32	0.21	71,789.52	0.20	69,627.20
9	Local roads	602,999.89	42.04	10.98	6,622,292.14	0.21	124,172.87	0.20	123,057.09
2	Low capacity ramp	5,943.91	12.06	12.31	73,161.82	0.45	2,654.09	0.28	1,685.37
1	High capacity ramp	19,136.81	34.99	9.70	185,629.72	0.24	4,593.71	0.28	5,358.31
	TOTAL	**12,820,275.94**			**139,274,479.22**	**g/day**	**2,792,089.93**	**g/day**	**2,810,315.74 g/day**
					153.52	**tons/day**	**3.08**	**tons/day**	**3.10 tons/day**

2027 Build with off-model assumptions

Functional Classification		(Model) Daily VMT	Avg speed (mph)	VMT reductions Bike/ped*	Transit**	Reduced VMT	CO rate (g/mi)	CO Sum (g/day)	VOC rate (g/mi)	VOC Sum (g/day)	NOx rate (g/mi)	NOx Sum (g/day)	
11/12	Interstate/ Freeway	4,762,237.40	46.26	0.00	-61,016.25	4,701,221.15	11.06	51,975,140.71	0.21	975,398.69	0.23	1,093,138.61	
14	Principal arterial	1,435,232.69	31.37	0.00	-18,388.94	1,416,843.74	10.72	15,182,135.63	0.23	322,004.50	0.20	279,499.18	
16	Minor arterial	2,085,979.47	29.60	-15,822.34	-26,726.65	2,043,430.49	10.72	21,904,898.96	0.23	473,282.08	0.20	408,686.10	
17	Urban collector	869,968.44	32.49	-6,598.79	-11,146.49	852,223.17	10.88	9,276,405.15	0.23	191,764.89	0.18	153,400.17	
19	Local roads	424,441.95	27.20	-3,219.43	-5,438.17	415,784.35	10.93	4,545,173.94	0.24	100,284.59	0.19	77,168.28	
14	Low capacity ramp	47,104.25	14.56	0.00	-603.52	46,500.72	11.84	550,410.93	0.38	17,695.35	0.24	11,364.38	
11/12	High capacity ramp	305,760.73	32.02	0.00	-3,917.56	301,843.17	10.42	3,145,205.79	0.24	71,220.17	0.22	66,405.50	
1	Interstate	885,156.09	46.84	0.00	-11,341.08	873,815.02	10.26	8,968,160.40	0.22	189,017.88	0.31	268,587.35	
2	Principal arterial	357,483.89	42.35	0.00	-4,580.27	352,903.62	10.93	3,855,841.99	0.21	72,454.18	0.21	75,765.34	
6	Minor arterial	209,956.43	46.17	0.00	-2,690.07	207,266.36	11.15	2,311,551.11	0.20	40,968.11	0.22	46,083.76	
7	Major Collector	463,955.17	40.53	0.00	-5,944.43	458,010.73	10.89	4,988,666.60	0.21	95,693.25	0.20	92,091.15	
8	Minor collector	344,918.82	40.93	0.00	-4,419.28	340,499.54	10.92	3,716,880.64	0.21	70,869.72	0.20	68,735.10	
9	Local roads	602,999.89	42.04	0.00	-7,725.95	595,273.95	10.98	6,537,443.91	0.21	122,581.90	0.20	121,480.42	
2	Low capacity ramp	5,943.91	12.06	0.00	-76.16	5,867.75	12.31	72,224.43	0.45	2,620.08	0.28	1,663.77	
1	High capacity ramp	19,136.81	34.99	0.00	-245.19	18,891.62	9.70	183,251.33	0.24	4,534.86	0.28	5,289.65	
	TOTAL	**12,820,275.94**		**-25,640.55**	**-164,260.00**	**12,630,375.39**		137,213,391.56	g/day	2,750,390.25	g/day	2,769,358.76	g/day
							Hybrid bus emission reductions***	-248,030.00	g/day	-75,090.00	g/day	-698,090.00	g/day
							Adjusted total	**136,965,361.56**	**g/day**	**2,675,300.25**	**g/day**	**2,071,268.76**	**g/day**
								150.98	**tons/day**	**2.95**	**tons/day**	**2.28**	**tons/day**

Emission Factors (rates) from:

MOBILE6.2 Emission Factor Tables for Regional, Mesoscale, and CMAQ Project Emission Calculations - Part A (NYSDOT EAB)

*bike/ped reduction assumes decrease of 0.2% VMT in 2027 build scenario = -25,641 miles/day

**transit reduction assumes 32,852 daily riders with 5 mile average trip length in 2027 build scenario = -164,260 miles/day

***Emission reductions resulting from Centro conversion from CNG to diesel-electric hybrid vehicles based on Centro data

Table 1 - Emissions Analysis
SMTC Long-Range Plan *2027* Energy Analysis

Scenario	Daily VMT	VOC (grams)	NO_X (grams)	CO (grams)
2027 No-build	12,820,010	2,792,844	2,810,512	139,269,694
2027 Build	12,820,276	2,792,090	2,810,316	139,274,479
2027 Build with off-model transit and bike/ped assumptions	12,630,375	2,675,300	2,071,269	136,965,362

Table 2 - Direct Vehicle Energy
SMTC Long-Range Plan *2027* Energy Analysis

Scenario	Total VMT	Light Duty Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2027 no-build	12,820,010	91.94%	11,786,076	21.25	554,639	69,329,859,996	-1.48
2027 build	12,630,375	91.94%	11,611,736	21.25	546,435	68,304,327,155	

Scenario	Total VMT	Medium Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2027 no-build	12,820,010	2.51%	321,355	8.61	37,323	4,665,431,439	-1.48
2027 build	12,630,375	2.51%	316,601	8.61	36,771	4,596,420,003	

Scenario	Total VMT	Heavy Trucks					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2027 no-build	12,820,010	5.56%	712,579	6.00	118,763	14,845,393,532	-1.48
2027 build	12,630,375	5.56%	702,038	6.00	117,006	14,625,799,282	

Scenario	Total VMT	All Vehicles					
		% of Total	VMT	Fuel Economy*	Fuel Used (gallons)	Direct Energy Consumption (btu)	% Change
2027 no-build	12,820,010	100.00%	12,820,010	n/a	710,725	**88,840,684,966**	-1.48
2027 build	12,630,375	100.00%	12,630,375	n/a	700,212	**87,526,546,440**	

Notes:

*From Table 2 - Fuel Correction Factors NYSDOT Subtask 12a: Energy Analysis Guidelines for TIPs and Plans

2027 Build scenario includes off model transit and bike/ped assumptions.

%of total: Vehicle split was estimated based on aggregating the 27 vehicle types from the 1999 Summer Time Vehicle Distributions Region 3, April, 2004 NYSDOT and then averaging their percentages.

Vehicle Type VMT: Calculated by multiplying the percentage of each vehicle type by the total VMT.

Fuel Used: Calculated by dividing Vehicle VMT by the fuel economy.

Direct Energy Consumption: Calculated by multiplying the rate of 125,000 BTU per gallon by the fuel used .

Table 3 - Indirect Energy
SMTC Long-Range Plan *2027* Energy Analysis

Roadway Construction Energy Consumed

Project Description*	Type of Improvement	Distance (miles)	Lanes	Lane Miles	Urban / Rural	Constr. Energy per Lane Mile (rate)	Constr. Energy Consumed (BTUs)
Bear Street Extension	New construction (4 lanes)	0.4	4	1.4	Urban	15.24	21,336,000,000
Third Lane of Frontage Road	Widen from 2 to 3 lanes	0.1	1	0.1	Urban	6	600,000,000
Additional Travel Lane on NY 31	Widen from 2 to 5 lanes	1.0	3	3.06	Urban	6	18,360,000,000
North Salina Street Lane Reduction	Restoration and rehabilitation	0.2	3	0.6	Urban	2.76	1,656,000,000
						TOTAL	**41,952,000,000**

Projects with no construction

Project Description	Type of Improvement
NYSDOT Bridge Painting 2008	Maintenance
NYSDOT Bridge Painting 2009	Maintenance
NYSDOT Bridge Painting 2010	Maintenance

Notes:
**There are no non-exempt construction projects in the SMTC 2007-2012 TIP. The projects listed are included in SMTC's long-range planning and are considered essential transportation projects to service anticipated development, although they are not programmed on the current TIP.*

Indirect vehicle energy was calculated using the Lane Mile Approach as described in Subtask 12a: Energy Analysis Guidelines for TIPs and Plans. Table 4 of Subtask 12a provides a table that associates a rate of Construction Energy Consumed per lane mile based on several types of improvements. The number of lane miles for each project was then multiplied by that rate, and a rate of Construction Energy Consumed in BTU's was calculated.

Table 4- CO_2 Emissions Estimates from Direct Energy Consumption
SMTC Long-Range Plan *2027* Energy Analysis

Scenario	Direct Energy (BTUs)			Carbon Emission Coefficients *			Metric Tons Carbon Emitted** (100% oxidation)			Total Metric Tons Carbon Emitted***			Total Tons Carbon Emitted****			
	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	Light Duty Vehicle	Medium Truck	Heavy Truck	All Vehicles
2027 no-build	69,329,859,996	4,665,431,439	14,845,393,532	19.34	19.95	19.95	1,341	93	296	1,327	92	293	1,463	102	323	**1,887**
2027 build	68,304,327,155	4,596,420,003	14,625,799,282	19.34	19.95	19.95	1,321	92	292	1,308	91	289	1,441	100	318	**1,860**

Difference: 2027 no-build minus build -28

2027 Build scenario includes off model transit and bike/ped assumptions.

* For this analysis, all Light Duty Vehicles are assumed to use gasoline and all trucks are assumed to use diesel

As per NYSDOT Subtask 12b: Greenhouse Gases (CO2) Emissions Estimates Guidelines for TIPs and Plans:

** Metric Tons C emitted (assuming 100% oxidation) = Total direct energy for roadway projects (BTUs) x Carbon emission coefficient (10^{6} metric tons of Carbon/10^{15} BTU)

*** a small portion (1%) of total carbon does not oxidize during combustion

**** 1 metric ton = 1.102 tons

Table 5 - CO_2 Emissions Estimates from Indirect Energy Consumption
SMTC Long-Range Plan *2027* Energy Analysis

Scenario	Indirect Energy (BTUs)	Carbon Emission Coefficient	Metric Tons Carbon Emitted	Total Metric Tons Carbon Emitted	Total Tons Carbon Emitted
2027 build	41,952,000,000.00	19.95	836.94	828.57	**913.09**

Table 6 - Summary
SMTC Long-Range Plan *2027* Energy Analysis

		Air Pollution Emissions			Energy		Greenhouse Gas (CO_2) Emissions	
Scenario	VMT	VOC g/day	NO_x g/day	CO g/day	Direct (BTUs)	Indirect* (BTUs)	Direct (tons)	Indirect (tons)
2027 No-Build	12,820,010	2,792,844	2,810,512	139,269,694	88,840,684,966	0	1,887	0
2027 Build **(with off-model assumptions)**	12,630,375	2,675,300	2,071,269	136,965,362	87,526,546,440	41,952,000,000	1,860	913
Change (Build - No Build)	-189,635	-117,544	-739,243	-2,304,332	-1,314,138,526	--	-28	--
Percent Change (Build - No Build)	-1.48%	-4.21%	-26.30%	-1.65%	-1.48%	--	-1.48%	--

** The intent of the indirect energy and greenhouse gas calculations was to measure the impact of the construction of the projects in the SMTC Long-Range Plan. The indirect energy used in the 2027 No-Build scenario is zero (as is the greenhouse gas emissions arising from the indirect energy used); therefore it is not possible to compute the percentage difference between the two scenarios.*