

Appendix 11.2: Shaft 33B Stationary Air Quality Analysis – Water Mains

A. SUMMARY

A quantified analysis of the potential emissions from construction equipment involved in the construction of the water mains for the reasonable worst case route, connecting Shaft 33B at the preferred Shaft Site to the existing trunk main distribution system, is presented below. Based on the evaluation of locations that could likely have the greatest projected emissions from construction along this corridor (water mains plus venturi chamber construction) or could be representative of typical water mains construction along an Avenue corridor (water mains only), two segments were analyzed. Segment 1a was analyzed for peak hourly and peak daily for the water mains only construction and Segment 1c was analyzed for peak hourly and peak daily for the water mains plus venturi construction. Since the results of the PM analyses for Segment 1a were higher, these results were used for the combined analysis as well. The first 12 months of water mains construction operations (Segments 1-3) were evaluated for the annual impacts. These Segments were determined to be the peak construction emissions for each averaging period. Since the water main construction could coincide with Stage 3 of the shaft construction under the schedule for the preferred site resulting in potential combined impacts from preferred Shaft Site and reasonable worst case route water mains construction, that stage was analyzed as well.

This section presents the detailed emissions used in the modeling process. For other analyses assumptions and methods see Section 3.11.

B. SOURCE EMISSION CALCULATIONS

ENGINE EMISSIONS

The engine emission factors for water mains construction equipment were developed following the methodology described in Section 3.11 “Air Quality Methodology”, and as described in section 2.1 above for the preferred Shaft Site.

The NO_x, PM, CO and SO₂ emission factors derived from the NONROAD model that were used to calculate engine emission rates are provided in Table 11.2-1.

Based on the engine emission factors described above, emission rates were calculated for each type of equipment expected to be on-site. These emission rates are provided in Table 11.2-2.

FUGITIVE DUST EMISSIONS

On-site fugitive dust due to construction vehicles (mobile sources) traveling on paved portions of the preferred Shaft Site and the water mains connections work areas, and due to material transfer operations were calculated as described above in section 11.1. Fugitive dust from mobile sources along the water mains, however, was not included in the stationary source model since it was already included in the mobile source model along First Avenue.

Fugitive emission rates from on-site mobile sources at the Shaft Site are provided in Appendix 11.1. The PM₁₀ and PM_{2.5} emission rates for soil and rock transfer activities are provided in Table 11.2-3.

OPERATIONAL PARAMETERS

In order to predict the maximum short-term and annual impacts from construction activities, it was necessary to conservatively estimate emission rates based upon overall emissions generated by onsite activities. Following the methodology described in section 3.11 “Air Quality Methodology”, it was determined that Segment 1a represented the most conservative case for peak hours and daily operations for the analysis of the water mains only and Segment 1c for the combined analysis of the preferred Shaft Site, the water mains, and the venturi chamber construction. As described above, the first 12 months of construction represented the most conservative annual period.

Source input data is provided in Table 11.2-4. Site diagram are provided in Figures 2 and 3, for the short-term and annual models, respectively.

C. RESULTING EMISSION RATES

Emission rates for the analysis are provided in Tables 11.2-5 through 11.2-9 for PM_{2.5}, PM₁₀, NO_x, SO₂, and CO, respectively for the water mains activity only analysis (Segment 1a), in Tables 11.2-10 through 11.2-14 for the water mains activity plus venturi chamber construction (Segment 1c), and in Tables 11.2-15 through 11.2-19 for the Stage 3 shaft site emissions. The 8-hour, 24-hour and annual emission rates were adjusted from the peak hour emissions value with the application of utilization factors (see Chapter 2 “Project Overview”).

The variation of total site-wide PM_{2.5} emission rates over the various Segments is presented in Figure 3.

**Table 11.2-1
Year 2008 NONROAD Emission Factors^a
for Applicable Watermain Construction Engines**

Equipment Type	Combustion Source Emission Factor (g/hp-hr)				
	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}
Excavator	1.224	3.393	0.003	0.122	0.118
Front End Loader	0.478	1.317	0.001	0.105	0.102
Telescoping Crane	0.388	2.451	0.002	0.104	0.101
Compressor	0.695	2.044	0.002	0.160	0.155
Dewatering pump	0.955	1.914	0.002	0.106	0.103
Paver	0.701	3.146	0.003	0.168	0.162
Compactor	0.960	1.915	0.002	0.110	0.106
Pavement Cutter	2.061	2.496	0.003	0.211	0.204
Chain saw, gas ^b	244.2	0.637	0.098	6.824	6.619
Generator for Welding	0.951	1.913	0.002	0.104	0.101

Note: a. Emission factors derived from the NONROAD model output were back calculated from the NONROAD regional estimates. Emission factor values are assumed for equipment model Year 2005 and is assumed to be for Tier 1 equipment when applicable and Tier 2 or 3 equipment if Tier 1 equipment is not referenced in the NONROAD model.
b. Emission factor values for chain saws are assumed for equipment model Year 2008. Model Year 2005 chain saws are not referenced in the NONROAD model output.

**Table 11.2-2
Estimated Peak Emission Rates
Fuel Combustion Sources**

Construction Equipment	Power Rating (hp)	Emission Rates per unit (g/sec)					Emission Rates per unit (lb/hr)				
		CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}	CO	NO _x	SO ₂	PM ₁₀	PM _{2.5}
Excavator	400	0.136	0.377	3.23E-04	0.014	0.013	1.08	2.99	2.56E-03	0.108	0.104
FE Loader, 3 1/2 cu yds	150	0.020	0.055	5.02E-05	0.004	0.004	0.16	0.44	3.98E-04	0.035	0.034
Telescoping Crane	150	0.016	0.102	8.73E-05	0.004	0.004	0.13	0.81	6.93E-04	0.034	0.033
Concrete truck	300	0.007	0.009	4.22E-06	3.22E-04	3.0E-04	0.05	0.07	3.35E-05	0.003	0.002
Dump truck	300	0.007	0.009	4.22E-06	3.22E-04	3.0E-04	0.05	0.07	3.35E-05	0.003	0.002
Flatbed truck	300	0.007	0.009	4.22E-06	3.22E-04	3.0E-04	0.05	0.07	3.35E-05	0.003	0.002
Compressor	50	0.010	0.028	3.24E-05	0.002	0.002	0.08	0.23	2.57E-04	0.018	0.017
Dewatering pump	25	0.007	0.013	1.62E-05	0.001	0.001	0.05	0.11	1.28E-04	0.006	0.006
Paver	200	0.039	0.175	1.61E-04	0.009	0.009	0.31	1.39	1.28E-03	0.074	0.072
Compactor	25	0.007	0.013	1.62E-05	0.001	0.001	0.05	0.11	1.28E-04	0.006	0.006
Pavement Cutter	25	0.014	0.017	2.24E-05	0.001	0.001	0.11	0.14	1.78E-04	0.012	0.011
Chain saw, gas	5	0.339	0.001	1.36E-04	0.009	0.009	2.69	0.01	1.08E-03	0.075	0.073
Generator for Welding	25	0.007	0.013	1.62E-05	0.001	0.001	0.05	0.11	1.28E-04	0.006	0.006

Notes: Construction equipment emission factors were derived from the USEPA NONROAD model. These factors, presented in grams per horsepower-hour (g/hp-hr), are provided in Table 11.2-2. Emission factors for dump trucks, flatbed trucks and concrete trucks are discussed below.
Heavy Duty Diesel Vehicle emissions were derived from USEPA MOBILE6.2 model. Since travel time is a very small percentage of time spent on-site, it was conservatively assumed that emission rates for all time spent on-site were the result of idling vehicles. Idle vehicle emission factors were generated using a vehicle speed of 2.5 mph.
MOBILE6.2 Emission Factors for Trucks:
CO: 9.82 grams per vehicle mile traveled (g/VMT) at 2.5 miles per hour
NO_x: 12.98 g/VMT
SO₂: 0.0152 g/hr
PM: 1.16g/hr
PM_{2.5}: 1.068 g/hr
Emission rates for delivery trucks and heavy vehicles (in g/sec) were calculated by multiplying the emission factor in g/VMT by 2.5 miles per hour and then dividing by 3,600 seconds per hour, except in the case of PM where idle emissions are output from the model.

**Table 11.2-3
Estimated Average Transfer Operation Fugitive Dust Emission Rates**

Period	Equipment	Activity	Quantity Removed ^a (tons/hour)	Emission Factor ^b (lb/ton)	PM ₁₀ Emission Rate (lb/hr)	PM ₁₀ Emission Rate (g/s)	PM _{2.5} Emission Rate (lb/hr)	PM _{2.5} Emission Rate (g/s)
Short Term Peak	Excavator	Excavates/Transfers to 25 cy Truck	87.4	5.39E-04	4.71E-02	5.93E-03	1.48E-02	1.86E-03
(Phase d of stages 5-7)	Loader	Loads Stockpiled Material to Truck	174.8	5.39E-04	9.42E-02	1.19E-02	2.96E-02	3.73E-03
Long Term Average	Excavator	Excavates/Transfers to 25 cy Truck	19.4	5.39E-04	1.04E-02	1.32E-03	3.28E-03	4.14E-04
(stages 5-7)	Loader	Loads Stockpiled Material to Truck	38.8	5.39E-04	2.09E-02	2.63E-03	6.57E-03	8.28E-04
Notes: a. Excavation/transfer rate in tons/hr was provided by the construction manager. b. Emission factors for soil transfer operations are based on Equation 1 from Section 13.2.4 of AP-42.								

**Table 11.2-4
Water Main Construction Source Modeling Parameters**

Construction Equipment	Exhaust Height Above Grade (Meters)	Stack Exit Velocity (m/s)	Source Type Identification
Telescoping Crane	2.7	1.97	Point
Concrete truck	3.7	0.001	Point
Compressor	1.5	0.001	Point
Dewatering pump	0.0	0.001	Point
Generator for Welding	1.5	0.001	Point
Notes: All other sources are moving sources modeled as volume sources, represented in the model as area sources with initial vertical dispersion. Point sources are modeled with the above parameters, except in the annual cases where the sources will all be moving throughout the year, and are therefore modeled as area sources at the height of emission.			

**Table 11.2-5
Water Mains Only Modeling Parameters
PM_{2.5} Emission Rates**

Construction Equipment	Peak Engine ^f Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^d Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual ^h (g/s-m ²)
Excavator	1.3E-03	1.86E-03	3.2E-03	1.59E-03	4.98E-04		
FE Loader, 3 1/2 cu yds	4.3E-04	N/A ^c	N/A ^c	N/A ^c	3.44E-05	2.07E-05	
Telescoping Crane ^h	3.2E-03	N/A ^a	N/A ^c	N/A ^c	1.95E-04		1.78E-07
Concrete truck	3.0E-04	N/A ^g	N/A ^c	N/A ^c	1.02E-05	9.78E-06	
Dump truck ^e	3.0E-04	N/A ^g	1.48E-05	1.48E-05	1.06E-05		
Flatbed truck ^e	3.0E-04	N/A ^g	1.48E-05	1.48E-05	1.06E-05		
Compressor	1.6E-03	N/A ^a	1.62E-03	4.04E-04	8.89E-05		8.09E-08
Dewatering pump ^h	7.2E-04	N/A ^a	7.2E-04	3.59E-04	3.17E-04		2.89E-07
Paver	9.0E-04	N/A ^a	N/A ^c	N/A ^c	4.96E-05		
Compactor	7.4E-04	N/A ^a	N/A ^c	N/A ^c	4.05E-05	1.22E-05	
Pavement Cutter	1.4E-03	N/A ^a	1.42E-03	2.13E-04	1.56E-05		
Chain saw, gas	9.2E-03	N/A ^a	9.2E-03	2.30E-03	5.05E-04	3.79E-04	
Generator for Welding ^h	7.0E-04	N/A ^a	N/A ^c	N/A ^c	4.33E-05		3.94E-08
Construction Equipment Engine & Fugitive Emissions-Volume Sources (g/s-m²):				4.04E-05	1.07E-06	8.39E-07	
Area (m ²):				102.2	1098.8	502.5	1098.8
Notes:	<p>These emissions are included in the dispersion model two times to account for construction on two blocks.</p> <p>a. These equipment are not involved in construction activities that generate fugitive dust emissions.</p> <p>b. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1a (i.e., worst case daily emissions) except for trucks which are based on an average one each per hour.</p> <p>c. These equipment do not operate in the worst case stage.</p> <p>d. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.</p> <p>e. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.</p> <p>f. Includes 25% reduction for use of DOC in all nonroad diesel engines greater than or equal to 50 hp.</p> <p>g. Resuspended dust PM_{2.5} emissions from surfaces were not included because vehicles will be traveling at 5 mph or less. This is in accordance with NYCDEP guidelines.</p> <p>h. These sources are modeled as point sources and are not included in the sum</p>						

**Table 11.2-6
Water Mains Only Modeling Parameters
PM₁₀ Emission Rates**

Construction Equipment	Peak Engine ^f Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^d Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual ^h (g/s-m ²)
Excavator, 2 cu yd	1.4E-03	5.93E-03	7.29E-03	3.64E-03	7.70E-04		
FE Loader, 3 1/2 cu yds	4.4E-04	N/A ^c	N/A ^c	N/A ^c	8.44E-05	5.06E-05	
Telescoping Crane ^h	3.3E-03	N/A ^a	N/A ^c	N/A ^c	2.01E-04		1.83E-07
Concrete truck	3.2E-04	N/A ^g	N/A ^c	N/A ^c	1.11E-05	1.06E-05	
Dump truck ^e	3.2E-04	N/A ^g	1.61E-05	1.61E-05	1.15E-05		
Flatbed truck ^e	3.2E-04	N/A ^g	1.61E-05	1.61E-05	1.15E-05		
Compressor, 800 cfm at 100 psi ^h	1.7E-03	N/A ^a	1.67E-03	4.17E-04	9.17E-05		8.34E-08
Dewatering pump ^h	7.4E-04	N/A ^a	7.4E-04	3.70E-04	3.27E-04		2.98E-07
Paver	9.3E-04	N/A ^a	N/A ^c	N/A ^c	5.11E-05		
Compactor	7.6E-04	N/A ^a	N/A ^c	N/A ^c	4.18E-05	1.25E-05	
Pavement Cutter	1.5E-03	N/A ^a	1.5E-03	2.19E-04	1.61E-05		
Chain saw, gas	9.5E-03	N/A ^a	9.5E-03	2.37E-03	5.21E-04	3.91E-04	
Generator for Welding ^h	7.2E-04	N/A ^a	N/A ^c	N/A ^c	4.47E-05		4.06E-08
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):				6.13E-05	1.38E-06	9.24E-07	
Area (m ²):				102.2	1098.8	502.5	1098.8
Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.							
a. These equipment are not involved in construction activities that generate fugitive dust emissions.							
b. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1a (i.e., worst case daily emissions) except for trucks which are based on an average one each per hour.							
c. These equipment do not operate in the worst case stage.							
d. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.							
e. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.							
f. Includes 25% reduction for use of DOC in all nonroad diesel engines greater than or equal to 50 hp.							
g. Resuspended road dust emissions were included separately in the mobile source model.							
h. These sources are modeled as point sources and are not included in the sum							

**Table 11.2-7
Water Mains Only Modeling Parameters
NO_x Emission Rates**

Construction Equipment	Peak Engine Emission Rate (g/sec)	Annual Average^a Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual^c (g/s-m²)
Excavator, 2 cu yd	3.8E-01	1.09E-01		
FE Loader, 3 1/2 cu yds	5.5E-02	1.51E-03	9.04E-04	
Telescoping Crane ^c	1.0E-01	6.31E-03		5.74E-06
Concrete truck	9.0E-03	3.10E-04	2.97E-04	
Dump truck ^b	9.0E-03	3.22E-04		
Flatbed truck ^b	9.0E-03	3.22E-04		
Compressor, 800 cfm at 100 psi ^c	2.8E-02	1.56E-03		1.42E-06
Dewatering pump ^c	1.3E-02	5.88E-03		5.35E-06
Paver	1.7E-01	9.60E-03		
Compactor	1.3E-02	7.31E-04	2.19E-04	
Pavement Cutter	1.7E-02	1.90E-04		
Chain saw, gas	8.8E-04	4.86E-05	3.65E-05	
Generator for Welding ^c	1.3E-02	8.21E-04		7.47E-07
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):		1.11E-04	2.90E-06	
Area (m ²):		1098.8	502.5	1098.8
Notes:	<p>These emissions are included in the dispersion model two times to account for construction on two blocks.</p> <p>a. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.</p> <p>b. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.</p> <p>c. These sources are modeled as point sources and are not included in the sum</p>			

**Table 11.2-8
Water Mains Only Modeling Parameters
CO Emission Rates**

Construction Equipment	Peak Engine Emission Rate (g/sec)	1-Hour Average ^a Emission Rate (g/sec)	8-hour Average ^a Emission Rate (g/sec)
Excavator, 2 cu yd	1.4E-01	1.36E-01	6.80E-02
FE Loader, 3 1/2 cu yds	1.99E-02	N/A ^b	N/A ^b
Telescoping Crane ^d	1.62E-02	N/A ^b	N/A ^b
Concrete truck	6.82E-03	N/A ^b	N/A ^b
Dump truck ^c	6.82E-03	3.41E-04	3.41E-04
Flatbed truck ^c	6.82E-03	3.41E-04	3.41E-04
Compressor, 800 cfm at 100 psi ^d	9.66E-03	9.66E-03	2.41E-03
Dewatering pump ^d	6.63E-03	6.63E-03	3.32E-03
Paver	3.89E-02	N/A ^b	N/A ^b
Compactor	6.67E-03	N/A ^b	N/A ^b
Pavement Cutter	1.43E-02	1.43E-02	2.15E-03
Chain saw, gas	3.39E-01	3.39E-01	8.48E-02
Generator for Welding ^d	6.60E-03	N/A ^b	N/A ^b
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/m²):		4.80E-03	1.52E-03
Area (m ²):		102.2	102.2
<p>Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.</p> <p>a. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1a (worst case short-term and daily stage) for the 1-hour and the 8-hr periods, except for trucks which are assumed one each for peak hour.</p> <p>b. These equipment do not operate in the worst case stage.</p> <p>c. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.</p> <p>d. These sources are modeled as point sources and are not included in the sum</p>			

Table 11.2-9
Water Mains Only Modeling Parameters
SO₂ Emission Rates

Construction Equipment	Peak Engine Emission Rate (g/sec)	3-Hour Average ^a Emission Rate (g/sec)	24-hour Average ^a Emission Rate (g/sec)	Annual Average ^b Emission Rate (g/sec)	Annual Average Emission Rate for Ventury Chambers Only (g/sec)	Point Sources as area sources for annual ^f (g/s-m ²)
Excavator, 2 cu yd	3.2E-04	3.23E-04	1.62E-04	9.32E-05		
FE Loader, 3 1/2 cu yds ^e	5.0E-05	N/A ^c	N/A ^c	1.38E-06	8.27E-07	
Telescoping Crane ^f	8.7E-05	N/A ^c	N/A ^c	5.40E-06		4.91E-09
Concrete truck ^e	4.2E-06	N/A ^c	N/A ^c	1.45E-07	1.39E-07	
Dump truck ^d	4.2E-06	2.11E-07	2.11E-07	1.51E-07		
Flatbed truck ^d	4.2E-06	2.11E-07	2.11E-07	1.51E-07		
Compressor, 800 cfm at 100 psi ^f	3.2E-05	3.24E-05	8.09E-06	1.78E-06		1.62E-09
Dewatering pump ^f	1.6E-05	1.62E-05	8.08E-06	7.15E-06		6.51E-09
Paver	1.6E-04	N/A ^c	N/A ^c	8.87E-06		
Compactor ^e	1.6E-05	N/A ^c	N/A ^c	8.88E-07	2.66E-07	
Pavement Cutter	2.2E-05	2.24E-05	3.36E-06	2.46E-07		
Chain saw, gas ^e	1.4E-04	1.36E-04	3.41E-05	7.49E-06	5.62E-06	
Generator for Welding ^f	1.6E-05	N/A ^c	N/A ^c	9.99E-07		9.09E-10
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):		4.72E-06	1.95E-06	1.02E-07	1.36E-08	
Area (m ²):		102.2	102.2	1098.8	502.5	1098.8
<p>Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.</p> <p>a. Emission factors for peak activity, to be modeled on a 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1a (worst case short-term and daily stage) for the 3-hour and 24-hr, except for trucks which are assumed one each for peak hour.</p> <p>b. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.</p> <p>c. These equipment do not operate in the worst case stage.</p> <p>d. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.</p> <p>e. These sources are included for venturi chamber construction only.</p> <p>f. These sources are modeled as point sources and are not included in the sum</p>						

**Table 11.2-10
Water Mains + Venturi Chamber Modeling Parameters
PM_{2.5} Emission Rates**

Construction Equipment	Peak Engine ^f Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^d Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual ^h (g/s-m ²)
Excavator ^g	1.3E-03	NA ^k	1.3E-03	6.57E-04	4.98E-04		
FE Loader, 3 1/2 cu yds ^g	4.3E-04	NA ^k	4.3E-04 ^l	4.26E-05 ^l	3.44E-05	2.07E-05	
Telescoping Crane ^{f,i}	3.2E-03	N/A ^a	3.2E-03	7.90E-04	1.95E-04		1.78E-07
Concrete truck ^j	3.0E-04	N/A ^h	3.0E-04 ^l	2.67E-04 ^l	1.02E-05	9.78E-06	
Dump truck ^e	3.0E-04	N/A ^h	1.48E-05	1.48E-05	1.06E-05		
Flatbed truck ^e	3.0E-04	N/A ^h	1.48E-05	1.48E-05	1.06E-05		
Compressor, 800 cfm at 100 psi ^{f,i}	1.6E-03	N/A ^a	N/A ^c	N/A ^c	8.89E-05		8.09E-08
Dewatering pump ⁱ	7.2E-04	N/A ^a	7.2E-04	6.46E-04	3.17E-04		2.89E-07
Paver ^g	9.0E-04	N/A ^a	N/A ^c	N/A ^c	4.96E-05		
Compactor	7.4E-04	N/A ^a	7.4E-04 ^l	7.38E-05 ^l	4.05E-05	1.22E-05	
Pavement Cutter	1.4E-03	N/A ^a	N/A ^c	N/A ^c	1.56E-05		
Chain saw, gas	9.2E-03	N/A ^a	9.2E-03 ^l	2.30E-03 ^l	5.05E-04	3.79E-04	
Generator for Welding ^j	7.0E-04	N/A ^a	7.0E-04	1.75E-04	4.33E-05		3.94E-08
Construction Equipment Engine & Fugitive Emissions-Volume Sources (g/s-m²):				6.72E-06	1.07E-06	8.39E-07	
Venturi Volume Sources (g/s-m²):				2.36E-05			
Area (m ²):				102.2	1098.8	502.5	1098.8

Notes:

- These emissions are included in the dispersion model two times to account for construction on two blocks.
- a. These equipment are not involved in construction activities that generate fugitive dust emissions.
- b. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1c (i.e., worst case daily emissions) except for trucks which are based on an average one each per hour.
- c. These equipment do not operate in the worst case stage.
- d. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.
- e. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.
- f. Includes 25% reduction for use of DOC in all nonroad diesel engines greater than or equal to 50 hp.
- g. Includes 90% reduction for use of DPF.
- h. Resuspended dust PM_{2.5} emissions from surfaces were not included because vehicles will be traveling at 5 mph or less. This is in accordance with NYCDEP guidelines
- i. These sources are modeled as point sources and are not included in the sum
- j. This source is modeled as a venturi point source and is not included in the venturi volume source sum.
- k. There is no excavation/transfer during this stage of water main construction and therefore no fugitive dust generated.
- l. These sources are used for venturi chamber construction only.

Table 11.2-11
Water Mains + Venturi Chamber Modeling Parameters
PM₁₀ Emission Rates

Construction Equipment	Peak Engine ^f Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^d Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual ^h (g/s-m ²)
Excavator ^g	1.4E-03	NA ^k	1.35E-03	6.77E-04	7.70E-04		
FE Loader, 3 1/2 cu yds ^g	4.4E-04	NA ^k	4.39E-04 ^l	4.39E-05 ^l	8.44E-05	5.06E-05	
Telescoping Crane ^{f,i}	3.3E-03	N/A ^a	3.26E-03	8.14E-04	2.01E-04		1.83E-07
Concrete truck ^j	3.2E-04	N/A ^h	3.22E-04 ^l	2.90E-04 ^l	1.11E-05	1.06E-05	
Dump truck ^e	3.2E-04	N/A ^h	1.61E-05	1.61E-05	1.15E-05		
Flatbed truck ^e	3.2E-04	N/A ^h	1.61E-05	1.61E-05	1.15E-05		
Compressor, 800 cfm at 100 psi ^{f,i}	1.7E-03	N/A ^a	N/A ^c	N/A ^c	9.17E-05		8.34E-08
Dewatering pump ⁱ	7.4E-04	N/A ^a	7.4E-04	6.66E-04	3.27E-04		2.98E-07
Paver ^g	9.3E-04	N/A ^a	N/A ^c	N/A ^c	5.11E-05		
Compactor	7.6E-04	N/A ^a	7.6E-04 ^l	7.61E-05 ^l	4.18E-05	1.25E-05	
Pavement Cutter	1.5E-03	N/A ^a	N/A ^c	N/A ^c	1.61E-05		
Chain saw, gas	9.5E-03	N/A ^a	9.5E-03 ^l	2.37E-03 ^l	5.21E-04	3.91E-04	
Generator for Welding ⁱ	7.2E-04	N/A ^a	7.2E-04	1.81E-04	4.47E-05		4.06E-08
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):				6.94E-06	1.38E-06	9.24E-07	
Venturi Volume Sources (g/s-m²):				2.44E-05			
Area (m ²):				102.2	1098.8	502.5	1098.8

Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.

a. These equipment are not involved in construction activities that generate fugitive dust emissions.

b. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1c (i.e., worst case daily emissions) except for trucks which are based on an average one each per hour.

c. These equipment do not operate in the worst case stage.

d. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.

e. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.

f. Includes 25% reduction for use of DOC in all nonroad diesel engines greater than or equal to 50 hp.

g. Includes 90% reduction for use of DPF.

h. Resuspended road dust emissions were included separately in the mobile source model.

i. These sources are modeled as point sources and are not included in the sum

j. This source is modeled as a venturi point source and is not included in the venturi volume source sum.

k. There is no excavation/transfer during this stage of water main construction and therefore no fugitive dust generated .

l. These sources are used for venturi chamber construction only.

Table 11.2-12
Water Mains + Venturi Chamber Modeling Parameters
NO_x Emission Rates

	Peak Engine Emission Rate (g/sec)	Annual Average^a Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual^c (g/s-m²)
Excavator, 2 cu yd	3.8E-01	1.09E-01		
FE Loader, 3 1/2 cu yds	5.5E-02	1.51E-03	9.04E-04	
Telescoping Crane ^c	1.0E-01	6.31E-03		5.74E-06
Concrete truck	9.0E-03	3.10E-04	2.97E-04	
Dump truck ^b	9.0E-03	3.22E-04		
Flatbed truck ^b	9.0E-03	3.22E-04		
Compressor, 800 cfm at 100 psi ^c	2.8E-02	1.56E-03		1.42E-06
Dewatering pump ^c	1.3E-02	5.88E-03		5.35E-06
Paver	1.7E-01	9.60E-03		
Compactor	1.3E-02	7.31E-04	2.19E-04	
Pavement Cutter	1.7E-02	1.90E-04		
Chain saw, gas	8.8E-04	4.86E-05	3.65E-05	
Generator for Welding ^c	1.3E-02	8.21E-04		7.47E-07
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):		1.11E-04	2.90E-06	
Area (m ²):		1098.8	502.5	1098.8
Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.				
a. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.				
b. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.				
c. These sources are modeled as point sources and are not included in the sum				

**Table 11.2-13
Water Mains + Venturi Chamber Modeling Parameters
CO Emission Rates**

Construction Equipment	Peak Engine Emission Rate (g/sec)	1-Hour Average^a Emission Rate (g/sec)	8-hour Average^a Emission Rate (g/sec)
Excavator, 2 cu yd	1.4E-01	1.36E-01	6.80E-02
FE Loader, 3 1/2 cu yds	1.99E-02	1.99E-02 ^f	1.99E-03 ^f
Telescoping Crane ^d	1.62E-02	1.62E-02	4.04E-03
Concrete truck ^e	6.82E-03	6.82E-03 ^f	6.14E-03 ^f
Dump truck ^c	6.82E-03	3.41E-04	3.41E-04
Flatbed truck ^c	6.82E-03	3.41E-04	3.41E-04
Compressor, 800 cfm at 100 psi ^d	9.66E-03	N/A ^b	N/A ^b
Dewatering pump ^d	6.63E-03	6.63E-03	5.97E-03
Paver	3.89E-02	N/A ^b	N/A ^b
Compactor	6.67E-03	6.67E-03 ^f	6.67E-04 ^f
Pavement Cutter	1.43E-02	N/A ^b	N/A ^b
Chain saw, gas	3.39E-01	3.39E-01 ^f	8.48E-02 ^f
Generator for Welding ^d	6.60E-03	6.60E-03	1.65E-03
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):		1.34E-03	1.50E-03
Venturi Volume Sources (g/s-m²):		3.58E-03	8.56E-04
Area (m ²):		102.2	102.2
Notes:	<p>These emissions are included in the dispersion model two times to account for construction on two blocks.</p> <p>a. Emission factors for peak activity, to be modeled on an 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1c (worst case short-term and daily stage) for the 1-hour and the 8-hr periods, except for trucks which are assumed one each for peak hour.</p> <p>b. These equipment do not operate in the worst case stage.</p> <p>c. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.</p> <p>d. These sources are modeled as point sources and are not included in the sum.</p> <p>e. This source is modeled as a venturi point source and is not included in the venturi volume source sum.</p> <p>f. These sources are used for venturi chamber construction only.</p>		

**Table 11.2-14
Water Mains Only Modeling Parameters
SO₂ Emission Rates**

Construction Equipment	Peak Engine Emission Rate (g/sec)	3-Hour Average ^a Emission Rate (g/sec)	24-hour Average ^a Emission Rate (g/sec)	Annual Average ^b Emission Rate (g/sec)	Annual Average Emission Rate for Venturi Chambers Only (g/sec)	Point Sources as area sources for annual ^f (g/s-m ²)
Excavator, 2 cu yd	3.2E-04	3.23E-04	1.62E-04	9.32E-05		
FE Loader, 3 1/2 cu yds	5.0E-05	5.02E-05	5.02E-06	1.38E-06	8.27E-07	
Telescoping Crane ^e	8.7E-05	8.73E-05	2.18E-05	5.40E-06		4.91E-09
Concrete truck ^f	4.2E-06	4.22E-06	3.80E-06	1.45E-07	1.39E-07	
Dump truck ^d	4.2E-06	2.11E-07	2.11E-07	1.51E-07		
Flatbed truck ^d	4.2E-06	2.11E-07	2.11E-07	1.51E-07		
Compressor, 800 cfm at 100 psi ^e	3.2E-05	N/A ^c	N/A ^c	1.78E-06		1.62E-09
Dewatering pump ^e	1.6E-05	1.62E-05	1.46E-05	7.15E-06		6.51E-09
Paver	1.6E-04	N/A ^c	N/A ^c	8.87E-06		
Compactor	1.6E-05	1.62E-05	1.62E-06	8.88E-07	2.66E-07	
Pavement Cutter	2.2E-05	N/A ^c	N/A ^c	2.46E-07		
Chain saw, gas	1.4E-04	1.36E-04	3.41E-05	7.49E-06	5.62E-06	
Generator for Welding ^e	1.6E-05	1.62E-05	4.04E-06	9.99E-07		9.09E-10
Construction Equipment Engine & Fugitive Emissions - Volume Sources (g/s-m²):		3.17E-06	1.58E-06	1.02E-07	1.36E-08	
Venturi Volume Sources (g/s-m²):		1.98E-06	3.98E-07			
Area (m ²):		102.2	102.2	1098.8	502.5	1098.8

Notes: These emissions are included in the dispersion model two times to account for construction on two blocks.

a. Emission factors for peak activity, to be modeled on a 8-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Segment 1c (worst case short-term and daily stage) for the 3-hour and 24-hr, except for trucks which are assumed one each for peak hour.

b. Emission factors for long term assume 8-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.

c. These equipment do not operate in the worst case stage.

d. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. These trucks were conservatively assumed one per hour and were not scaled back for actual annual activity.

e. These sources are modeled as point sources and are not included in the sum.

f. This source is modeled as a venturi point source and is not included in the venturi volume source sum.

Table 11.2-15
Modeling Parameters -- Stage 3
PM_{2.5} Emission Rates

Construction Equipment	Peak Engine ^e Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^c Emission Rate (g/sec)
Excavator, 2 cu yd	9.7E-04	N/A ^a	9.7E-04	4.83E-05	3.45E-05
FE Loader, 3 1/2 cu yds	4.3E-04	N/A ^a	4.3E-04	2.13E-05	1.52E-05
Derrick Crane, 100 ton ^g	4.9E-03	N/A ^a	4.9E-03	1.24E-03	8.84E-04
Concrete pump, 30 cu yds/hr ^{g,h}	4.7E-04	N/A ^a	4.7E-04	4.25E-04	8.43E-05
Concrete truck ^{g,h}	3.2E-04	N/A ^f	3.2E-04	2.85E-04	5.65E-05
Flatbed truck ^d	1.6E-05	N/A ^f	1.6E-05	1.58E-05	1.13E-05
Emission Rate for all Volume Sources in Area of Activity (g/sec):				8.55E-05	6.10E-05
Average Emission Rate per Volume Source for 18 vol. Sources (g/sec):				4.75E-06	3.39E-06
Notes:	<p>a. These equipment are not involved in construction activities that generate fugitive dust emissions. Only a negligible amount of material will be excavated or filled during this stage.</p> <p>b. Emission factors for peak activity, to be modeled on a 16-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Stage 3 (i.e., worst case short-term) except for flatbed trucks which are assumed 1 per hour.</p> <p>c. Emission factors for long term assume 16-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.</p> <p>d. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load.</p> <p>e. Includes 25% reduction for use of DOC in all nonroad engines greater than or equal to 50 hP.</p> <p>f. Resuspended dust PM_{2.5} emissions from surfaces were not included because vehicles will be traveling at 5 mph or less. This is in accordance with NYCDEP guidelines.</p> <p>g. These sources are modeled as point sources and are not included in the sum</p> <p>h. During concrete pours, concrete trucks may be operating constantly on site (assumed 90% of the day) as indicated by the Construction team.</p>				

Table 11.2-16
Modeling Parameters -- Stage 3
PM₁₀ Emission Rates

Construction Equipment	Peak Engine ^e Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average ^b Emission Rate (g/sec)	Annual Average ^c Emission Rate (g/sec)
Excavator, 2 cu yd	1.0E-03	N/A ^a	9.97E-04	4.98E-05	3.56E-05
FE Loader, 3 1/2 cu yds	4.4E-04	N/A ^a	4.39E-04	2.19E-05	1.57E-05
Derrick Crane, 100 ton ^g	5.1E-03	N/A ^a	5.10E-03	1.28E-03	9.11E-04
Concrete pump, 30 cu yds/hr ^{g,h}	4.9E-04	N/A ^a	4.87E-04	4.38E-04	8.69E-05
Concrete truck ^{g,h}	3.4E-04	N/A ^f	3.44E-04	3.10E-04	6.15E-05
Flatbed truck ^d	1.7E-05	N/A ^f	1.72E-05	1.72E-05	1.23E-05
Fugitive Road Dust ^f	--	--	--	3.21E-03	2.86E-04
Emission Rate for all Volume Sources in Area of Activity (g/sec):				3.30E-03	3.49E-04
Average Emission Rate per Volume Source for 18 vol. Sources (g/sec):				1.83E-04	1.94E-05
Notes:					
a. These equipment are not involved in construction activities that generate fugitive dust emissions. Only a negligible amount of material will be excavated or filled during this stage.					
b. Emission factors for peak activity, to be modeled on a 16-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Stage 3 (i.e., worst case short-term) except for flatbed trucks which are assumed 1 per hour.					
c. Emission factors for long term assume 16-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week.					
d. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load.					
e. Includes 25% reduction for use of DOC in all nonroad engines greater than or equal to 50 hp.					
f. Based on 3 trucks per hour for peak (24-hour) and 370 trucks total for the annual.					
g. These sources are modeled as point sources and are not included in the sum					
h. During concrete pours, concrete trucks may be operating constantly on site (assumed 90% of the day) as indicated by the Construction team.					

Table 11.2-17
Modeling Parameters -- Stage 3
NO_x Emission Rates

Construction Equipment	Peak Engine Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	24-hour Average Emission Rate (g/sec)	Annual Average ^a Emission Rate (g/sec)
Excavator, 2 cu yd	1.8E-01	---	1.75E-01	---	6.26E-03
FE Loader, 3 1/2 cu yds	5.5E-02	---	5.49E-02	---	1.96E-03
Derrick Crane, 100 ton ^c	1.8E-01	---	1.85E-01	---	3.30E-02
Concrete pump, 30 cu yds/hr ^c	6.7E-02	---	6.71E-02	---	1.20E-02
Concrete truck ^c	1.1E-02	---	1.09E-02	---	1.95E-03
Flatbed truck ^b	5.5E-04	---	5.47E-04	---	3.91E-04
Emission Rate for all Volume Sources in Area of Activity (g/sec):				---	8.61E-03
Average Emission Rate per Volume Source for 18 vol. Sources (g/sec):				---	4.79E-04
<p>Notes: a. Emission factors for long term assume 16-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week. b. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. c. These sources are modeled as point sources and are not included in the sum</p>					

**Table 11.2-18
Modeling Parameters -- Stage 3
CO Emission Rates**

Construction Equipment	Peak Engine Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hourly Total Emission Rate (g/sec)	8-hour/24-hour Average ^a Emission Rate (g/sec)	Annual Average Emission Rate (g/sec)
Excavator, 2 cu yd	3.95E-02	---	3.95E-02	1.97E-03	---
FE Loader, 3 1/2 cu yds	1.99E-02	---	1.99E-02	9.96E-04	---
Derrick Crane, 100 ton ^c	2.55E-02	---	2.55E-02	6.39E-03	---
Concrete pump, 30 cu yds/hr ^{c,d}	2.87E-02	---	2.87E-02	2.59E-02	---
Concrete truck ^{c,d}	8.28E-03	---	8.28E-03	7.45E-03	---
Flatbed truck ^b	4.14E-04	---	4.14E-04	4.14E-04	---
Emission Rate for all Volume Sources in Area of Activity (g/sec):			5.98E-02	3.38E-03	---
Average Emission Rate per Volume Source for 18 vol. Sources (g/sec):			3.32E-03	1.88E-04	---
<p>Notes:</p> <ul style="list-style-type: none"> a. Emission factors for peak activity, to be modeled on a 16-hour work day basis (emission factor for remaining hours is zero). Scaling factors are based on percent usage factors for Stage 3 (i.e., worst case short-term) except for flatbed trucks which are assumed 1 per hour. b. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. c. These sources are modeled as point sources and are not included in the sum. d. During concrete pours, concrete trucks may be operating constantly on site (assumed 90% of the day) as indicated by the Construction team. 					

Table 11.2-19
Modeling Parameters -- Stage 3
SO₂ Emission Rates

Construction Equipment	Peak Engine Emission Rate (g/sec)	Peak Fugitive Emission Rate (g/sec)	Peak Hour / 3-hour Total Emission Rate (g/sec)	8-hour/24-hour Average ^a Emission Rate (g/sec)	Annual Average ^a Emission Rate (g/sec)
Excavator, 2 cu yd	1.6E-04	---	1.61E-04	8.07E-06	5.77E-06
FE Loader, 3 1/2 cu yds	5.0E-05	---	5.02E-05	2.51E-06	1.79E-06
Derrick Crane, 100 ton ^c	1.6E-04	---	1.60E-04	4.00E-05	2.86E-05
Concrete pump, 30 cu yds/hr ^{c,d}	6.5E-05	---	6.46E-05	5.82E-05	1.15E-05
Concrete truck ^{c,d}	1.1E-04	---	1.14E-04	1.03E-04	2.03E-05
Flatbed truck ^b	5.7E-06	---	5.69E-06	5.69E-06	4.07E-06
Emission Rate for all Volume Sources in Area of Activity (g/sec):			2.17E-04	1.63E-05	1.16E-05
Average Emission Rate per Volume Source for 18 vol. Sources (g/sec):			1.21E-05	9.04E-07	6.46E-07
Notes:	a. Emission factors for long term assume 16-hour work day (emission factor for remaining hours is zero). Scaling factors are based on the average usage factors for a year, based on a 5-day work week. b. These trucks are subject to idling laws and are assumed to run a total of 3 minutes for each trip/load. c. These sources are modeled as point sources and are not included in the sum. d. During concrete pours, concrete trucks may be operating constantly on site (assumed 90% of the day) as indicated by the Construction team.				

*

Figure 2
Annual Model Sources and Receptors

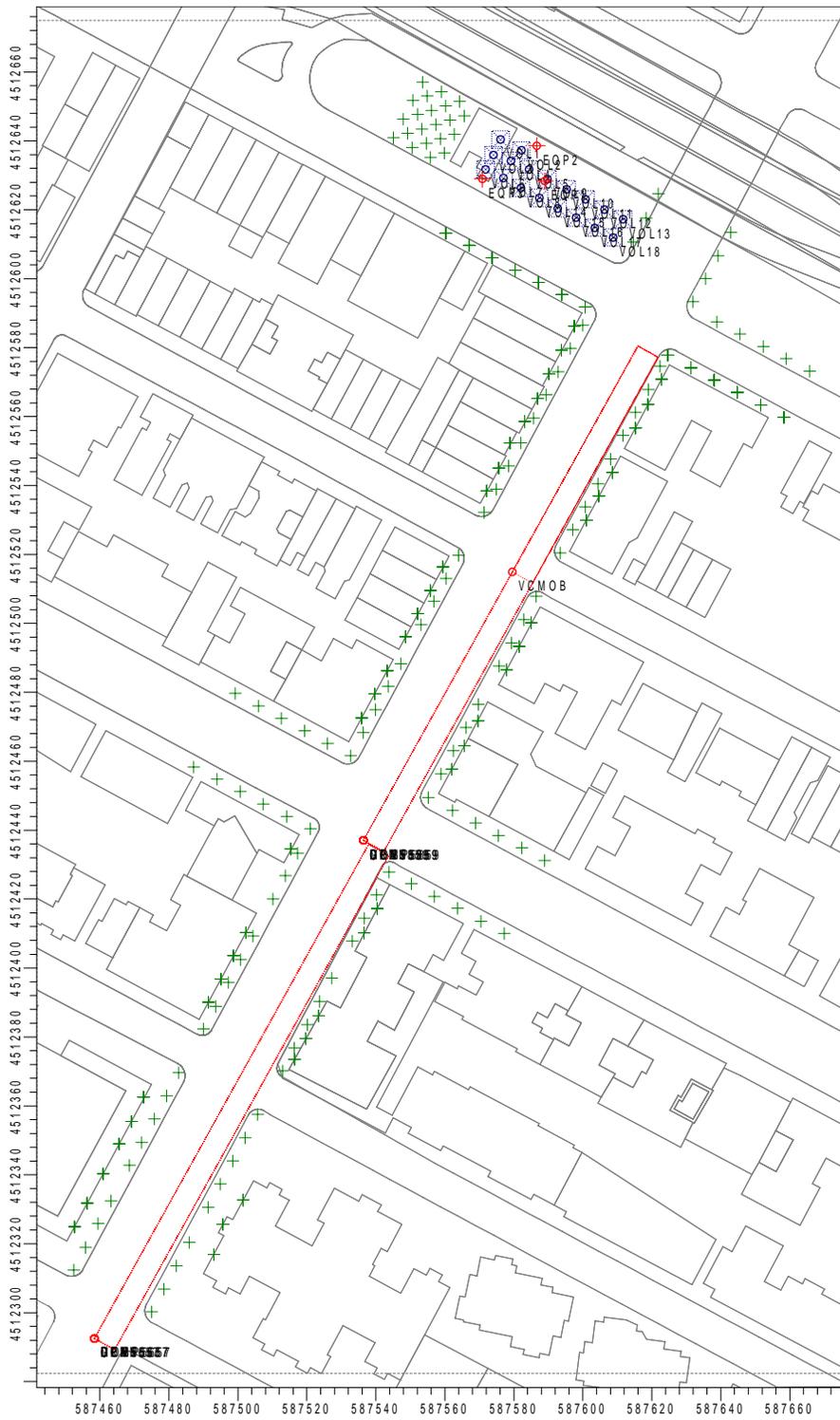
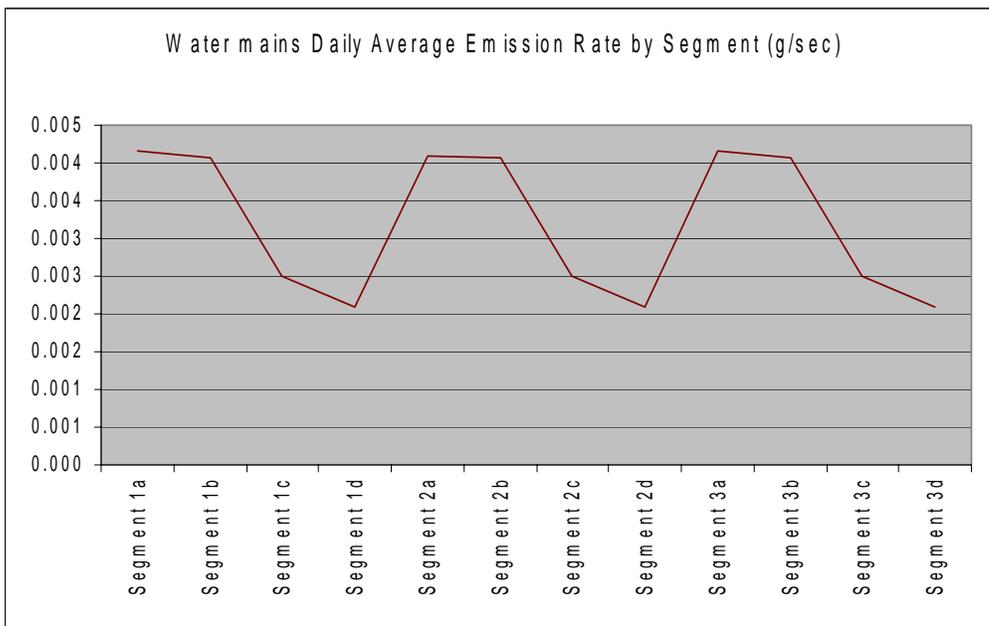
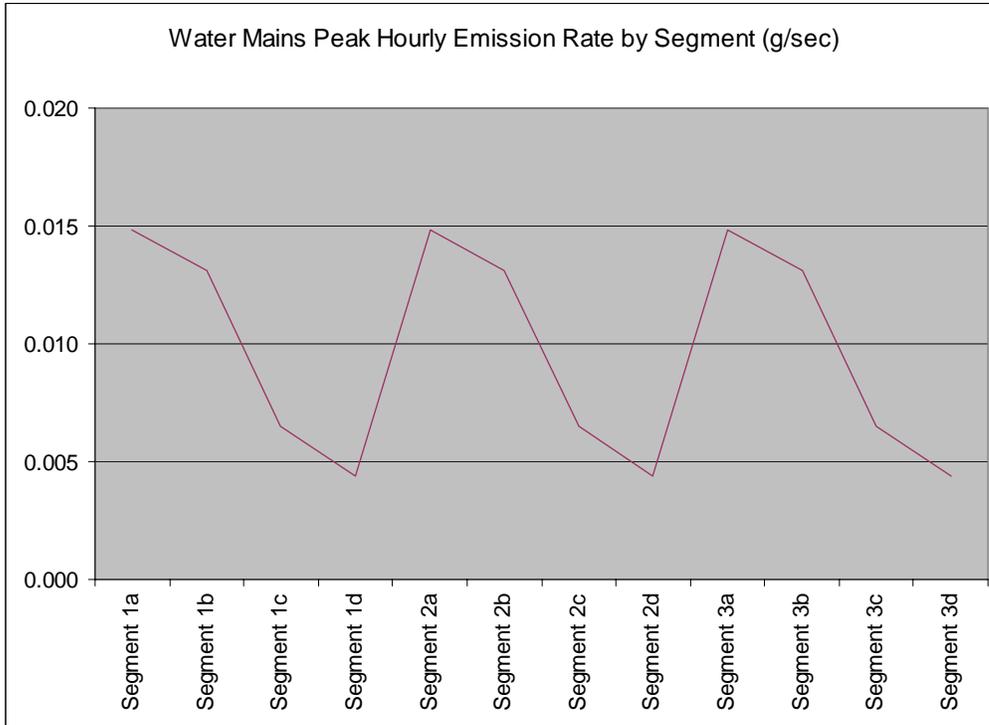


Figure 3
Peak Hourly and Daily Site-Wide PM_{2.5}



NOTE: When including the construction of the venturi chamber for the cumulative analysis, Segment 1c has a peak hourly emission rate of 0.017 g/sec, and a daily emission rate of 0.005 g/sec, which are the highest hourly and daily cumulative emission rates.