Appendix F: Air Quality

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Parking Garage Analysis

Parking Garage Analysis
Estimate of CO Emission Rates within the Garage Under 2019 Build Conditions

Autos	Cold Idle	Cold @ 5mph	Hot @ 5 mph
	g/hr	g/veh-mile	g/veh-mile
	63.12	19.51	7.01

Garage	Capacity	Max Hour Period		Max 8 hour Period		# of Levels	Garage	Mean Travel Dist	Max ER	8-hr ER	Max 1-hr Conc	Max 8-hr Conc
	veh	In	Out	In	Out		gsf	ft	g/sec	g/sec	ppm	ppm
30th St betw. 11&12th Ave	850	72	31	50	22	4	1,711,184	1429	0.0924	0.0647	0.10	0.07

Assumptions:
Emission factors for CO under 2018 Build conditions were obtained from MOBILE 6 Mobile Source Emission Factor Model
Maximum hour is 1-hour period with largest number of autos departing
Maximum 8-hour period is the 8-hour period with largest average number of departing autos over 8 hours
Garage GSF are total gross square feet of garage area without mechanical areas that is a sum of cellular and 3 sub-cellar area
Travel distance assumed to be 2/3 of the sum of length travel distance and 1/2 of the sum of width within the garage, including 4 levels
Max 1-hour and 8-hour average ER - maximum hourly average CO emission rates within the garage for these respective averaging periods
Peak hour: PM

Parking Garage Analysis
Calculation of Cumulative CO Impacts from Garage and Adjacent Street Emissions

Garage	8-hr CO ER per Vent	8-hr CO Conc. Within the Garage		sigma y(0)	sigma y(1.52)	sigma z(1.52)	8-hr CO Impact at 1.52m (5 feet)		Total 8-hr CO Conc. at 1.52 m (5 feet)				
	g/sec	ppm	ug/m3	m	m	m	ug/m3	ppm	ppm				
30th St betw. 11&12th Ave	0.065	0.07	0.00006	18.36	18.61	18.58	0.00004	0.05	**2.9**				
										Highest On-Street Emissions		Max 8-hr On-Street Impacts	Total Estimated 8-hr CO Conc. at 15.24 m (150 feet)
					sigma y(15.24)	sigma z(15.24)	at 15.24 m (150 feet)						
					m	m	ug/m3	ppm		g/mile-hr	g/m-sec	ppm	ppm
					20.80	20.50	0.00003	0.04		4,394	0.00076	0.2	**3.1**

Assumptions:
Assumes that garage is vented through one vent located at 3.66 m (12 feet) above grade.
Receptors are at sidewalks at 1.83 m (6 feet) above grade.
Receptor distances from vent are either 1.52 m (5 feet) or 15.24 m (50 feet)
8-hour persistence factor is assumed to be 0.7
8-hour CO background concentrations is 2.9 ppm
Street traffic volume consists of street volume and volume exiting from the parking garage
Street Volume: PM **627** veh/hr

Parking Garage Analysis
Estimate of CO Emission Rates within the Garage Under 2019 Build Conditions

Autos	Cold Idle	Cold @ 5mph	Hot @ 5 mph
	g/hr	g/veh-mile	g/veh-mile
	63.12	19.51	7.01

Garage	Capacity	Max Hour Period		Max 8 hour Period		# of Levels	Garage	Mean Travel Dist	Max ER	8-hr ER	Max 1-hr Conc	Max 8-hr Conc
	veh	In	Out	In	Out		gsf	ft	g/sec	g/sec	ppm	ppm
33rd St betw. 11&12th Ave	750	33	274	23	192	2	133,969	1344	0.4743	0.3320	6.55	4.58

Assumptions:

Emission factors for CO under 2018 Build conditions were obtained from MOBILE 6 Mobile Source Emission Factor Model

Maximum hour is 1-hour period with largest number of autos departing

Maximum 8-hour period is the 8-hour period with largest average number of departing autos over 8 hours

Garage GSF are total gross square feet of garage area without mechanical areas that is a sum of cellular and 1 sub-cellar area

Travel distance assumed to be 2/3 of the sum of longest travel distance within the garage, including 2 levels

Max 1-hour and 8-hour average ER - maximum hourly average CO emission rates within the garage for these respective averaging periods

Peak hour: PM

Parking Garage Analysis
Calculation of Cumulative CO Impacts from Garage and Adjacent Street Emissions

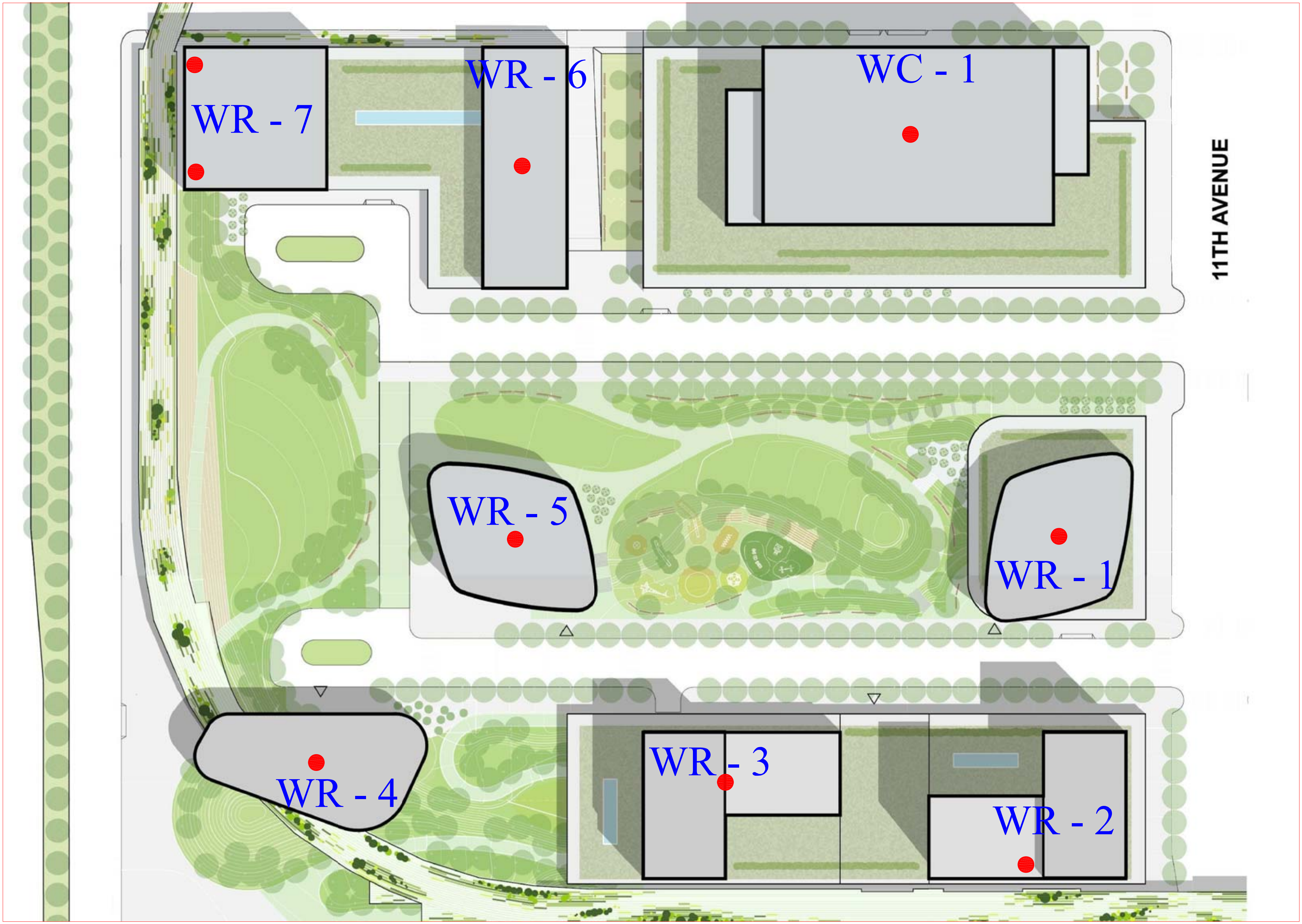
Garage	8-hr CO ER per Vent	8-hr CO Conc. Within the Garage		sigma y(0)	sigma y(1.52)	sigma z(1.52)	8-hr CO Impact at 1.52m (5 feet)		Total 8-hr CO Conc. at 1.52 m (5 feet)				
	g/sec	ppm	ug/m3	m	m	m	ug/m3	ppm	ppm				
33rd St betw. 11&12th Ave	0.332	4.58	0.00400	5.14	5.38	5.35	0.00242	2.77	**5.7**				
					sigma y(15.24)	sigma z(15.24)	at 15.24m (50 feet)			Highest On-Street Emissions		Max 8-hr On-Street Impacts	Total Estimated 8-hr CO Conc. at 15.24 m (150 feet)
					m	m	ug/m3	ppm		g/mile-hr	g/m-sec	ppm	ppm
					7.58	7.27	0.00130	1.49		3,784	0.00065	0.1	**4.5**

Assumptions:
Assumes that garage is vented through one vent located at 3.66 m (12 feet) above grade.
Receptors are at sidewalks at 1.83 m (6 feet) above grade.
Receptor distances from vent are either 1.52 m (5 feet) or 15.24 m (50 feet)
8-hour persistence factor is assumed to be 0.7
8-hour CO background concentrations is 2.9 ppm
Street traffic volume consists of street volume and volume exiting from the parking garage
Street Volume: PM **540** veh/hr

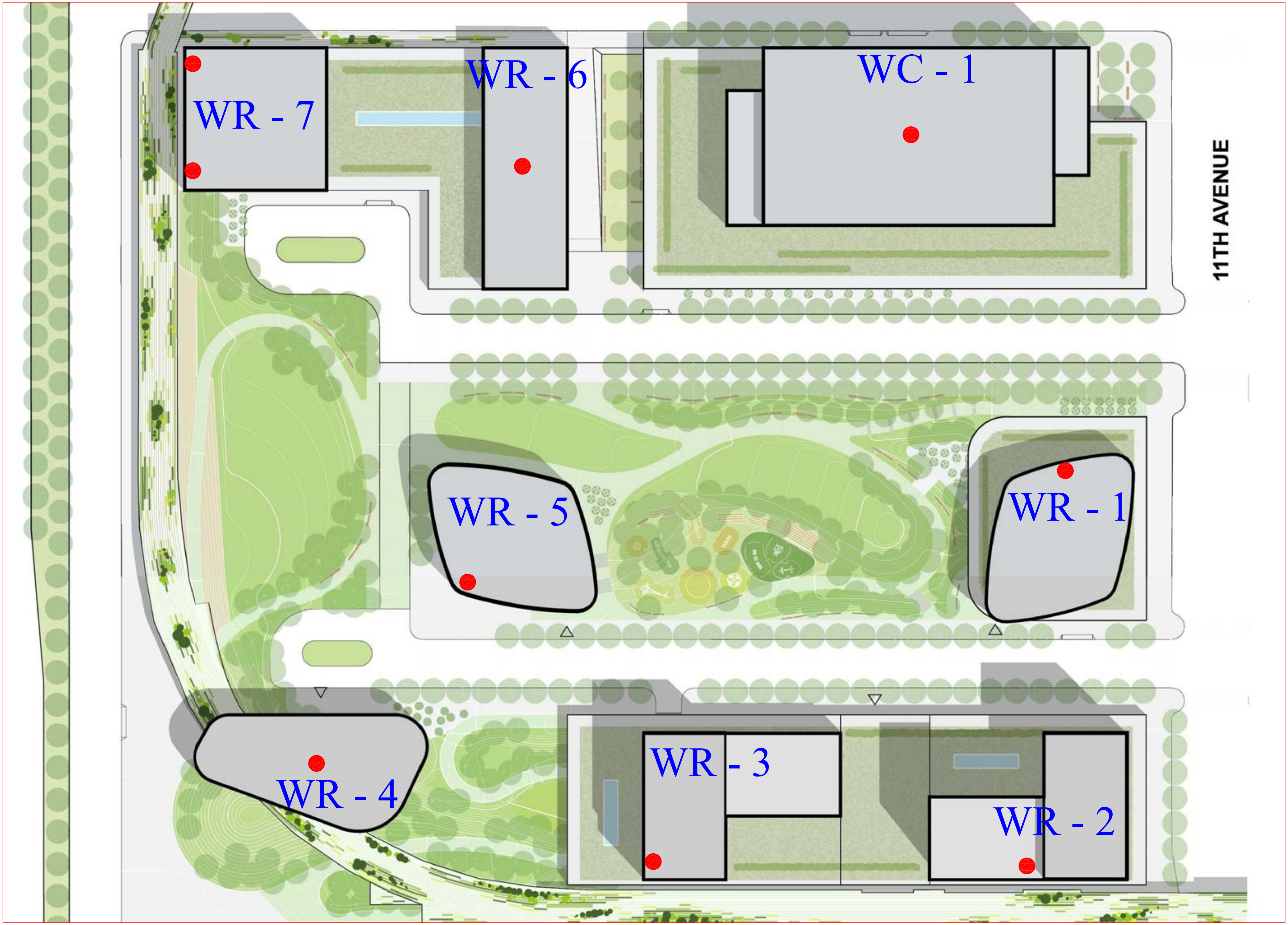
HVAC ANALYSIS

DEVELOPMENT SITE BUILDING ON BUILDING IMPACTS

SCENARIO 1 - MAXIMUM COMMERCIAL



SCENARIO 2 - MAXIMUM RESIDENTIAL/OFFICE



SCENARIO 3 - MAXIMUM RESIDENTIAL/HOTEL

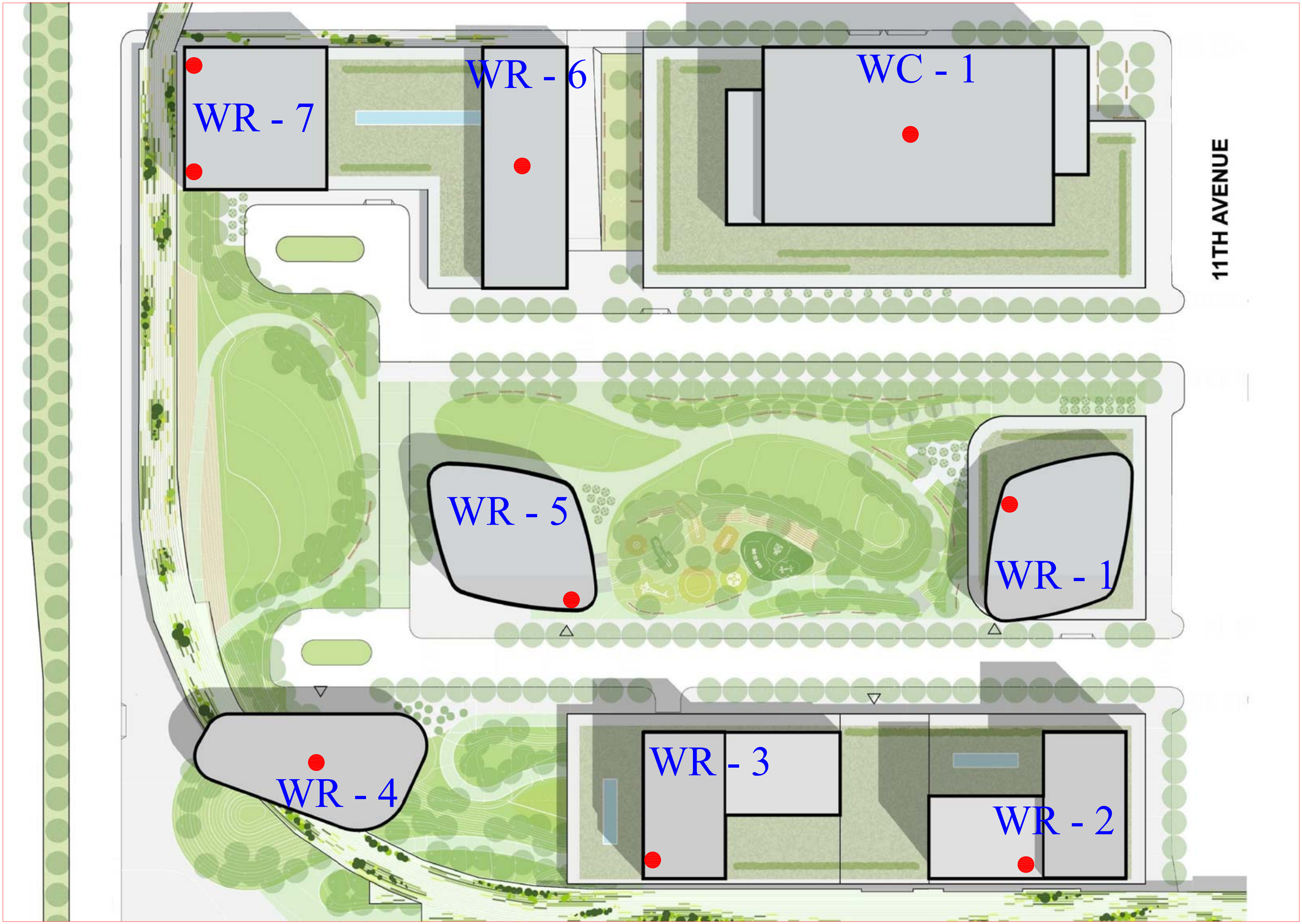


Table AQ-1
WRY Development RWCDS Scenario
Estimated Pollutants Emission Rates and Source Parameters for Fuel #2

Site No.	Pollutant	Fuel Factors [1]	Proposed Development Size	Annual Fuel Consumption	AP-42 Emission Factors [2]	Estimated Emission Rates [5]		Emission Source Parameters Used in the Analysis			
								Heat Input [6]	Stack		
									Height	Diameter	Ex. Velocity
		gal/ft^2-yr	ft^2	gal/year	lb/10^3 gal	lb/year	g/sec	MMBtu/hr	meters	meters	m/sec
AQ Scenario 1 - Max Commercial Scenario											
WRY-1	**24-hr SO2 [3,5]**	0.38	730,000	277,400	28.4	7,878	0.414	16.2	225.6	0.762	9.144
	24-hr PM2.5 [4,5]				2.13	591	0.031				
	Annual PM2.5 [4]				2.13	591	0.008				
	24-hr PM10 [4,5]				2.38	660	0.035				
WRY-2	**24-hr SO2 [3,5]**	0.38	710,000	269,800	28.4	7,662	0.402	15.7	207.3	0.9144	9.144
	24-hr PM2.5 [4,5]				2.13	575	0.030				
	Annual PM2.5 [4]				2.13	575	0.008				
	24-hr PM10 [4,5]				2.38	642	0.034				
WRY-3	**24-hr SO2 [3,5]**	0.38	585,000	222,300	28.4	6,313	0.331	13.0	176.8	0.8636	9.144
	24-hr PM2.5 [4,5]				2.13	473	0.025				
	Annual PM2.5 [4]				2.13	473	0.007				
	24-hr PM10 [4,5]				2.38	529	0.028				
WRY-4	**24-hr SO2 [3,5]**	0.38	375,000	142,500	28.4	4,047	0.212	8.3	164.6	0.762	9.144
	24-hr PM2.5 [4,5]				2.13	304	0.016				
	Annual PM2.5 [4]				2.13	304	0.004				
	24-hr PM10 [4,5]				2.38	339	0.018				
WRY-5	**24-hr SO2 [3,5]**	0.38	535,000	203,300	28.4	5,774	0.303	11.9	161.5	0.6096	9.144
	24-hr PM2.5 [4,5]				2.13	433	0.023				
	Annual PM2.5 [4]				2.13	433	0.006				
	24-hr PM10 [4,5]				2.38	484	0.025				
WRY-6	**24-hr SO2 [3,5]**	0.38	550,000	209,000	28.4	5,936	0.312	12.2	207.3	0.8128	9.144
	24-hr PM2.5 [4,5]				2.13	445	0.023				
	Annual PM2.5 [4]				2.13	445	0.006				
	24-hr PM10 [4,5]				2.38	497	0.026				
WRY-7	**24-hr SO2 [3,5]**	0.38	675,000	256,500	28.4	7,285	0.382	15.0	176.8	0.8128	9.144
	24-hr PM2.5 [4,5]				2.13	546	0.029				
	Annual PM2.5 [4]				2.13	546	0.008				
	24-hr PM10 [4,5]				2.38	610	0.032				
WC-1	**24-hr SO2 [3,5]**	0.38	2,315,000	879,700	28.4	24,983	1.312	51.3	268.2	1.6764	9.144
	24-hr PM2.5 [4,5]				2.13	1,874	0.098				
	Annual PM2.5 [4]				2.13	1,874	0.027				
	24-hr PM10 [4,5]				2.38	2,094	0.110				

Table AQ-1
WRY Development RWCDS Scenario
Estimated Pollutants Emission Rates and Source Parameters for Fuel #2

Site No.	Pollutant	Fuel Factors [1]	Proposed Development Size	Annual Fuel Consumption	AP-42 Emission Factors [2]	Estimated Emission Rates [5]		Emission Source Parameters Used in the Analysis: Heat Input [6]	Stack Height	Stack Diameter	Stack Ex. Velocity
		gal/ft^2-yr	ft^2	gal/year	$lb/10^3$ gal	lb/year	g/sec	MMBtu/hr	meters	meters	m/sec
AQ Scenario 2 - Max Residential/Office Option											
WRY-1	24-hr SO2 [3,5]	0.38	805,000	305,900	28.4	8,688	0.456	17.8	243.8	0.762	9.144
	24-hr PM2.5 [4,5]				2.13	652	0.034				
	Annual PM2.5 [4]				2.13	652	0.009				
	24-hr PM10 [4,5]				2.38	728	0.038				
WRY-2	24-hr SO2 [3,5]	0.38	822,500	312,550	28.4	8,876	0.466	18.2	234.7	0.9144	9.144
	24-hr PM2.5 [4,5]				2.13	666	0.035				
	Annual PM2.5 [4]				2.13	666	0.010				
	24-hr PM10 [4,5]				2.38	744	0.039				
WRY-3	24-hr SO2 [3,5]	0.38	697,500	265,050	28.4	7,527	0.395	15.5	204.2	0.8636	9.144
	24-hr PM2.5 [4,5]				2.13	565	0.030				
	Annual PM2.5 [4]				2.13	565	0.008				
	24-hr PM10 [4,5]				2.38	631	0.033				
WRY-4	24-hr SO2 [3,5]	0.38	375,000	142,500	28.4	4,047	0.212	8.3	164.6	0.7620	9.144
	24-hr PM2.5 [4,5]				2.13	304	0.016				
	Annual PM2.5 [4]				2.13	304	0.004				
	24-hr PM10 [4,5]				2.38	339	0.018				
WRY-5	24-hr SO2 [3,5]	0.38	660,000	250,800	28.4	7,123	0.374	14.6	198.1	0.6096	9.144
	24-hr PM2.5 [4,5]				2.13	534	0.028				
	Annual PM2.5 [4]				2.13	534	0.008				
	24-hr PM10 [4,5]				2.38	597	0.031				
WRY-6	24-hr SO2 [3,5]	0.38	662,500	251,750	28.4	7,150	0.375	14.7	234.7	0.8128	9.144
	24-hr PM2.5 [4,5]				2.13	536	0.028				
	Annual PM2.5 [4]				2.13	536	0.008				
	24-hr PM10 [4,5]				2.38	599	0.031				
WRY-7	24-hr SO2 [3,5]	0.38	775,000	294,500	28.4	8,364	0.439	17.2	204.2	0.8128	9.144
	24-hr PM2.5 [4,5]				2.13	627	0.033				
	Annual PM2.5 [4]				2.13	627	0.009				
	24-hr PM10 [4,5]				2.38	701	0.037				
WC-1	24-hr SO2 [3,5]	0.38	1,625,000	617,500	28.4	17,537	0.921	36.0	268.2	1.6764	9.144
	24-hr PM2.5 [4,5]				2.13	1,315	0.069				
	Annual PM2.5 [4]				2.13	1,315	0.019				
	24-hr PM10 [4,5]				2.38	1,470	0.077				

Table AQ-1
WRY Development RWCDS Scenario
Estimated Pollutants Emission Rates and Source Parameters for Fuel #2

Site No.	Pollutant	Fuel Factors (1)	Proposed Development Size	Annual Fuel Consumption	AP-42 Emission Factors (2)	Estimated Emission Rates (5)		Emission Source Parameters Used in the Analysis			
								Heat Input (6)	Stack		
									Height	Diameter	Ex. Velocity
		gal/ft^2-yr	ft^2	gal/year	lb/10^3 gal	lb/year	g/sec	MMBtu/hr	meters	meters	m/sec
AQ Scenario 3 - Max Residential/Hotel Option											
WRY-1	**24-hr SO2 (3,5)**	0.38	792,500	301,150	28.4	8,553	0.449	17.6	240.8	0.762	9.144
	24-hr PM2.5 (4,5)				2.13	641	0.034				
	Annual PM2.5 (4)				2.13	641	0.009				
	24-hr PM10 (4,5)				2.38	717	0.038				
WRY-2	**24-hr SO2 (3,5)**	0.38	885,000	336,300	28.4	9,551	0.501	19.6	253.0	0.9144	9.144
	24-hr PM2.5 (4,5)				2.13	716	0.038				
	Annual PM2.5 (4)				2.13	716	0.010				
	24-hr PM10 (4,5)				2.38	800	0.042				
WRY-3	**24-hr SO2 (3,5)**	0.38	772,500	293,550	28.4	8,337	0.438	17.1	222.5	0.8636	9.144
	24-hr PM2.5 (4,5)				2.13	625	0.033				
	Annual PM2.5 (4)				2.13	625	0.009				
	24-hr PM10 (4,5)				2.38	699	0.037				
WRY-4	**24-hr SO2 (3,5)**	0.38	375,000	142,500	28.4	4,047	0.212	8.3	164.6	0.7620	9.144
	24-hr PM2.5 (4,5)				2.13	304	0.016				
	Annual PM2.5 (4)				2.13	304	0.004				
	24-hr PM10 (4,5)				2.38	339	0.018				
WRY-5	**24-hr SO2 (3,5)**	0.38	747,500	284,050	28.4	8,067	0.424	16.6	219.5	0.6096	9.144
	24-hr PM2.5 (4,5)				2.13	605	0.032				
	Annual PM2.5 (4)				2.13	605	0.009				
	24-hr PM10 (4,5)				2.38	676	0.035				
WRY-6	**24-hr SO2 (3,5)**	0.38	737,500	280,250	28.4	7,959	0.418	16.3	253.0	0.8128	9.144
	24-hr PM2.5 (4,5)				2.13	597	0.031				
	Annual PM2.5 (4)				2.13	597	0.009				
	24-hr PM10 (4,5)				2.38	667	0.035				
WRY-7	**24-hr SO2 (3,5)**	0.38	850,000	323,000	28.4	9,173	0.482	18.8	222.5	0.8128	9.144
	24-hr PM2.5 (4,5)				2.13	688	0.036				
	Annual PM2.5 (4)				2.13	688	0.010				
	24-hr PM10 (4,5)				2.38	769	0.040				
WC-1	**24-hr SO2 (3,5)**	0.38	1,128,000	428,640	28.4	12,173	0.639	25.0	268.2	1.6764	9.144
	24-hr PM2.5 (4,5)				2.13	913	0.048				
	Annual PM2.5 (4)				2.13	913	0.013				
	24-hr PM10 (4,5)				2.38	1,020	0.054				

Notes:

1. Fuel consumption rates (0.38 gallons of No. 2 fuel oil per square foot) are based on fuel factors presented in the CEQR Technical Manual Appendix 7 for residential buildings in NYC
2. Emission factors for fuel oil are obtained from the EPA Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion for Boilers with less then 100 MMBtu/hr"
3. SO2 emission factors from fuel oil combustion are estimated using the equation SO2=142S, where S= sulfur content (O.2%) in fuel oil No.2
4. PM10 and PM2.5 emission factors from fuel combustion that include both filterable and condensable PM emissions were estimated using cumulative particle size distribution

Table AQ-1
WRY Development RWCDS Scenario
Estimated Pollutants Emission Rates and Source Parameters for Fuel #2

Site No.	Pollutant	Fuel Factors [1]	Proposed Development Size	Annual Fuel Consumption	AP-42 Emission Factors [2]	Estimated Emission Rates [5]		Emission Source Parameters Used in the Analysis			
								Heat Input [6]	Stack		
									Height	Diameter	Ex. Velocity
		gal/ft^2-yr	ft^2	gal/year	$lb/10^3$ gal	lb/year	g/sec	MMBtu/hr	meters	meters	m/sec

from Table 1.3.7 "Cumulative Particle Size Distribution" and size-specific emission factors for uncontrolled commercial boilers burning residual or distillate oil

5. Short-term emission rates were estimated based on assumption that fuel would be consumed in a 100 day (2,400 hrs) heating season

6. Boiler heat input (MMBtu/hr) was estimated based on annual fuel consumption rate, duration of heating season, and fuel heating value of 140,000 Btu/gal

Western Rail Yard
Estimated Annual NOx, PM2.5, and SO2 Emission Rates from Boilers using Natural Gas

Fuel Type	Fuel Factors (1)	Development Size	Annual Fuel Consumption	NOx Emission Factor	PM2.5 Emission Factor	SO2 Emission Factor	Annual NOx Emission Rate		Annual PM2.5 Emission Rate		Annual SO2 Emission Rate	
	ft3/ft^2-year	ft^2	ft3/year	lb/10^6ft3	lb/10^6ft3	lb/10^6ft3	lb/year	g/sec	lb/year	g/sec	lb/year	g/sec
AQ Scenario 1 - Max Commercial Scenario												
WRY-1	52.8	730,000	38,544,000	100	7.6	0.6	3,854	0.055	293	0.004	23.1	0.0003
WRY-2	52.8	710,000	37,488,000				3,749	0.054	285	0.004	22.5	0.0003
WRY-3	52.8	585,000	30,888,000				3,089	0.044	235	0.003	18.5	0.0003
WRY-4	52.8	375,000	19,800,000				1,980	0.028	150	0.002	11.9	0.0002
WRY-5	52.8	535,000	28,248,000				2,825	0.041	215	0.003	16.9	0.0002
WRY-6	52.8	550,000	29,040,000				2,904	0.042	221	0.003	17.4	0.0003
WRY-7	52.8	675,000	35,640,000				3,564	0.051	271	0.004	21.4	0.0003
WC-1	52.8	2,315,000	122,232,000				12,223	0.176	929	0.013	73.3	0.0011
AQ Scenario 2 - Max Residential/Office Option												
WRY-1	52.8	805,000	42,504,000	100	7.6	0.6	4,250	0.061	323	0.005	25.5	0.0004
WRY-2	52.8	822,500	43,428,000				4,343	0.062	330	0.005	26.1	0.0004
WRY-3	52.8	697,500	36,828,000				3,683	0.053	280	0.004	22.1	0.0003
WRY-4	52.8	375,000	19,800,000				1,980	0.028	150	0.002	11.9	0.0002
WRY-5	52.8	660,000	34,848,000				3,485	0.050	265	0.004	20.9	0.0003
WRY-6	52.8	662,500	34,980,000				3,498	0.050	266	0.004	21.0	0.0003
WRY-7	52.8	775,000	40,920,000				4,092	0.059	311	0.004	24.6	0.0004
WC-1	52.8	1,625,000	85,800,000				8,580	0.123	652	0.009	51.5	0.0007
AQ Scenario 3 - Max Residential/Hotel Option												
WRY-1	52.8	792,000	41,817,600	100	7.6	0.6	4,182	0.060	318	0.005	25.1	0.0004
WRY-2	52.8	885,000	46,728,000				4,673	0.067	355	0.005	28.0	0.0004
WRY-3	52.8	772,000	40,761,600				4,076	0.059	310	0.004	24.5	0.0004
WRY-4	52.8	375,000	19,800,000				1,980	0.028	150	0.002	11.9	0.0002
WRY-5	52.8	747,500	39,468,000				3,947	0.057	300	0.004	23.7	0.0003
WRY-6	52.8	737,500	38,940,000				3,894	0.056	296	0.004	23.4	0.0003
WRY-7	52.8	850,000	44,880,000				4,488	0.065	341	0.005	26.9	0.0004
WC-1	52.8	1,128,000	59,558,400				5,956	0.086	453	0.007	35.7	0.0005

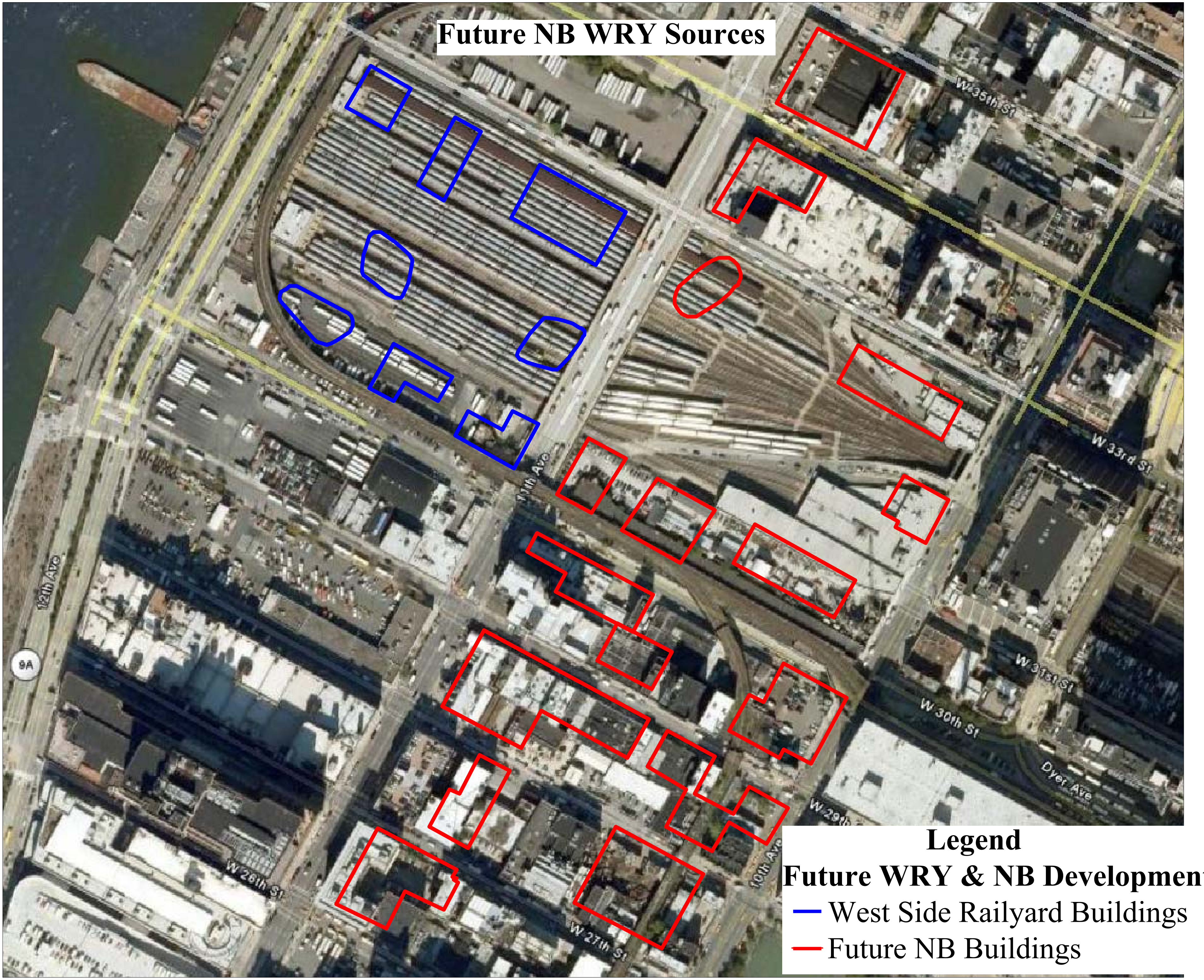
Notes:

Emission factors for natural gas combustion are obtained from the EPA Table 1.3-1 "Criteria Pollutant Emission Factors for Natural Gas Combustion for Boilers with less then 100 MMBtu/hr"

NO2 emissions from natural gas are assumed to be uncontrolled (NO2 = 100 lb/MMBtu)

PM10 and PM2.5 emission factors from natural gas combustion include both filterable and condensable PM emissions.

DEVELOPMENT SITE ON BUILDING FUTURE NO BUILD


Future NB WRY Sources
W 35th St
W 33rd St
W 31st St
W 30th St
Dyer Ave
W 29th St
W 26th St
W 27th St
11th Ave
10th Ave
12th Ave
9A
Legend
Future WRY & NB Development
West Side Railyard Buildings
Future NB Buildings

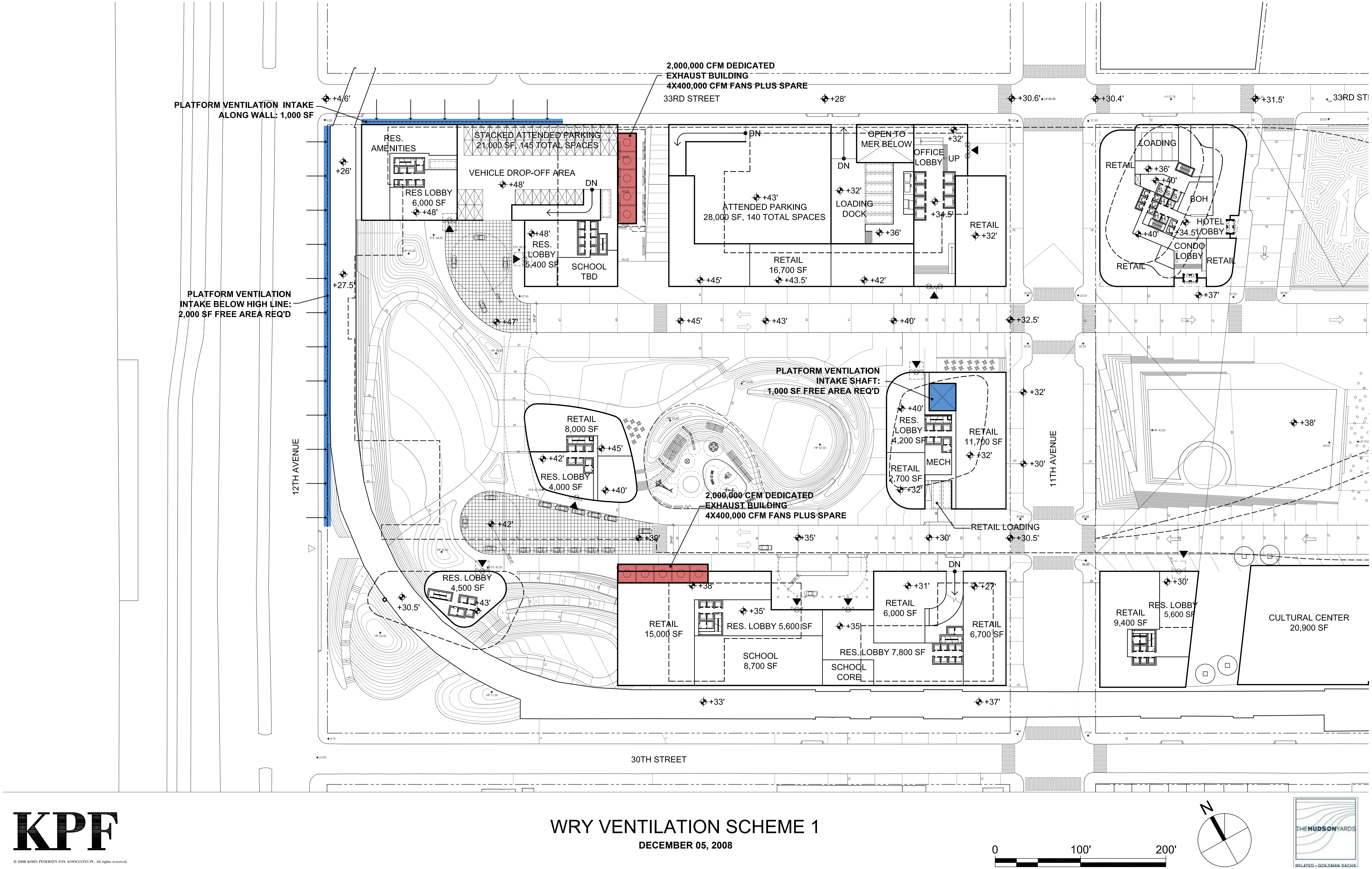
WRY Development Project
Pollutant Emission Rates from 2018 No-Build Developments

Pollutant	Fuel Factors (1)	Proposed Development Size	Annual Fuel Consumption	Estimated Emission Rates		Stack Parameters		
						Height	Diameter	Velocity
	gal/ft²-yr	ft²	gal/year	lb/year	g/sec	meters	meters	m/sec
ERY EC-1 Building								
24-hr SO2	0.38	2,405,000	913,900	25,955	1.363	250.2	1.9812	9.144
24-hr PM2.5				1,947	0.102			
Annual PM2.5				1,947	0.028			
24-hr PM10				2,175	0.114			
ERY EC-2 Building								
24-hr SO2	0.38	2,440,000	927,200	26,332	1.382	275.2	1.9812	9.144
24-hr PM2.5				1,975	0.104			
Annual PM2.5				1,975	0.028			
24-hr PM10				2,207	0.116			
ERY EH-1/ER-3 Building								
24-hr SO2	0.38	1,117,500	424,650	12,060	0.633	250.6	1.0668	9.144
24-hr PM2.5				905	0.047			
Annual PM2.5				905	0.013			
24-hr PM10				1,011	0.053			
ERY ER-1 Building								
24-hr SO2	0.38	690,000	262,200	7,446	0.391	260.0	0.7620	9.144
24-hr PM2.5				558	0.029			
Annual PM2.5				558	0.008			
24-hr PM10				624	0.033			
ERY ER-2 Building								
24-hr SO2	0.38	528,000	200,640	5,698	0.299	172.5	0.7620	9.144
24-hr PM2.5				427	0.022			
Annual PM2.5				427	0.006			
24-hr PM10				478	0.025			
ERY ECF-1 Building								
24-hr SO2	0.38	230,000	87,400	2,482	0.130	33.5	0.508	9.144
24-hr PM2.5				186	0.010			
Annual PM2.5				186	0.003			
24-hr PM10				208	0.011			
Hudson Yard Site 2, 11th Avenue, (Extell), Block 705A								
24-hr SO2	0.38	1,574,930	598,473	16,997	0.892	207.0	1.22	10.2
24-hr PM2.5				1,275	0.067			
Annual PM2.5				1,275	0.018			
24-hr PM10				1,424	0.075			
Hudson Yard Site 3, West 316 11th Avenue, Block 701, Lots 62, 68,70								
24-hr SO2	0.38	315,070	119,727	3,400	0.179	109.1	0.31	5.8
24-hr PM2.5				255	0.013			
Annual PM2.5				255	0.004			
24-hr PM10				285	0.015			
Hudson Yard Site 4, 11th Avenue, Moinian, Block 706A								
24-hr SO2	0.38	1,811,080	688,210	19,545	1.026	287.4	1.22	10.2
24-hr PM2.5				1,466	0.077			
Annual PM2.5				1,466	0.021			
24-hr PM10				1,638	0.086			

WRY Development Project
Pollutant Emission Rates from 2018 No-Build Developments

Related Site 7, 10th Avenue, Block 701, Lots 30, 33, 36, 37, 42, 44								
24-hr SO2	0.38	354,700	134,786	3,828	0.201	101.5	0.31	5.8
24-hr PM2.5				287	0.015			
Annual PM2.5				287	0.004			
24-hr PM10				321	0.017			
Avalon Bay Properties, 11th Avenue, Block 700, Lots 1, 49-61, Part of Site 3 West Chelsea								
24-hr SO2	0.38	510,000	193,800	5,504	0.289	86.0	0.61	5.9
24-hr PM2.5				413	0.022			
Annual PM2.5				413	0.006			
24-hr PM10				461	0.024			
Related Site 6, Midblock 30th Street, Block 701								
24-hr SO2	0.38	337,800	128,364	3,646	0.191	101.5	0.31	5.8
24-hr PM2.5				273	0.014			
Annual PM2.5				273	0.004			
24-hr PM10				306	0.016			
W.Chelsea Site 9, 10th Avenue, Block 700, Lots 27, 32, 34, 38, 42, 44, 45								
24-hr SO2	0.38	77,950	29,621	841	0.044	89.3	0.15	3.9
24-hr PM2.5				63	0.003			
Annual PM2.5				63	0.001			
24-hr PM10				70	0.004			
W.Chelsea Site 52, 547 West 27th Street, Block 699, Lot 5								
24-hr SO2	0.38	115,848	44,022	1,250	0.066	24.1	0.15	3.9
24-hr PM2.5				94	0.005			
Annual PM2.5				94	0.001			
24-hr PM10				105	0.006			
W.Chelsea Site 53, 507 West 27th Street, Block 699, Lots 22-27, 44								
24-hr SO2	0.38	280,526	106,600	3,027	0.159	42.1	0.31	5.8
24-hr PM2.5				227	0.012			
Annual PM2.5				227	0.003			
24-hr PM10				254	0.013			

DIESEL EMISSIONS FROM WRY SITE ANALYSIS



KPF

WRY VENTILATION SCHEME 1

DECEMBER 05, 2008

THE HUDSON YARDS

RELATED + GOLDMAN SACHS

WESTERN RAIL YARD PROJECT

Total Emissions from AMTRAK Ventilation

Pollutant	Peak Emissions		Annual Emissions	
	total	per stack	total	per stack
	g/sec	g/sec	g/sec	g/sec
CO	0.0319	**0.0159**		
NO_2			0.0064	**0.0032**
PM10	0.0032	**0.0016**		
PM2.5	0.0031	**0.0015**	0.0005	**0.0002**

Note: A NO2 to NOx ratio of 0.39 was used.

Stack parameters

Number	2	
Diameter	9.144	m
Radius	4.572	m
Exit velocity	400,000	CFM
	2.9	m/sec

Western Rail Yards Ventilation Study
Locomotive Emissions in 2016

Locomotive Emission Factors

Pollutant	Tier 1	Tier 2	Tier 3	Tier 4
	g/bhp-hr	g/bhp-hr	g/bhp-hr	g/bhp-hr
CO	2.2	1.5	1.5	1.5
NOx	7.4	5.5	5.5	1.3
HC	0.55	0.3	0.3	0.14
VOC	0.58	0.32	0.32	0.15
PM10	0.22	0.14	0.04	0.03
PM2.5	0.213	0.136	0.039	0.029
SO2	0.45	0.45	0.45	0.45
Year of manufacture	1993-2004	2005-2011	2012-2014	after 2015

Notes:
1.Emission factors -- 73 CFR part 126, subpart B: 1033.101
2. VOC EF = 1.053
3. PM2.5 EF= 0.97
4. The use of ultra-low sulfur fuel is mandated for locomotives after 2012. According to EPA Reguatory Impact Analysis PM10 EF will be 0.06 g/bhp-hr lower for Tier 2 and 3.
5. SO2 EF were estimated following EPA NonRoad Model approach based on brake-specific fuel consumption and content of sulfur in fuel.

Locomotive ave fuel	20.8	bhp-hr/gal
consumption	154.97	g/hp-hr
Diesel fuel density	7.1	lb/gal
fract. S conv to PM	0.02247	g PM S/g fuel S
fract. S conv to SO2	2	g SO2/g S
S content of diesel	0.0015	eqv 15 ppm

Train Information

Locomotives per train	2	
HP per Locomotive	3,000	
Average locomotive load factor	44%	
Average Train HP	2,632	
Hotel mode load factor	0.3%	
Hotel mode HP	21	
Average train trip	0.16	ml
Train speed	**10**	mph
Average time in motion	0.016	hr
	56	sec

Pollutant	Tier 1	Hotel Emissions		Moving Emissions		Total Emissions	
		Peak	Annual	Peak	Annual	Peak	Annual
	g/bhp-hr	g/sec	g/sec	g/sec	g/sec	g/sec	g/sec
CO	2.2	0.0263	0.0010	0.00521	0.00372	**0.03153**	**0.00473**
NOx	7.4	0.0885	0.0034	0.01751	0.01252	**0.10604**	**0.01592**
HC	0.55	0.0066	0.0003	0.00130	0.00093	**0.00788**	**0.00118**
VOC	0.58	0.0069	0.0003	0.00137	0.00098	**0.00830**	**0.00125**
PM10	0.22	0.0026	0.0001	0.00052	0.00037	**0.00315**	**0.00047**
PM2.5	0.213	0.0026	0.0001	0.00050	0.00036	**0.00306**	**0.00046**
SO2	0.45	0.0054	0.0002	0.00107	0.00077	**0.00649**	**0.00097**

	Number of trains	Time	
		hr/day	days/year
Hotel Mode	1	6	14
	4	11	14
Motion Mode	5	0.08	261

Note:
Trains at WRY are manufactured in 1998-1999, hence subject to Tier 1 emission standards.

Western Rail Yards Ventilation Study
Diesel Truck Emissions

Pollutant	Moving				Idle				Total	
	EF	Time	Peak	Annual	EF	Time	Peak	Annual	Peak	Annual
	g/ml	d/yr	g/sec	g/sec	g/hr	d/yr	g/sec	g/sec	g/sec	g/sec
CO	1.489	260	8.08E-05	5.75E-05	6.61	260	2.49E-04	1.77E-04	**3.29E-04**	**2.35E-04**
NO_x	3.311	260	1.80E-04	1.28E-04	10.91	260	4.10E-04	2.92E-04	**5.90E-04**	**4.20E-04**
PM10	0.0825	260	4.47E-06	3.19E-06	1.0156	260	3.82E-05	2.72E-05	**4.27E-05**	**3.04E-05**
PM2.5	0.0525	260	2.85E-06	2.03E-06	0.9343	260	3.51E-05	2.50E-05	**3.80E-05**	**2.71E-05**

Trucks	Number	Distance	Speed	Time	
				Moving	**Idle**
		ml	mph	hr	hr
Delivery&Maintenanc	13	0.36	10	0.036	0.25
Garbage	1	10	10	1	0

LOCOMOTIVE EMISSIONS AT ADDITIONAL HOUSING SITE

DRAFT

To: Helen Ginzburg

From: Richard Ray

Date: March 19, 2009

Subject: Diesel Emissions Estimates for HYDC Overbuild at 49th Street to 50th Street in Manhattan

INTRODUCTION

Amtrak Engineering Practice No. EP4006 states that "the development of property resulting in enclosed overbuild structure over tracks shall include design features to ensure adequate ventilation, illumination, emergency egress and fire protection to provide a safety environment for Amtrak employees and customers during normal and emergency operations." Developers building over Amtrak tracks must provide both emergency ventilation for train car fires and normal ventilation for dilution of diesel emissions where diesel locomotives are used that meet the fire-life safety and diesel emissions design criteria for "built-over tunnels" listed in Amtrak's EP4006. The planned construction by the Hudson Yards Development Corporation (HYDC) over active Amtrak Empire Line tracks between 48th and 49th Streets in Manhattan would be subject to Amtrak approval and meeting the requirements of EP4006.

The results of ventilation studies previously performed for the overbuild of the Amtrak Empire Line at Riverside South between 61st Street and 72nd Street in Manhattan indicate that the number and size of ventilation shafts required for overbuilt structures enclosing the Empire Line tracks are dictated by emergency ventilation needs. The emergency ventilation shafts and mechanical exhaust fans provided for emergency ventilation can typically also be used to provide normal ventilation for dilution of diesel engine emissions. Where only natural ventilation systems are provided for train fire emergencies, a separate mechanical exhaust system would be needed to maintain acceptable concentrations of diesel engine exhaust products in the overbuild for stopped or slow-moving trains.

Electricification of the Empire Line ends near 42nd Street, requiring diesel locomotives for powering passenger trains north of 42nd Street. Calculations have been performed to determine estimated emission rates of nitrogen dioxide (NO_2), the critical pollutant for diesel rail tunnels, as well as other diesel engine pollutants from ventilation shafts to be constructed through the HYDC overbuild between 48th and 49th Streets. The calculations were based on notch setting and horsepower usage data provided by MotivePower for the MP36PH-3C diesel locomotive, Tier 2 federal regulation limits for diesel locomotive exhaust pollutants, and assumptions regarding the length of continuous built-over tunnel created by the construction of the HYDC overbuild.

EXISTING CONDITIONS ADJACENT TO HYDC OVERBUILD SITE

Construction of the HYDC overbuild between 48th and 49th Streets will adjoin an existing two-block section of track overbuild to the south (Clinton Mews between 46th and 47th Streets and LEV Parkview Developers between 47th and 48th) and an existing eleven-block section to the north. Completion of the HYDC overbuild will create a continuous 14-block long "built-over tunnel" with the south portal at

46th Street and the north portal at 60th Street. Older overbuilt sections to the north (49th to 51st Streets, 53rd to 58th Streets, and 59th to 60th Streets) may not be completely airtight, with irregularly sized openings to atmosphere located on the sides of the tracks around structural columns and girders supporting bridges and streets above. These openings would serve as exhaust openings for train-driven "piston effect" ventilation during normal train operations.

Based on discussions with Amtrak and the Riverside South ventilation system controls contractor, the LEV Parkview overbuild between 47th and 48th Streets has been provided with a ventilation shaft equipped with two 40 hp jet fans and the Clinton Green overbuild between 51st and 53rd Streets has been provided with a total of four ventilation shafts with two 40 hp exhaust jet fans in each shaft (two shafts per tower with eight jet fans overall). This is a similar ventilation system to that used over much of the Riverside South overbuild between 61st and 72nd Streets. Emission rate calculations for the HYDC overbuild are based on the assumption that ventilation shafts provided by HYDC between 48th and 49th Streets will be the only shafts between the LEV Parkview and Clinton Green overbuilds (i.e., between 48th and 51st Streets).

VENTILATION SHAFT REQUIREMENTS

To determine the number and size of ventilation shafts required at the HYDC overbuild site, emergency ventilation simulations that model an Amfleet coach car fire beneath the HYDC overbuild should be performed. These simulations would need to account for the geometry of the HYDC "built-over tunnel" as well as the connecting "built-over tunnels" to the south and north. Openings to atmosphere along the sides of the track should be field surveyed and accounted for in the tunnel model, as well as shafts or ventilation systems that exist in any adjoining buildings. However, based on the results of ventilation studies conducted previously for the Riverside South overbuild, it can be assumed that ventilation shafts with a minimum total cross-sectional area of approximately 250 square feet placed directly over the Amtrak track area will be required to provide sufficient emergency ventilation during a train car fire.

Overbuild ventilation shafts would need to be equipped with jet fans, or separate centrifugal or axial fans and dampers, to exhaust pollutants generated by diesel locomotives during normal train operations. For moving trains, "piston effect" ventilation through the shafts will normally maintain diesel engine pollutant concentrations at acceptable levels, but a separate mechanical exhaust ventilation system would be needed for idling or slow-moving locomotives. An NO_2 monitoring system would also have to be provided for the built-over track area. If shafts cannot be located over the track area, separate plenums and larger exhaust fan systems may be required to provide adequate emergency ventilation.

SHAFT DIESEL EMISSIONS

The attached emission rate calculations are based on the assumption that no ventilation shafts are provided north of the HYDC overbuild between 49th Street and the Clinton Green overbuild beginning at 51st Street and that all emissions generated by the diesel locomotives (two per train) between 48th and 51st Streets (a total distance of approximately 795 feet) will be exhausted from a shaft, or shafts, in the HYDC overbuild. At a posted speed limit of 25 mph for that portion of the Empire Line, the locomotives will be in the 48th to 51st Street zone for about 22 seconds.

As noted by Bendelius in the *Tunnel Engineering Handbook* (1995), it can be demonstrated that if the oxides of nitrogen (NO_x) from diesel exhaust gas can be maintained within acceptable specified limits, all other diesel exhaust contaminants in a rail tunnel will also be maintained at acceptable concentrations. Nitrogen dioxide (NO_2) concentrations were evaluated for this study, instead of nitrous oxide (NO), because NO_2 has lower 15-minute (5 ppm) and 8-hour (3 ppm) legal exposure limits than NO (25 ppm). According to Hobbs et al. ("Train Generated Air Contaminants in the Train Crew's Working Environment," US Department of Transportation, 1977), approximately 90% (by volume) of the NO_x contained in raw diesel locomotive exhaust is nitric oxide (NO). However, as a result of molecular oxidation caused by high temperatures and exposure to sunlight, some of the NO converts to nitrogen dioxide (NO_2). In ambient air, the conversion rate is quite slow compared to the air exchange rates experienced in tunnels. For the overbuild analysis, total NO_x emitted by the diesel locomotive engine exhaust was conservatively assumed to be comprised of 25% (by weight) NO_2 and 75% NO.

Approximately 21.79 grams (g) of NO_2 would be discharged from the two MP MP36PH-3C diesel locomotives during the 22-second time interval required for the locomotives to move between 48th Street and 51st Street. As many as 54 trains per day are projected to operate along this stretch of track for the Empire LIne, which includes possible future use of these tracks by Metro North Railroad. A total of 1,177 g of NO_2 would be discharged over a 24-hour period from 54 trains, at an average hourly rate of 49.04 g/hour. Assuming a maximum of four trains traveling through this section of track per hour during peak hour usage, the maximum hourly discharge rate of NO_2 would be 87.18 g/hour.

The diesel engine pollutants discharged from the locomotives would be exhausted through the HYDC shaft(s), LEV Parkview shaft, Clinton Green overbuild shafts and the 46th Street portal. Piston action from train movement will draw airflow from the outside atmosphere into the overbuild through the shafts and portals located behind the train and exhaust airflow from the overbuild to the outside atmosphere through the shafts and portals located in front of the train. NO_2 concentration levels are limited to 50 ppm discharge from the shafts by EPA regulations, and as stated previously to 3 ppm for 8-hour time weighted exposure in the tunnels (OSHA). Assuming complete mixing of NO_2 with the ambient tunnel atmosphere, the maximum hourly discharge rate of 87.18 g/hour from moving trains would require approximately 23,500 cfm (ft^3/min.) of airflow through the tunnel to dilute it to 3 ppm. Only 1,400 cfm of airflow would be required to be exhausted from the HYDC shaft(s) to maintain NO_2 concentrations below 50 ppm in the shafts. Previous ventilation system analysis of the overbuild between 61st and 72nd St. indicates that the "piston effect" from trains moving through the overbuild at 25 mph will produce intake or exhaust airflow quantities through the shafts ranging from 10,000 cfm to 220,000 cfm, depending on the location of the train.

For stopped trains that idle in "hotel mode", the average NO_2 emission rate would be approximately 28.44 g/hour, requiring 7,700 cfm of airflow through the overbuilt tunnel to dilute NO_2 concentrations to 3 ppm or less, and only 460 cfm exhausting from the shafts to dilute NO_2 concentrations to less than 50 ppm. Since a stopped train provides no "piston effect", a mechanical ventilation system would be required to dilute NO_2 concentrations to acceptable levels for stopped trains. The calculations were based on complete mixing of the tunnel atmosphere and locomotive exhaust airstream. In reality, the hot gases from the diesel engine exhaust (in excess of 900 degrees Fahrenheit) will layer against the crown of the overbuilt tunnel at an elevation well above the breathing level of railroad workers or train passengers. Exhaust fans with a capacity of 30,000 cfm per shaft, or jet fans, are being used in other built-over portions of the Empire Line to clear high concentrations of NO_2 produced by stopped or slow-moving trains.

HYDC AFFORDABLE HOUSING DEVELOPMENT

AMTRAK VENTILATION EMISSIONS

With Downwash

Pollutant	Time Period	Impact	Background Concentration	Total Concentration	NAAQS	STV	Units
CO	8 hours	0.01	2.9	**2.91**	9		PPM
NO_2	1 year	0.99	71	**71.99**	100		$\mu g/m^3$
PM_{10}	24 hours	0.98	60	**61.0**	150		$\mu g/m^3$
$PM_{2.5}$	24 hours	**0.98**	n/a	n/a	n/a	2 to 5	$\mu g/m^3$
	1 year	**0.1**	n/a	n/a	n/a	0.3	$\mu g/m^3$
SO_2	3 hours	29	202	**231**	1300		$\mu g/m^3$
	24 hours	14	123	**137**	365		$\mu g/m^3$
	1 year	0.8	37	**37.8**	80		$\mu g/m^3$

Direct Impacts

Pollutant	Time Period	Impact	Background Concentration	Total Concentration	NAAQS	STV	Units
CO	8 hours	0.03	2.9	**2.93**	9		PPM
NO_2	1 year	1.8	71	**72.8**	100		PPM
PM_{10}	24 hours	1.96	60	**62.0**	150		$\mu g/m^3$
$PM_{2.5}$	24 hours	**1.96**	n/a	n/a	n/a	2 to 5	$\mu g/m^3$
	1 year	**0.18**	n/a	n/a	n/a	0.3	$\mu g/m^3$
SO_2	3 hours	207	202	**409**	1300		$\mu g/m^3$
	24 hours	32	123	**155**	365		$\mu g/m^3$
	1 year	1.3	37	**38.3**	80		$\mu g/m^3$

HYDC AFFORDABLE HOUSING DEVELOPMENT
AMTRAK VENTILATION EMISSIONS

Pollutant	Moving Trains			
	Peak Hour		Daily Average	
	g/hr	g/sec	g/hr	g/sec
CO	95.10	**0.03**	53.49	**0.015**
NO_2	87.18	**0.02**	49.04	**0.014**
PM_{10}	8.88	**0.002**	4.99	**0.001**
$PM_{2.5}$	8.62	**0.002**	4.85	**0.001**
SO_2	28.53	**0.008**	16.05	**0.004**

AIR TOXIC ANALYSIS

Analysis of the Non-Carcinogenic Toxic Pollutants at Development Site and Additional Housing Sites

Facility Name	Facility Address	Type of Business	NYCDEP Permit No.	Emission Point	CAS Registry No.	Compound	Permitted Emission Rates lb/hr	Permitted Emission Rates lb/year	Est. Short-Term Conc. ug/m^3	NYSDEC SGC ug/m^3	Est. Short-Term Conc. % of SGC	Est. Annual Av. Conc. ug/m^3	NYSDEC AGC ug/m^3	Hazard Index
Development Site														
MIDTOWN NEON SIGN CORP	550 West 30 Street, Manhattan	Spray Booth	PA089687	XONH0001	NY075-00-(	PM10	0.02	24	14.0507	380	3.6975	8.74E-03	50	1.75E-04
					00108-88-3	Toluene	2.16	2,593	1517.478	37,000	4.1013	9.40E-01	400	2.36E-02
FEDERAL EXPRESS CORP	528 West 34 Street, Manhattan	Vehicular Exhaust Removal System	PA044092	XMQ80001	00108-88-3	Toluene	1.18	613	610.013	37,000	1.6486	2.00E-03	400	5.00E-06
					00630-08-0	rbon Monox	22.46	11,679	11610.9	14,000	82.936	2.80E+00	-	2.77E-07
					00124-38-9	arbon Dioxi	176.5	9.18	9.1243	5,400,000	0.0002	2.18E-03	21,000	1.43E-09
NOAN BLOCK	314 11 Avenue, Manhattan	Spray Booth			00108-88-3	Toluene	0.99	495	1047.392	37,000	2.8308	1.26E-09	400	3.16E-12
					00067-63-0	propyl Alco	0.48	240	507.826	98,000	0.5182	6.13E-06	7,000	8.76E-14
					00067-64-1	Acetone	0.49	245	518.406	180,000	0.288	5.58E-06	28,000	2.24E-14
					00123-86-4	Butyl Acetat	0.49	245	518.406	95,000	0.5457	5.70E-06	17,000	3.68E-14
Additional Housing Site: West 48th Street														
BMW of MANHATTAN	547 West 47 Street, Manhattan	Auto Tailpipe Exhaust System	PA046188	XQ3J0001	00108-88-3	Toluene	0.4	1,000	423.1886	37,000	1.1438	9.30E-01	400	2.32E-03
					00630-08-0	rbon Monox	1	2,500	1057.972	14,000	7.5569	2.30E+00	-	-
					10102-44-0	trogen Diox	0.001	2.5	1.0579	-	-	0. 23E-02	100	2.32E-05
Additional Housing Site: West 54th Street														
A & C PIANO CRAFT, INC	333 West 52 Street, Manhattan	Piano Woodwork Machines	PA035996	XFGB0001	NY075-00-(	PM10	0.001	1.6	1.0579	380	0.2784	1.44E-03	50	9.41E-06
LOUIS FERON, INC	333 West 52 Street, Manhattan	Pickling & Melting	PA027886	X3XQ0001	07664-93-9	furic Acid M	0.001	1.5	0.1522	120	0.1268	8.96E-05	1	8.96E-05

Analysis of the Carcinogenic Toxic Pollutants at Additional Housing Sites

Facility Name	NYCDEP Permit No.	Emission Point	CAS Registry No.	Compound	Permitted Emission Rates		NYSDEC AGC	Estimated Annual Conc.	Incremental Cancer Risk
					lb/hr	**lb/year**	**ug/m^3**	**ug/m^3**	**per million**
WEST SIDE CLEANERS	PA019999	XGRW0001	00127-18-4	Tetrachloethylene (PERC)	0.00018	0.276	1.0	0.287E-03	0.287E-03
KIMS CLEANERS	PA011995	X77U0001	00127-18-4	Tetrachloethylene (PERC)	0.015	22.5	1.0	0.414E-02	0.414E-02
NEAT CLEANERS	PB024901	X9XX0001	00127-18-4	Tetrachloethylene (PERC)	0.009	15.22	1.0	0.158E-01	0.158E-01