APPENDIX A

Emission Reduction Calculation Methodology

Appendix A

Emission Reduction Calculation Methodology

A. Introduction

In this appendix, ARB staff discusses the calculation methodology used to determine potential emission reductions from implementing the port truck strategies outlined in this report.

B. Port Truck Population and Age Distribution

1. Population of Trucks in Routine Port Service

Precise port truck population data was not available as we prepared this report. As a result, ARB staff utilized an indirect method (detailed below) to estimate the population of the port truck fleet.

ARB staff utilized Caltrans traffic data to estimate port truck population for the ports of Long Beach, Los Angeles, and Oakland. A port truck population estimated at 12,000 was derived using truck population data from the Caltrans publication "Annual Average Daily Traffic Count on the California State Highway System." The publication details actual counts of specific types of vehicles using California's roadways. ARB staff Used Caltrans traffic volume data for the major arteries servicing the ports of Long Beach, Los Angeles and Oakland (Freeways 710, 110 and 880).

Ports of Long Beach and Los Angeles

- Freeway 710: ARB staff used daily traffic value of 28,550 trips **(~14,000 each direction**) for class 8-14 trucks, at post mile 011.264 from Caltrans Highway Log.
- Freeway 110: ARB staff used daily traffic value of 12,500 trips **(~6,000 each direction**) for class 8-14 trucks, at post mile 09.87 from Caltrans Highway log.

ARB staff then added the two freeway counts together to obtain an estimated total volume of 20,000 trips per day. Assuming 2 round trips per day for an average port truck (which equates to 3-4 containers per day based on conversation with port officials), approximately 10,000 port trucks[1] operate at POLA and POLB per day.

Port of Oakland

- Freeway 880: ARB staff used daily traffic value of 14,300 trips **(~7,000 each direction**) for class 8-14 trucks, at post mile 31.091 from Caltrans Highway Log.

Freeway 880 services more than just the Port of Oakland. Therefore, staff subtracted trips generated from nearby freeways in an attempt to ferret out non-port traffic.

[1] 20,000 trips per day/2 trips per day per truck = 10,000 trucks per day

Subtracting the 3,896 trips[2] from nearby freeways from the 14,300 trips from freeway 880, and, assuming port trucks generated 80 percent of the remaining trips (conversation with CalTrans officials), yield a result of 4,000 trips each direction from port trucks.[3]

Assuming an average port truck makes 3 trips per day (conversation with Port of Oakland officials), a total of 1,333 port trucks operate at the Port of Oakland each day using the freeway. Additionally, according to port officials, approximately 35 percent of the Port of Oakland truck fleet does not use the freeway. Combining the off and on freeway truck fleet yields a population of approximately 2,000[4] port trucks servicing the Port of Oakland.

Thus, a 2005 population of 12,000 trucks (10,000 for POLA and POLB + ~2,000 for Oakland) was derived.

2. Age Distribution

The age distribution for port trucks is based on a 2002 study by Starcrest. Starcrest surveyed ~7,200 trucks operating at three terminals at the ports of Long Beach and Los Angeles. ARB staff assumed that the average port truck age of 12.9 years (derived from Starcrest Study) will remain constant over time in this analysis. Table 1 represents projected baseline fleet age distributions.

Table1: Baseline Port Truck Fleet Age Distribution

Age Group	2005 %	2010 %	2015 %	2020 %
pre-'88	14	3	1	0
88-'93	36	17	3	1
94-'02	49	62	38	12
03-'06	1	16	30	20
07-'09	0	2	22	23
2010+	0	0	6	44
Total	100	100	100	100

3. Population Growth

There is no data available detailing the growth in the port truck fleet compared to container volume growth. ARB staff assumed that half of the future container growth will be satisfied through port truck fleet increases and half through increases in efficiency of port operations and increased use of rail transportation. Assuming a five

[2] 1,490 trips from I-80 and 2,406 trips from freeway 980
[3] Port trips: (14,300 – 3,896) * 0.8 = 8,323 (approximately 4,000 trips each direction)
[4] Oakland truck fleet: 1,333 trucks / .65 = 2,050 trucks (approximately 2,000 trucks)

percent fleet growth rate staff calculated an annual increase of 600 port trucks. The anticipated port truck population through 2020 is presented in Table 2.

Table 2: Estimated port truck population

Year	2005	2010	2015	2020
Number of trucks	12,000	15,000	18,000	21,000

4. Vehicle Miles Traveled

Port truck vehicle miles traveled (VMT) were calculated using the container balancing method. The method is based upon the number of inbound and outbound containers, as well as empty containers being moved out. Staff assumed that the number of containers would be balanced and the flow of ship containers would be consistent with the number of containers being moved by trucks and trains. Table 3 presents the projected VMT for ports trucks.

Table 3: Port Trucks VMT

Year	2005	2010	2015	2020
VMT	66.04	60.1	68.4	77.7

C. Baseline Emissions

ARB staff is currently in the process of developing a new version of California's EMFAC model for estimating emissions from on-road motor vehicles. While this model is not yet complete, we included some recently available data for the trucks considered in this analysis.

At the time of this draft report, the emission inventory numbers are undergoing further review and may result in additional changes in future versions of this report. Baseline port truck emissions for 2005 were based on composite emission rates at 500,000 miles (Table 4). The weighted emission factors were calculated by multiplying the truck fleet percent of population by the composite emission rates (See Table 4).

Table 4: Baseline Emissions (2005) from Existing Port Trucks Fleet

Age Group	Population	Percent of Population (rounded)	Composite Emission Rate		Weighted Composite Emission Rate	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	1,680	14	24.00	3.11	3.26	0.42
88-'93	4,320	36	22.80	2.30	8.16	0.82
94-'02	5,880	49	21.60	1.05	10.58	0.51
03-'06	120	1	15.20	0.62	0.21	0.01
07-'09	0	0	9.17	0.09	0.00	0.00
post 2009	0	0	2.72	0.07	0.00	0.00
Total	12,000	100				
Fleet Emission Rate					22.21	1.77
Per Truck VMT		66.4	Annual Emission NOx			7075
			Annual Emissions PM			564

Baseline emissions for 2005 were calculated as follows:

Baseline NOx = VMT * Weighted Fleet Emission Rate * Number of Days * Number of Vehicles / Conversion Factors

Baseline NOx = 66.04 * 22.21 * 365 * 12,000 / 454 / 2,000 = 7075 TPY

Baseline PM = VMT * Weighted Emission Rate * Number of Days * Number of Vehicles / Conversion Factor

Baseline PM = 66.04 * 1.77 * 365 * 12,000 / 454 / 2,000 = 564 TPY

D. Expected Emission Reductions

1. PM Emission Reduction

To maximize PM emission reductions, ARB staff is proposing replacement of all trucks that can't be retrofitted with DPFs (level 3 PM emission control technologies). Since model year 1994 and later trucks meet 0.1g/bhp-hr PM emission standards and can be equipped with a DPF, all pre-1994 trucks (which do not meet 0.1g/bhp-hr PM emission standards) would have to be replaced. Assuming a typical DPF efficiency of 85 percent[5], we can expect the retrofitted port fleet to experience PM emission reductions of approximately 85 percent. Since all proposed strategies recommend replacement of

[5] ARB – level 3 verified technologies achieve a minimum 85% emission reduction

all pre-1994 trucks and installation of DPFs, PM emission reduction for all strategies would be approximately equal.

2. NOx Emission Reduction

NOx emission reductions can be achieved through fleet modernization programs that replace the older trucks that have higher NOx emissions with newer trucks that have lower NOx emissions. Additionally, reductions can also be achieved through the use of verified reduction technologies, such as a catalyst that reduces NOx emissions by 25 percent.

E. Trucks Replacement Strategies

Strategy 1 requires the replacement of 1993 MY and older trucks with 1998 MY or newer trucks and the installation of DPFs on the entire existing fleet by 2010, as well as place emission requirements on trucks entering port service.

Strategy 2 requires the replacement of 2002 MY (NOx engine standard 4.0 g/bhp-h and 6.0 g/bhp-h) and older trucks with 2003 MY (NOx engine standard 2.5 g/bhp-h) or newer trucks and the installation of DPFs on the entire existing fleet by 2010. Strategy 2 also places the same emission requirements on trucks entering port service as strategy 1.

Strategy 3 would require the replacement of 1993 MY and older trucks with 1998 MY or newer trucks and the installation of DPFs or a DPF / NOx combination system (1994-2002 MY trucks only) on the entire existing fleet by 2010. Like the first two strategies, strategy 3 places the same emission requirements on trucks entering port service. However, strategy 3 also has a second phase which further reduces emissions starting in 2017.

Strategy 3: Phase 2

- By 2017, all pre-2003 trucks must be replaced with trucks meeting 2010 OEM engine standards.

- By 2019, all 2003-2006 existing trucks must be replaced with trucks meeting 2010 OEM engine standards.

The following requirements for trucks entering port service are applicable to all strategies.

- From 2007 – 2011 trucks must meet 2003 OEM engine standards and be equipped with a DPF.

- From 2012 – 2014 trucks must meet 2007 OEM engine standards.

- Beginning in 2015 trucks must meet 2010 OEM engine standards.

F. Emissions Benefits from Proposed Strategies

1. Strategy 1: Truck Upgrades and Emission Benefits - Existing Fleet

a. Truck Upgrades

Staff assumed the 2005 port truck age distribution (Table 1) would remain constant through the start of strategy 1 in 2007. Staff also assumed that most of the truck operators, having the knowledge of an impending funded fleet modernization program, would postpone natural fleet turnover until program implementation in 2010. Staff then assumed that the age distribution of the upgraded trucks would be heavily influenced with 2002 or older MY trucks with some 2003+ MY trucks as shown in Table 5. To determine the number of pre-1994 MY trucks that would need to be upgraded with 1998+ MY trucks, staff summed the pre-1994 MY trucks from the 2005 baseline in Table 5. To determine the number of trucks that would need to be retrofitted with DPFs, staff summed the pre-2007 MY trucks from the 2010 anticipated age distribution in Table 5.

Table 5: Strategy 1 - Age Distributions of Port Trucks after Full Implementation in 2010 - Existing Fleet

Age Group	2005 Baseline		2010		# upgrades	# DPF
	%	# trucks	%	# trucks		
pre-'88	14	1,680	0	0	6,000	11,728
88-'93	36	4,320	0	0		
94-'02	49	5,880	88	10,528		
03-'06	1	120	10	1,200		
07-'09	0	0	2	240		
2010+	0	0	0	32		
Total	100%	12,000	100%	12,000		

b. Emission Benefits

Staff assumed the reduction in emission rates (g/mile) would be proportional to the reductions in total emissions, assuming constant miles traveled. Staff calculated the weighted (Percent of Population x Base Emission Rate) emission rates after the full implementation of strategy 1 – existing fleet (Table 6). Fleet weighted emissions rates are the sums of weighted emission rates for all age groups.

Table 6: Emission Rates after Implementation of Strategy 1
Existing Fleet

Age Group	Population	Percent of Population (rounded)	Composite Emission Rates		Weighted Composite Emission Rates	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0.00	0.00
88 to '93	0	0	22.80	2.30	0.00	0.00
94 to '02	10,528	88	21.60	0.16	19.01	0.14
03 to '06	1,200	10	15.20	0.62	1.52	0.06
07 to '09	240	2	9.17	0.09	0.18	0.00
post 2009	32	0	2.72	0.07	0.00	0.00
Total	12,000	100				
Fleet Emission Rate					20.71	0.20

The percent difference in baseline weighted fleet emission rates (Table 4) and the strategy 1 weighted fleet emission rates (Table 6) is equal to the percent emission reductions[6]. Emission benefits from strategy 1 are presented in Table 7.

Table 7: Emission Benefits from Strategy 1 - Existing Fleet

	Base NOx (2005)	NOx (2010)	NOx Reduction	Base PM (2005)	PM (2010)	PM Reduction
Emission Rate (g/mile)	22.21	20.71	7 %	1.77	0.20	89 %
Emissions (TPY)	7,075			564		
Emission Reductions (TPY)			478			500

c. New Trucks Entering Port Service after 2006

i. From 2007-2011

For calculations purposes, ARB staff assumed that trucks entering port service in 2006 would be MY 1994-2002. From 2007-2011, trucks must meet the 2003 OEM engine standards and be equipped with DPF's.

[6] Assuming constant miles traveled

To determine the number of pre-2003 MY trucks that would need to be replaced with 2003+ MY trucks, staff summed the pre-2003 MY trucks from the 2011 "baseline" in (Table 8).

Table 8: Number of Trucks and Age Distribution Entering Service 2007-2011 (Fleet Growth)

Age Group	2011 "Baseline"		2011 New Fleet
	%	# trucks	# trucks
pre-'88	3	89	0
88-'93	17	504	0
94-'02	62	1,852	600*
03-'06	16	486	2,918
07-'09	2	61	72
2010+	0	8	10
Total	100	3,000	3,600

*600 Trucks entering service in 2006

Emissions Benefits from Trucks Entering Port Service 2006-2011

Given the 2010-2020 "baseline" age distribution (Table 1) and composite emissions rates in g/mile, staff calculated base average weighted emission rates (Percent of Population x Base Emission Rates) for years 2010, 2015 and 2020. Using linear regression staff calculated values for the remaining years (Table 9).

Table 9: Fleet weighted Base Emission Rates in g/mile 2010 to 2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NOx	20.60	19.65	18.71	17.76	16.82	15.87	14.53	13.19	11.85	10.51	9.17
PM	1.24	1.13	1.03	0.92	0.82	0.71	0.63	0.55	0.48	0.40	0.32

Then, staff calculated the weighted average emission rates for the new fleet in 2011 (Table 10).

Table 10: Emission Rates from Trucks Entering Port Service through 2011

Age Group	Population	Percent Of Population	Composite Emission Rates		Weighted Composite Emission Rate	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0.00	0.00
88-'93	0	0	22.80	2.30	0.00	0.00
94-'02	600	17	16.20	0.16	2.70	0.03
03-'06	2,918	81	15.20	0.12	12.32	0.10
07-'09	72	2	9.17	0.09	0.18	0.00
post 2009	10	0	2.72	0.07	0.01	0.00
Total	3,600	100				
Fleet Emission Rate					15.21	0.13

Emission benefits from truck upgrade versus baseline 2011

E = C * VMT * F* D / B

Where:
VMT = Vehicle Miles Traveled
B = Conversion factor from grams to tons
C = Fleet average emissions rates
D = number of trucks in the fleet
F = number of days

NOx emission benefits:

E1 = (19.65-15.21) * 61.76 * 365 * 3,600 / 454 / 2,000 = 397 TPY

PM emission benefits:

E2 = (1.13-0.13) * 61.76 * 365 * 3,600 / 454 / 2,000 = 84 TPY

ii. 2012-2014

From 2012 – 2014 trucks must meet 2007 OEM engine standard. Table 11 presents age distributions of the trucks entering port service in 2012 to 2014. To determine the number of pre-2007 MY trucks that would need to be replaced with 2007+ MY trucks, staff summed the pre-2007 MY trucks from the 2014 “baseline” in (Table 11).

Table 11: Number of Trucks and Age Distribution Entering Service 2012-2014 (Fleet Growth)

Age Group	2014 "Baseline"		2014 New Fleet
	%	# trucks	# trucks
pre-'88	1	15	0
88-'93	3	57	0
94-'02	38	687	0
03-'06	30	538	0
07-'09	22	395	1,692
2010+	6	108	108
Total	100	1,800	1,800

Emissions Benefits from Trucks Entering Port Service 2012-2014

Staff calculated the weighted average emission rates for the fleet in 2014 using the same methodology as described in section b. (Table 12).

Table 12: Emission Rates from Trucks Entering Port Service through 2012-2014

Age Group	Population	Percent Of Population	Composite Emission Rates		Weighted Composite Emission Rates	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0.00	0.00
88-'93	0	0	22.80	2.30	0.00	0.00
94-'02	0	0	16.20	0.16	0.00	0.00
03-'06	0	0	15.20	0.12	0.00	0.00
07-'09	1,692	94	9.17	0.09	8.62	0.08
post 2009	108	6	2.72	0.07	0.16	0.00
Total	1,800	100				
Fleet Emission Rate					8.78	0.09

Emission benefits from trucks upgrade versus baseline 2014 (same methodology as described in section c-i.

NOx emission benefits:

E3= (16.82-8.78) * 66.74 * 365 * 1,800 / 454 / 2,000 = 388 TPY

PM emission benefits:

E4= (0.82-0.09) * 66.74 * 365 * 1,800 / 454 / 2,000 = 35 TPY

iii. 2015-2020

From 2015 – 2020 trucks must meet 2010 OEM engine standard. Table 13 presents age distributions of the trucks entering port service in 2015 to 2020. To determine the number of pre-2010 MY trucks that would need to be replaced with 2010+ MY trucks, staff summed the pre-2010 MY trucks from the 2020 “baseline” in (Table 13).

Table 13: Number of Trucks and Age Distribution Entering Service 2015-2020 (Fleet Growth)

Age Group	2020 "Baseline"		2020 New Fleet
	%	# trucks	# trucks
pre-'88	0	0	0
88-'93	1	37	0
94-'02	12	449	0
03-'06	20	722	0
07-'09	23	816	0
MY 2010+	44	1,573	3,600
Total	100%	3,600	3,600

Emissions Benefits from Trucks Entering Port Pervice 2015-2020

Staff calculated the weighted average emissions rates for the fleet in 2020 using the same methodology as described in section b (Table 14).

Table 14: Emission Rates from Trucks Entering Port Service through 2015-2020

Age Group	Population	Percent Of Population	Composite Emission Rates		Weighted Composite Emission Rates	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0	0
88-'93	0	0	22.80	2.30	0	0
94-'02	0	0	16.20	0.16	0	0
03-'06	0	0	15.20	0.12	0	0
07-'09	0	0	9.17	0.09	0	0
post 2009	3,600	100	2.72	0.07	2.72	0.07
Total	3,600	100				
Fleet Emission Rate					2.72	0.07

Emission benefits from trucks upgrade versus baseline 2020 (same methodology as described in section c- i.

NOx emission benefits:

E5 = (9.17-2.72) * 77.7 * 365 * 3,600 / 454 / 2,000 = 725 TPY

PM emission benefits:

E6 = (0.32-0.07) * 77.7 * 365 * 3,600 / 454 / 2,000 = 28 TPY

2. Strategy 2: Truck Upgrades and Emission Benefits - Existing Fleet

a. Truck Upgrades

Staff assumed that the 2005 port truck age distribution (Table 1) would remain constant through the start of strategy 2 in 2007. Staff again assumed that most of the truck operators, having the knowledge of an impending funded fleet modernization program, would postpone natural fleet turnover until program implementation by 2010. Staff then assumed that the age distribution of the upgraded trucks would be heavily weighted with 2003 MY trucks with some 2007+ MY trucks as shown in Table 15. To determine the number of pre-2003 MY trucks that would need to be replaced with 2003+ MY trucks, staff summed the pre-2003 MY trucks from the 2005 baseline in Table 15. To determine the number of trucks that would need to be retrofitted with DPFs, staff summed the pre-2007 MY trucks from the 2010 anticipated age distribution in Table 15.

Table 15: Strategy 2 - Age Distributions of Port Trucks after Full Implementation Existing Fleet

Age Group	2005 Baseline		2010		# upgrades	# DPF
	%	# trucks	%	# trucks		
pre-'88	14	1,680	0	0	11,728	11,728
88-'93	36	4,320	0	0		
94-'02	49	5,880	0	0		
03-'06	1	120	98	11,728		
07-'09	0	0	2	240		
2010+	0	0	0	32		
Total	100	12,000	100%	12,000		

b. Emission Benefits

Again, staff assumed the reduction in emission rates (g/mile) would be proportional to the reductions in total emissions, assuming constant miles traveled. Staff calculated the weighted (Percent of Population x Base Emission Rate) emission rates after the full implementation of strategy 2 – existing fleet (Table 16). Fleet weighted emissions rates are the sums of weighted emission rates for all age groups.

Table 16: Emission Rates after Implementation of Strategy 2 - Existing Fleet

Age Group	Population	Percent of Population (rounded)	Weighted Emission Rates		Composite Weighted Emission Rates	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0.00	0.00
88-'93	0	0	22.80	2.30	0.00	0.00
94-'02	0	0	21.60	0.16	0.00	0.00
03-'06	11,728	98	15.20	0.12	14.86	0.12
07-'09	240	2	9.17	0.09	0.18	0.00
post 2009	32	0	2.72	0.07	0.00	0.00
Total	12,000	100				
Fleet Emission Rate					15.04	0.12

The percent difference in baseline weighted fleet emission rates (Table 4) and the strategy 2 weighted fleet emission rates (Table 16) is equal to the percent emission reductions[7]. Emission benefits from strategy 2 are presented in Table 17.

Table 17: Emission Benefits from Strategy 2 - Existing Fleet

	Base NOx (2005)	NOx (2010)	NOx Reduction	Base PM (2005)	PM (2010)	PM Reduction
Emission Rate (g/mile)	22.21	15.04	32 %	1.77	0.12	93 %
Emissions (TPY)	7,075			564		
Emission Reductions (TPY)			2,285			525

c. New Trucks Entering Port Service after 2006

Since the new trucks entering port service after 2006 for all strategies have to meet the same requirements, the emission benefits from the new fleet would be equal (see section 1-c-i-ii-iii.

[7] Assuming constant miles traveled

3. Strategy 3: Truck Upgrades and Emission Benefits - Existing Fleet

a. Truck Upgrades

Staff assumed the 2005 port truck age distribution (Table 1) would remain constant through the start of Strategy 3 in 2007. Staff assumed that most of the truck operators, having the knowledge of an impending funded fleet modernization program, would postpone natural fleet turnover until program implementation by 2010. Staff then assumed that the age distribution of the upgraded trucks would be heavily weighted with 2002 or older MY trucks with some 2003+ MY trucks as shown in Table 18. To determine the number of pre-1994 MY trucks that would need to be replaced with 1998+ MY trucks, staff summed the pre-1994 MY trucks from the 2005 baseline in Table 18. To determine the number of trucks that would need to be retrofitted with DPFs, staff summed the 2003-2006 MY trucks from the 2010 anticipated age distribution in Table 18. To determine the number of trucks that would need to be retrofitted with DPFs / NOx systems, staff summed the 1994-2002 MY trucks from the 2010 anticipated age distribution in Table 18.

Table 18: Strategy 3 - Age Distributions of Port Trucks after Full Implementation Existing Fleet

Age Group	2005 Baseline		2010		# upgrades	# DPF	# DPF+ NOx
	%	# trucks	%	# trucks			
pre-'88	14	1,680	0	0	6,000	1,200	10,528
88-'93	36	4,320	0	0			
94-'02	49	5,880	88	10,528			
03-'06	1	120	10	1,200			
07-'09	0	0	2	240			
2010+	0	0	0	32			
Total	100	12,000	100	12,000			

b. Emission Benefits

Again, staff assumed the reduction in emission rates (g/mile) would be proportional to the reductions in total emissions, assuming constant miles traveled. Staff calculated the weighted (Percent of Population x Base Emission Rate) emission rates after the full implementation of strategy 3 – existing fleet (Table 19). Fleet weighted emissions rates are the sums of weighted emission rates for all age groups.

Table 19: Emission Rates after Implementation of Strategy 3
Existing Fleet

Age Group	Population	Percent Of Population	Weighted Emission Rates		Weighted Composite Emission Rates	
			NOx (g/mile)	PM (g/mile)	NOx (g/mile)	PM (g/mile)
Pre '88	0	0	24.00	3.11	0.00	0.00
88-'93	0	0	22.80	2.30	0.00	0.00
94-'02	10,528	88	16.20	0.16	14.21	0.14
03-'06	1,200	10	15.20	0.12	1.52	0.01
07-'09	240	2	9.17	0.09	0.18	0.00
post 2009	32	0	2.72	0.07	0.00	0.00
Total	12,000	100				
Fleet Emission Rate					15.92	0.15

The difference in baseline weighted fleet emission rates (Table 4) and the strategy 3 weighted fleet emission rates (Table 19) is equal to the percent emission reductions[8] (Table 20).

Table 20: Emission Benefits from Strategy 3
Existing Fleet

	Base NOx (2005)	NOx (2010)	NOx Reduction	Base PM (2005)	PM (2010)	PM Reduction
Emission Rate (g/mile)	22.21	15.92	28%	1.77	0.15	91%
Emissions (TPY)	7,075			564		
Emission Reductions (TPY)			2,006			516

Using the same methodology as described above to determine emission benefits for the Strategy 3 existing fleet in 2010; staff calculated the emission benefits from existing fleet in 2015 and 2020 (Table 21).

[8] Assuming constant miles traveled

Table 21: Emission Benefits from Strategy 3 Existing Fleet in 2015 and 2020

	Base NOx (2005)	NOx (2015)	NOx (2020)	NOx Reduction (2015)	NOx Reduction (2020)	Base PM (2005)	PM (2015)	PM (2020)	PM Reduction (2015)	PM Reduction (2020)
Emission Rate (g/mile)	22.21	14.13	4.07	36%	81%	1.77	0.13	0.10	93%	94%
Emissions (TPY)	7,075					564				
Emission Reductions (TPY)				2,574	5,779				523	532

d. Strategy 3: Phase 2 Emission Benefits

Phase 2 of strategy 3 requires accelerated fleet turn over:

- By 2017, all pre-2003 port trucks must be replaced with trucks meeting 2010 OEM engine standards.
- By 2019, all 2003-2006 port trucks must be replaced with trucks meeting 2010 OEM engine standards.

Staff estimates no additional PM benefits from this effort as all trucks are currently equipped with DPFs from Phase 1. Phase 2 would provide additional NOx emission benefits. The port truck fleet would have approximately 25% meeting MY 2007 engine standards and 75% of the fleet meeting 2010 MY engine standards.

To determine the overall emission benefits, staff calculated NOx emission benefits from natural fleet turnover for 2005 – 2020 (base emission reductions – Table 22). Then, staff calculated the NOx emission benefits for 2005 – 2020 for strategy 3 phase 2 implementation.

Total emission reductions from phase 2 of 1,154 TPY in 2017 and 3,576 TPY in 2020 were calculated by subtracting the base emission reductions from phase 2 emissions reductions and adding emission benefits from trucks entering port service (2006 – 2020).

Table 22: Strategy 3: Phase 2 - NOx Emission Benefits

Base Emission Reductions						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Reductions NOx (TPY)	2,006	2431	2855	3280	3704	4,129
Strategy 3 - Phase 2 Emission Reductions						
	2015	2016	2017	2018	2019	2020
Reductions NOx (TPY)	2558	3195	3832	4469	5106	5743
12,000 Existing Fleet Benefits			977			1,614
New Port Fleet Benefits			177			1,962
Total Fleet Reductions NOx (TPY)			1,154			3,576

c. New Trucks Entering Port Service after 2006

Since the new trucks entering port service after 2006 for all strategies have to meet the same requirements, the emission benefits from the new fleet would be equal (see section 1-c-i-ii-iii.