

**Appendix E**  
**Air Quality Assessments**

# SCOUP

# Construction Trucks Emission Analysis

07/14/2024



moffatt & nichol

# Document Verification

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# Outline

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1. Introduction
2. Inputs and Emission Factors
3. Results



01

# Introduction

# Project Background

- › The task corresponds to address the emissions of a construction project with several scenarios for a trucking operation.
- › There are three scenarios of trips per week:

Maximum Monthly Truck Trips	Maximum number of Weekly Truck Trips	Maximum Daily Number of Truck Trips Projected	Maximum Hourly Number of Truck Trips Projected	Intervals (minutes)
3840	960	160	16	3.75
1920	480	80	8	7.5
1440	360	60	6	10

- › There are three durations for the operation for each scenario:
  - 15 weeks
  - 22 weeks
  - 30 weeks
- › The objective of the project is to have an estimate of the emissions of pollutants for each scenario and requirements and compare them to the SCAQMD thresholds (daily).
- › Emissions must include passenger vehicles round trips to the field site.
- › Emissions must include idling for trucks for 10 minutes at site.
- › Only emissions from trucks and passenger cars are included in this analysis as per definition for the project. No other equipment is considered.

# Scenario Notation

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Scenarios	1	2	3
a	960 weekly trips / 15 weeks	480 / 15	360 / 15
b	960 / 22	480 / 22	360 / 22
c	960 / 30	480 / 30	360 / 30

In the following slides, Scenarios will be called as following:

Scenario 1: 960 weekly trips

Scenario 2: 480 weekly trips

Scenario 3: 360 weekly trips

Cases for each scenario:

a) 15 weeks

b) 22 weeks

c) 30 weeks

# Introduction to Emission Task

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- › The objective of the emission task is to obtain the emission projection for the construction project.
- › Emissions came from construction trucks used in the project and the trips from and to the construction site.
- › The list of equipment considering in the emission analysis include:
  - › Strong Arms
  - › Bottom Dumps
  - › Super 10s
- › The calculation was done using Emissions Estimation formula with EMFAC model emission factors.
- › There is little information on the characteristics of the trucks, such as horsepower, age and mileage. Therefore, the calculation must consider the data that we are certain about: Travel time/distance and Idling time at site.



# 02

## Inputs and Emission Factors

# Inputs

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- › Weekly number of truck trips
- › Durations of the Project
- › Distance to the construction site (15 miles)
- › Idling time in the construction site (10 minutes)
- › Passenger vehicles round trip (37 miles)
- › Passenger vehicle daily trips (10)

# Emission Factors Running Engine (grams/mile)

NOx_RUNEX	PM2.5_RUNEX	PM10_RUNEX	CO2_RUNEX	CH4_RUNEX	N2O_RUNEX	ROG_RUNEX	TOG_RUNEX	NH3_RUNEX	SOx_RUNEX	CO_RUNEX
1.1377	0.0131	0.0137	1,551.5748	0.0716	0.2484	0.0124	0.0854	0.2755	0.0139	0.4915

Strong Arms, Bottom Dumps, Super 10s are classified T7 Class 8 in EMFAC Model (2021 version for 2025 calendar year):

Using Los Angeles area distribution:

- Diesel Single Dump: 22.88%
  - Electricity Single Dump: 0.26%
  - Natural Gas Single Dump: 1.65%
  - Diesel Other: 68.98%
  - Electricity Other: 0.94%
  - Natural Gas Other: 5.28%
- Aggregating all Emission Factors, we obtain an averaged representative value for T7 Class 8.

# Emission Factors Idling Engine (grams/hour)

NOx_IDLEX	PM2.5_IDLEX	PM10_IDLEX	CO2_IDLEX	CH4_IDLEX	N2O_IDLEX	ROG_IDLEX	TOG_IDLEX	SOx_IDLEX	CO_IDLEX
0.8648	0.0006	0.0007	199.1110	0.0923	0.0326	0.0732	0.1726	0.0016	1.2238

Strong Arms, Bottom Dumps, Super 10s are classified T7 Class 8 in EMFAC Model (2021 version for 2025 calendar year):

Using Los Angeles area distribution:

- Diesel Single Dump: 22.88%
  - Electricity Single Dump: 0.26%
  - Natural Gas Single Dump: 1.65%
  - Diesel Other: 68.98%
  - Electricity Other: 0.94%
  - Natural Gas Other: 5.28%
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- Aggregating all Emission Factors, we obtain an averaged representative value for T7 Class 8.
  - There are no NH3 idling emissions in the EMFAC Model.

# Emission Factors Running Passenger Vehicle: Vehicle Share (EMFAC Model)

Region	Calendar Year	Vehicle Category	Fuel	Population	Total VMT	%
Los Angeles (SC)	2025LDA		Gasoline	3261717.882	128067964.6	47.59%
Los Angeles (SC)	2025LDA		Diesel	8115.47098	234266.2649	0.09%
Los Angeles (SC)	2025LDA		Electricity	193284.3415	9414235.572	3.50%
Los Angeles (SC)	2025LDA		Plug-in Hybrid	98452.19235	4526938.566	1.68%
Los Angeles (SC)	2025LDT1		Gasoline	307303.6162	11174163.84	4.15%
Los Angeles (SC)	2025LDT1		Diesel	107.1360043	2101.61697	0.00%
Los Angeles (SC)	2025LDT1		Electricity	1046.875547	45556.73451	0.02%
Los Angeles (SC)	2025LDT1		Plug-in Hybrid	677.1342963	34223.91571	0.01%
Los Angeles (SC)	2025LDT2		Gasoline	1598846.897	65845213.92	24.47%
Los Angeles (SC)	2025LDT2		Diesel	5200.085859	223595.1163	0.08%
Los Angeles (SC)	2025LDT2		Electricity	14017.6954	505882.2277	0.19%
Los Angeles (SC)	2025LDT2		Plug-in Hybrid	16355.85292	792451.7915	0.29%
Los Angeles (SC)	2025LHD1		Gasoline	123869.9548	4952849.986	1.84%
Los Angeles (SC)	2025LHD1		Diesel	58715.67018	2596323.511	0.96%
Los Angeles (SC)	2025LHD1		Electricity	1406.155134	98271.34501	0.04%
Los Angeles (SC)	2025LHD2		Gasoline	18894.4929	706862.803	0.26%
Los Angeles (SC)	2025LHD2		Diesel	26698.07852	1155746.821	0.43%
Los Angeles (SC)	2025LHD2		Electricity	363.0686742	24101.85724	0.01%
Los Angeles (SC)	2025MCY		Gasoline	150473.4563	988230.8863	0.37%
Los Angeles (SC)	2025MDV		Gasoline	952282.7935	36302116.46	13.49%
Los Angeles (SC)	2025MDV		Diesel	11031.50419	427142.2782	0.16%
Los Angeles (SC)	2025MDV		Electricity	15185.9899	547666.3841	0.20%
Los Angeles (SC)	2025MDV		Plug-in Hybrid	9770.106857	434969.1711	0.16%

# Emission Factors Running Engine (grams/mile): Passenger Vehicles

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NO <sub>x</sub> _RUNEX	PM2.5_RUNEX	PM10_RUNEX	CO <sub>2</sub> _RUNEX	CH <sub>4</sub> _RUNEX	N <sub>2</sub> O_RUNEX	ROG_RUNEX	TOG_RUNEX	NH <sub>3</sub> _RUNEX	SO <sub>x</sub> _RUNEX	CO_RUNEX
0.0757	0.0016	0.0017	314.6772	0.0039	0.0068	0.0183	0.0253	0.0369	0.0031	0.8895

- › Used share of vehicles from typical passenger distribution in California.

# Emission Formula

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Equation 6.1

$$E = \textit{Activity} \times \textit{EF}$$

Where:

$E$  = Emissions (grams/year)

$\textit{Activity}$  = Activity (average number of miles driven per truck, hours of idle operation)

$\textit{EF}$  = Emission factor (amount of pollutant emitted per unit of activity), g/mile or g/hour



# 03

## Results

# Truck Idling: Scenario 1

Scenario 1				NOx IDLEX	PM2.5 IDLEX	PM10 IDLEX	CO2 IDLEX	CH4 IDLEX	N2O IDLEX	ROG IDLEX	TOG IDLEX	SOx IDLEX	CO IDLEX
			g/day	20.7563	0.0150	0.0158	4,778.6640	2.2151	0.7822	1.7559	4.1432	0.0393	29.3723
			g/hour	0.8648	0.0006	0.0007	199.1110	0.0923	0.0326	0.0732	0.1726	0.0016	1.2238
	Trip	10	Minutes	0.1441	0.0001	0.0001	33.1852	0.0154	0.0054	0.0122	0.0288	0.0003	0.2040
	Weekly 1	960	Metric Tons	0.0001	0.0000	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
a)	Weeks	15	Metric Tons	0.0021	0.0000	0.0000	0.4779	0.0002	0.0001	0.0002	0.0004	0.0000	0.0029
b)	Weeks	22	Metric Tons	0.0030	0.0000	0.0000	0.7009	0.0003	0.0001	0.0003	0.0006	0.0000	0.0043
c)	Weeks	30	Metric Tons	0.0042	0.0000	0.0000	0.9557	0.0004	0.0002	0.0004	0.0008	0.0000	0.0059

Idling produces 0.48 metric tons of CO2 emissions for a 15-week Project, 0.7 metric tons for a 22-week Project and 0.96 metric tons for a 30-week Project.

# Idling Emission (lb per Day) for Three Scenarios

	Trips per day/Length		NOx IDLEX	PM2.5 IDLEX	PM10 IDLEX	CO2 IDLEX	CH4 IDLEX	N2O IDLEX	ROG IDLEX	TOG IDLEX	SOx IDLEX	CO IDLEX
Trip	10 Minutes		0.1441	0.0001	0.0001	33.1852	0.0154	0.0054	0.0122	0.0288	0.0003	0.2040
<b>Scenario 1</b>	<b>160</b>		23.0625	0.0167	0.0175	5,309.6266	2.4613	0.8691	1.9510	4.6035	0.0436	32.6359
Lb per day			0.0508	0.0000	0.0000	11.7057	0.0054	0.0019	0.0043	0.0101	0.0001	0.0719

	Trips per day/Length		NOx IDLEX	PM2.5 IDLEX	PM10 IDLEX	CO2 IDLEX	CH4 IDLEX	N2O IDLEX	ROG IDLEX	TOG IDLEX	SOx IDLEX	CO IDLEX
Trip	10 minutes		0.1441	0.0001	0.0001	33.1852	0.0154	0.0054	0.0122	0.0288	0.0003	0.2040
<b>Scenario 2</b>	<b>80</b>		11.5313	0.0083	0.0088	2,654.8133	1.2306	0.4346	0.9755	2.3018	0.0218	16.3179
Lb per day			0.0254	0.0000	0.0000	5.8529	0.0027	0.0010	0.0022	0.0051	0.0000	0.0360

	Trips per day/Length		NOx IDLEX	PM2.5 IDLEX	PM10 IDLEX	CO2 IDLEX	CH4 IDLEX	N2O IDLEX	ROG IDLEX	TOG IDLEX	SOx IDLEX	CO IDLEX
Trip	10 minutes		0.1441	0.0001	0.0001	33.1852	0.0154	0.0054	0.0122	0.0288	0.0003	0.2040
<b>Scenario 3</b>	<b>60</b>		8.6484	0.0062	0.0066	1,991.1100	0.9230	0.3259	0.7316	1.7263	0.0164	12.2384
Lb per day			0.0191	0.0000	0.0000	4.3896	0.0020	0.0007	0.0016	0.0038	0.0000	0.0270

# Passenger Vehicles: Scenario 1

Scenario 1				NOx_	PM2.5_	PM10_	CO2_	CH4_	N2O_	ROG_	TOG_	NH3_	SOx_	CO_
			g/mile	0.0757	0.0016	0.0017	314.6772	0.0039	0.0068	0.0183	0.0253	0.0369	0.0031	0.8895
	Trip	37	miles	g/trip	2.8006	0.0599	0.0647	11,643.0578	0.1452	0.2532	0.6759	0.9349	1.3666	32.9107
	Weekly 1	50		Grams	140.0276	2.9949	3.2340	582,152.8917	7.2591	12.6610	33.7971	46.7429	68.3297	1,645.5340
<b>a)</b>	<b>Weeks</b>	<b>15</b>		Metric Tons	0.0021	0.0000	0.0000	8.7323	0.0001	0.0002	0.0005	0.0007	0.0010	0.0247
<b>b)</b>	<b>Weeks</b>	<b>22</b>		Metric Tons	0.0031	0.0001	0.0001	12.8074	0.0002	0.0003	0.0007	0.0010	0.0015	0.0362
<b>c)</b>	<b>Weeks</b>	<b>30</b>		Metric Tons	0.0042	0.0001	0.0001	17.4646	0.0002	0.0004	0.0010	0.0014	0.0020	0.0494
	lb per Day	10		Lb	0.06	0.00	0.00	256.69	0.00	0.01	0.01	0.02	0.03	0.73

Passenger vehicles produce 8.73 metric tons of CO2 for a 15-week project, 12.81 metric tons for a 22-week project and 17.46 metric tons for a 30-week project.

In pounds per day, the total CO2 emissions produced is 256.69 lb per day.

# Scenario 1, 960 Trips per Week: Total Emission

Scenario 1					NOx	PM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
					1.1377	0.0131	0.0137	1,551.5748	0.0716	0.2484	0.0124	0.0854	0.2755	0.0139	0.4915
	Trip	15	miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
	Idle			Metric Tons	0.0001	0.0000	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
	Weekly 1	960		Metric Tons	0.0164	0.0002	0.0002	22.3427	0.0010	0.0036	0.0002	0.0012	0.0040	0.0002	0.0071
	Passenger			Metric Tons	0.0001	0.0000	0.0000	0.5822	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0016
<b>a)</b>	<b>Weeks</b>	<b>15</b>		Metric Tons	<b>0.2499</b>	<b>0.0029</b>	<b>0.0030</b>	<b>344.3508</b>	<b>0.0158</b>	<b>0.0539</b>	<b>0.0034</b>	<b>0.0196</b>	<b>0.0605</b>	<b>0.0031</b>	<b>0.1338</b>
<b>b)</b>	<b>Weeks</b>	<b>22</b>		Metric Tons	<b>0.3666</b>	<b>0.0042</b>	<b>0.0044</b>	<b>505.0478</b>	<b>0.0232</b>	<b>0.0791</b>	<b>0.0049</b>	<b>0.0287</b>	<b>0.0888</b>	<b>0.0045</b>	<b>0.1962</b>
<b>c)</b>	<b>Weeks</b>	<b>30</b>		Metric Tons	<b>0.4999</b>	<b>0.0058</b>	<b>0.0060</b>	<b>688.7016</b>	<b>0.0316</b>	<b>0.1079</b>	<b>0.0067</b>	<b>0.0391</b>	<b>0.1211</b>	<b>0.0062</b>	<b>0.2676</b>

This scenario produces 344.35 metric tons (MT) of CO2 for 15 weeks, 505.05 MT of CO2 when Project lasts 22 weeks and 688.7 MT of CO2 for the Project lasting 30 weeks.

# Scenario 2, 480 Trips per Week: Total Emissions

Scenario 2					NOx	PM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
	Trip	15	miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
	Idle			Metric Tons	0.0001	0.0000	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
	Weekly 2	480		Metric Tons	0.0082	0.0001	0.0001	11.1714	0.0005	0.0018	0.0001	0.0006	0.0020	0.0001	0.0035
	Passenger			Metric Tons	0.0001	0.0000	0.0000	0.5822	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0016
<b>a)</b>	<b>Weeks</b>	<b>15</b>		Metric Tons	<b>0.1271</b>	<b>0.0015</b>	<b>0.0015</b>	<b>176.7805</b>	<b>0.0081</b>	<b>0.0271</b>	<b>0.0020</b>	<b>0.0103</b>	<b>0.0308</b>	<b>0.0016</b>	<b>0.0807</b>
<b>b)</b>	<b>Weeks</b>	<b>22</b>		Metric Tons	<b>0.1863</b>	<b>0.0021</b>	<b>0.0022</b>	<b>259.2780</b>	<b>0.0118</b>	<b>0.0397</b>	<b>0.0030</b>	<b>0.0152</b>	<b>0.0451</b>	<b>0.0023</b>	<b>0.1184</b>
<b>c)</b>	<b>Weeks</b>	<b>30</b>		Metric Tons	<b>0.2541</b>	<b>0.0029</b>	<b>0.0031</b>	<b>353.5609</b>	<b>0.0161</b>	<b>0.0542</b>	<b>0.0040</b>	<b>0.0207</b>	<b>0.0616</b>	<b>0.0032</b>	<b>0.1614</b>

This scenario produces 176.78 MT of CO2 for 15 weeks, 259.28 MT of CO2 when Project lasts 22 weeks and 353.56 MT of CO2 for the Project lasting 30 weeks.

# Scenario 3, 360 Trips per Week: Total Emissions

Scenario 3				NOx	PM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
Trip	15	miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
Idle			Metric Tons	0.0001	0.0000	0.0000	0.0319	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
Weekly 3	360		Metric Tons	0.0061	0.0001	0.0001	8.3785	0.0004	0.0013	0.0001	0.0005	0.0015	0.0001	0.0027
Passenger			Metric Tons	0.0001	0.0000	0.0000	0.5822	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0016
<b>a) Weeks</b>	<b>15</b>		Metric Tons	<b>0.0963</b>	<b>0.0011</b>	<b>0.0012</b>	<b>134.8879</b>	<b>0.0061</b>	<b>0.0204</b>	<b>0.0017</b>	<b>0.0080</b>	<b>0.0233</b>	<b>0.0012</b>	<b>0.0674</b>
<b>b) Weeks</b>	<b>22</b>		Metric Tons	<b>0.1413</b>	<b>0.0016</b>	<b>0.0017</b>	<b>197.8356</b>	<b>0.0090</b>	<b>0.0299</b>	<b>0.0025</b>	<b>0.0118</b>	<b>0.0342</b>	<b>0.0018</b>	<b>0.0989</b>
<b>c) Weeks</b>	<b>30</b>		Metric Tons	<b>0.1927</b>	<b>0.0022</b>	<b>0.0023</b>	<b>269.7758</b>	<b>0.0123</b>	<b>0.0408</b>	<b>0.0034</b>	<b>0.0161</b>	<b>0.0467</b>	<b>0.0024</b>	<b>0.1349</b>

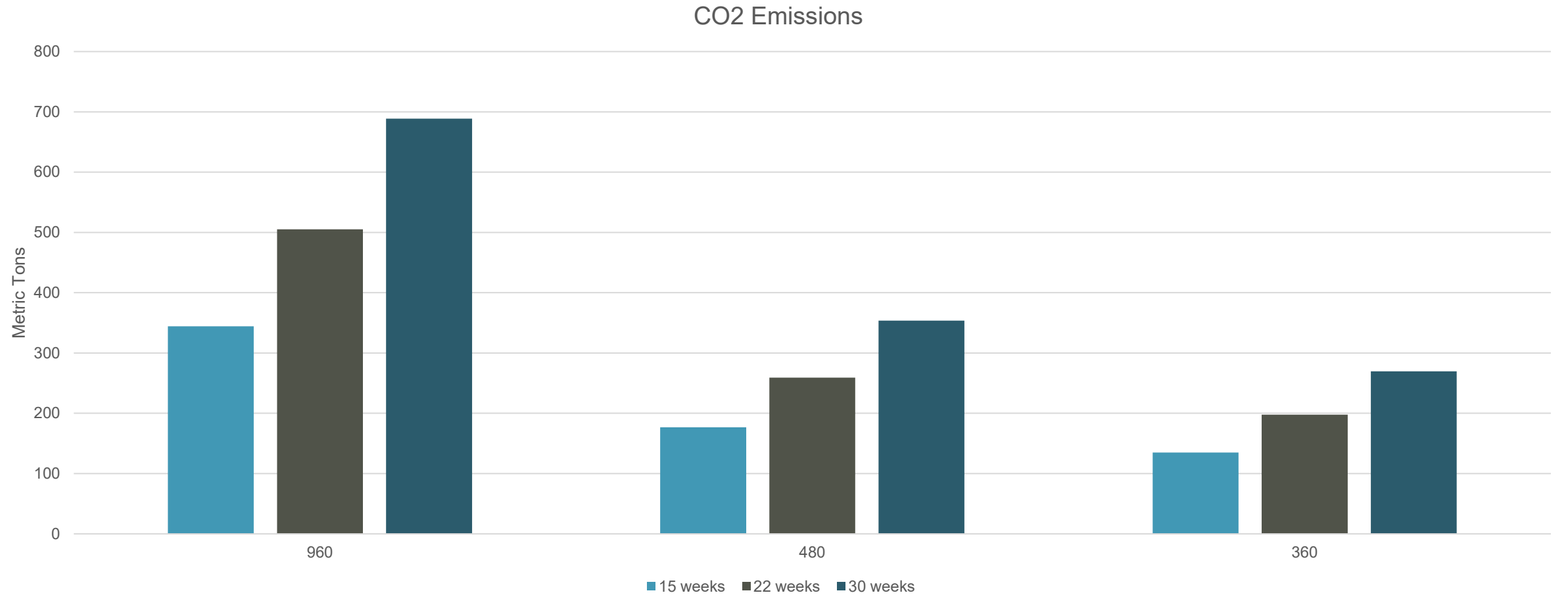
This scenario produces 134.89 MT of CO2 for 15 weeks, 197.84 MT of CO2 when Project lasts 22 weeks and 269.78 MT of CO2 for the Project lasting 30 weeks.

# Summary of Scenario results – total annual CO2 emissions (tons)

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Cases \ Scenarios	1: 960 weekly trips	2: 480 weekly trips	3: 360 weekly trips
a) 15 weeks	344.35	176.78	134.89
b) 22 weeks	505.05	259.28	197.84
c) 30 weeks	688.7	353.56	269.78

# Results: Summary – Total Emissions



# SCAQMD thresholds

- › NO<sub>x</sub>: 100 lb/day
- › VOC: 75 lb/day
- › PM<sub>10</sub>: 150 lb/day
- › PM<sub>2.5</sub>: 55 lb/day
- › SO<sub>x</sub>: 150 lb/day
- › CO: 550 lb/day
- › Lead: 3 lb/day



## South Coast Air Quality Management District

21865 Copley Drive, Diamond Bar, CA 91765-4178  
(909) 396-2000 • [www.aqmd.gov](http://www.aqmd.gov)

**South Coast AQMD Air Quality Significance Thresholds**

<b>Mass Daily Thresholds <sup>a</sup></b>		
<b>Pollutant</b>	<b>Construction</b>	<b>Operation</b>
<b>NO<sub>x</sub></b>	100 lbs/day	55 lbs/day
<b>VOC</b>	75 lbs/day	55 lbs/day
<b>PM<sub>10</sub></b>	150 lbs/day	150 lbs/day
<b>PM<sub>2.5</sub></b>	55 lbs/day	55 lbs/day
<b>SO<sub>x</sub></b>	150 lbs/day	150 lbs/day
<b>CO</b>	550 lbs/day	550 lbs/day
<b>Lead</b>	3 lbs/day	3 lbs/day

# 160 daily trips (960 weekly trips): Daily Emission

			NOx	IPM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
			1.1377	0.0131	0.0137	1,551.5748	0.0716	0.2484	0.0124	0.0854	0.2755	0.0139	0.4915
Trip	15 miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
Daily1	160	grams	2,730.5253	31.5365	32.9746	3,723,779.5177	171.8254	596.1921	29.6583	205.0594	661.1823	33.3174	1,179.7085
Pound		Lb	6.0198	0.0695	0.0727	8,209.5286	0.3788	1.3144	0.0654	0.4521	1.4577	0.0735	2.6008
Idle		Lb	0.0508	0.0000	0.0000	11.7057	0.0054	0.0019	0.0043	0.0101		0.0001	0.0719
Passenger		lb	0.0617	0.0013	0.0014	256.6855	0.0032	0.0056	0.0149	0.0206	0.0301	0.0025	0.7256
<b>Total</b>		<b>lb</b>	<b>6.1324</b>	<b>0.0709</b>	<b>0.0742</b>	<b>8,477.9198</b>	<b>0.3874</b>	<b>1.3219</b>	<b>0.0846</b>	<b>0.4828</b>	<b>1.4878</b>	<b>0.0761</b>	<b>3.3983</b>
Threshold		lb	100	55	150	N/A	N/A	N/A	75	N/A	N/A	150	550

All total values of pollutants are below SCAQMD thresholds.

CO2 emissions are 8,477.92 lb per day.

# 80 daily trips (480 weekly trips): Daily Emission

			NOx	PM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
			1.1377	0.0131	0.0137	1,551.5748	0.0716	0.2484	0.0124	0.0854	0.2755	0.0139	0.4915
Trip	15 miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
Daily1	160	grams	1,365.2626	15.7683	16.4873	1,861,889.7589	85.9127	298.0960	14.8291	102.5297	330.5912	16.6587	589.8542
Pound		Lb	3.0099	0.0348	0.0363	4,104.7643	0.1894	0.6572	0.0327	0.2260	0.7288	0.0367	1.3004
Idle		Lb	0.0254	0.0000	0.0000	5.8529	0.0027	0.0010	0.0022	0.0051		0.0000	0.0360
Passenger		lb	0.0617	0.0013	0.0014	256.6855	0.0032	0.0056	0.0149	0.0206	0.0301	0.0025	0.7256
<b>Total</b>		<b>lb</b>	<b>3.0971</b>	<b>0.0361</b>	<b>0.0378</b>	<b>4,367.3026</b>	<b>0.1953</b>	<b>0.6637</b>	<b>0.0497</b>	<b>0.2517</b>	<b>0.7590</b>	<b>0.0393</b>	<b>2.0619</b>
Threshold		lb	100	55	150	N/A	N/A	N/A	75	N/A	N/A	150	550

All pollutants follow SCAQMD thresholds.

CO2 emissions are 4,367.3 lb per day.

# 60 daily trips (360 weekly trips): Daily Emission

			NOx	PM2.5	PM10	CO2	CH4	N2O	ROG	TOG	NH3	SOx	CO
			1.1377	0.0131	0.0137	1,551.5748	0.0716	0.2484	0.0124	0.0854	0.2755	0.0139	0.4915
Trip	15 miles	g/trip	17.0658	0.1971	0.2061	23,273.6220	1.0739	3.7262	0.1854	1.2816	4.1324	0.2082	7.3732
Daily1	160	grams	1,023.9470	11.8262	12.3655	1,396,417.3192	64.4345	223.5720	11.1219	76.8973	247.9434	12.4940	442.3907
Pound		Lb	2.2574	0.0261	0.0273	3,078.5732	0.1421	0.4929	0.0245	0.1695	0.5466	0.0275	0.9753
Idle		Lb	0.0191	0.0000	0.0000	4.3896	0.0020	0.0007	0.0016	0.0038		0.0000	0.0270
Passenger		lb	0.0617	0.0013	0.0014	256.6855	0.0032	0.0056	0.0149	0.0206	0.0301	0.0025	0.7256
<b>Total</b>		<b>lb</b>	<b>2.3382</b>	<b>0.0274</b>	<b>0.0287</b>	<b>3,339.6483</b>	<b>0.1473</b>	<b>0.4992</b>	<b>0.0410</b>	<b>0.1939</b>	<b>0.5767</b>	<b>0.0301</b>	<b>1.7278</b>
Threshold		lb	100	55	150	N/A	N/A	N/A	75	N/A	N/A	150	550

All pollutants follow SCAQMD thresholds.

CO2 emissions are 3,339.65 lb per day.

# Conclusions

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- › An emission analysis was performed using available data, assumptions on characteristics of the construction project and standardized methodology provided by the EMFAC model and Emission estimation formulas for vehicles. The analysis shows that the project is within daily thresholds under the SCAQMD regulation.
- › The Project produces a maximum of 680.7 metric tons of CO<sub>2</sub> for the whole duration. This happens for Scenario 1 (960 weekly trips). Scenario 2 produces a maximum of 353.56 metric tons of CO<sub>2</sub> and Scenario 3 a total of 269.78 metric tons under the longest Project. In a daily basis this means 8,477.92 lb per day of CO<sub>2</sub> for Scenario 1. This is aligned with a 2025 approved fleet of trucks under the T7 classification using the benchmark of a California typical fleet.

**Thank you**

**SCOUP**

# **Construction Rail Freight Emission Analysis**

07/15/2024



moffatt & nichol

# Document Verification

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**Client:**

**Project name:** SCOUP

**Document title:** Emission Analysis

**Document sub-title:** N/A

**Status:** Draft

**Date:** 07/15/2025

**Project number:** 210606/14

**File reference:**

**Source data:** N/A

Version	Description	Date	Prepared by	Verified by	Approved by
A	Initial Draft for Review	07/15/2025	FG	AZ	--
B	Draft	07/17/2025	--	--	--

# Outline

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1. Introduction
2. Inputs and Emission Factors
3. Results



01

# Introduction

# Project Background

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- › For a construction project in California, a rail service is programmed for moving cargo related to the project.
- › This rail service consists of 100 cargo cars and is planned to use 100% new 4400 BHP locomotives (Tier 4).
- › The service is set to operate once per week for 54 weeks.
- › Emissions must be calculated for this rail service, comparing them to the SCAQMD thresholds.
- › The projected emissions will be compared to an average rail service using current day locomotives ranging from Tier 0 to Tier 4 following statistics from CARB.
- › Daily emissions for the rail service will be added to the truck emissions of the same construction project. The combined emission will also be compared to the SCAQMD thresholds.



02

## Inputs and Emission Factors

# Inputs

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- › Number of weekly trips (1 per week)
- › Maximum number of weeks (54)
- › Length of the round trip (19.8 miles)
- › Speed of the trip (30 miles per hour, therefore each trip takes 0.66 hours)
- › Engine Power (4,400 BHP)
- › Idling time at site (8 hours per trip)

# Emission Factors for Long Haul Rail Services (grams per bhp-hr)

**Table 1 - Line-Haul Emission Factors (g/bhp-hr)**

	PM <sub>10</sub>	HC	NO <sub>x</sub>	CO
UNCONTROLLED	0.32	0.48	13.00	1.28
TIER 0	0.32	0.48	8.60	1.28
TIER 0+	0.20	0.30	7.20	1.28
TIER 1	0.32	0.47	6.70	1.28
TIER 1+	0.20	0.29	6.70	1.28
TIER2	0.18	0.26	4.95	1.28
TIER 2+ & TIER 3	0.08	0.13	4.95	1.28
TIER 4	0.015	0.04	1.00	1.28

+ INDICATES THAT THESE ARE THE REVISED STANDARDS IN 40 CFR PART 1033

EPA suggests g/bhp-hr or g/gal (fuel consumption) for estimating emissions.

**From EPA-420-F09-025: Emission Factors for Locomotives – Technical Highlights**

# Emission Factors Idling Engine

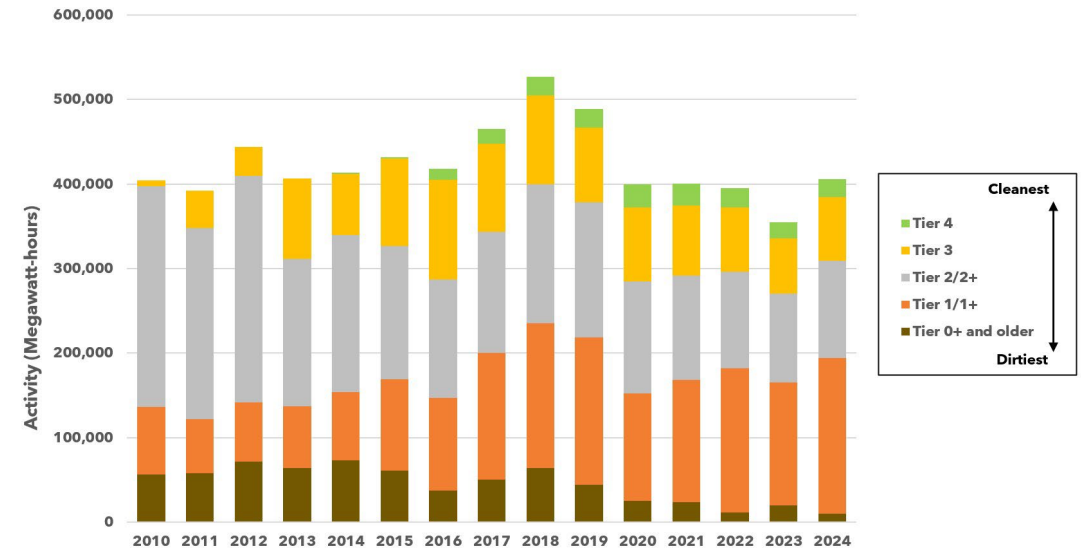
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- › EPA Locomotive Emission Standards, 40 CFR Part 1033 recommends using 4% of rated power for idling in Tier 0 to Tier 2 engines and 3% of rated power for Tier 3 to Tier 4 engines. This values are used as Load Factor for the idling engine when calculating emissions.
- › Emission factors stay the same for 4,400 BHP engines.

# 2024 Locomotive Share by CARB

A weighted average of the statistics reported by CARB on the usage of Union Pacific and BNSF locomotives allows to generate a weighted emission factor for each pollutant in grams per bhp-hr.

Tier	Union Pacific	MWh	BNSF Railway	MWh	Average
Pre Tier 0	0.04%	73	0.27%	553	0.15%
Tier 0	2.64%	5,286	2.03%	4,067	2.30%
Tier 1	51.29%	102,502	40.90%	81,754	45.39%
Tier 2	26.22%	52,412	31.36%	62,681	28.35%
Tier 3	14.71%	29,406	23.02%	46,001	18.58%
Tier 4	5.10%	10,188	5.50%	10,984	5.22%



## Aggregated Emission Factor Combining UP and BNSF Fleet Mixing

PM	HC	NOX	CO
0.22	0.33	5.63	1.28

# Emission Factors for PM25 and VOC

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- › EPA recommends using the following emission factors for PM2.5 and VOC (Volatile Organic Compound):
  - › PM2.5 is set to be 0.97 times the Particulate Matter (PM).
  - › VOC is set to be 1.053 times the Hydrocarbons (HC).
  
- › EPA doesn't have specific emission factors for CO2 or SOX for rail freight. A calculation of those pollutants requires knowledge of the composition of fuel that the locomotive is using and its gal/hour consumption but is still an approximation by EPA acknowledgment in their recommendations.

# SCAQMD thresholds

- › NO<sub>x</sub>: 100 lb/day
- › VOC: 75 lb/day
- › PM<sub>10</sub>: 150 lb/day
- › PM<sub>2.5</sub>: 55 lb/day
- › SO<sub>x</sub>: 150 lb/day
- › CO: 550 lb/day
- › Lead: 3 lb/day



## South Coast Air Quality Management District

21865 Copley Drive, Diamond Bar, CA 91765-4178  
(909) 396-2000 • [www.aqmd.gov](http://www.aqmd.gov)

**South Coast AQMD Air Quality Significance Thresholds**

<b>Mass Daily Thresholds <sup>a</sup></b>		
<b>Pollutant</b>	<b>Construction</b>	<b>Operation</b>
<b>NO<sub>x</sub></b>	100 lbs/day	55 lbs/day
<b>VOC</b>	75 lbs/day	55 lbs/day
<b>PM<sub>10</sub></b>	150 lbs/day	150 lbs/day
<b>PM<sub>2.5</sub></b>	55 lbs/day	55 lbs/day
<b>SO<sub>x</sub></b>	150 lbs/day	150 lbs/day
<b>CO</b>	550 lbs/day	550 lbs/day
<b>Lead</b>	3 lbs/day	3 lbs/day



# 03

## Results

# Emissions per Trip: Tier 4 Engines (Daily Emissions, one trip per week)

Engine Status	PM	HC	NOX	CO	BHP	Hr	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
Tier 4 Trip	0.015	0.04	1	1.28	4400	0.66	43.56	116.16	2904	3717.12	122.3165	42.2532
Tier 4 Idling	0.015	0.04	1	1.28	132	8	15.84	42.24	1056	1351.68	44.47872	15.3648
Total (grams)	--	--	--	--	--	--	59.4	158.4	3960	5068.8	166.7952	57.618
Daily (lb)	--	--	--	--	--	--	0.130955	0.349212	8.730306	11.17479	0.36772	0.127026
<b>Threshold (lb)</b>	--	--	--	--	--	--	<b>150</b>	<b>N/A</b>	<b>100</b>	<b>550</b>	<b>75</b>	<b>55</b>

With Tier 4 engines, the Project is within SCAQMD daily emission thresholds by itself.

# Total Daily Emissions: Adding Project Trucks Values in lb, Rail Tier 4

--	Daily Trips	PM	HC	NOX	CO	VOC	PM25
--	Rail Tier 4	0.1310	0.3492	8.7303	11.1748	0.3677	0.1270
a)	Truck 160	0.0742	--	6.1324	3.3983	0.0846	0.0709
--	Total	0.2052	0.3492	14.8627	14.5731	0.4523	0.1979
--	<b>Threshold</b>	150.0000	N/A	100.0000	550.0000	75.0000	55.0000

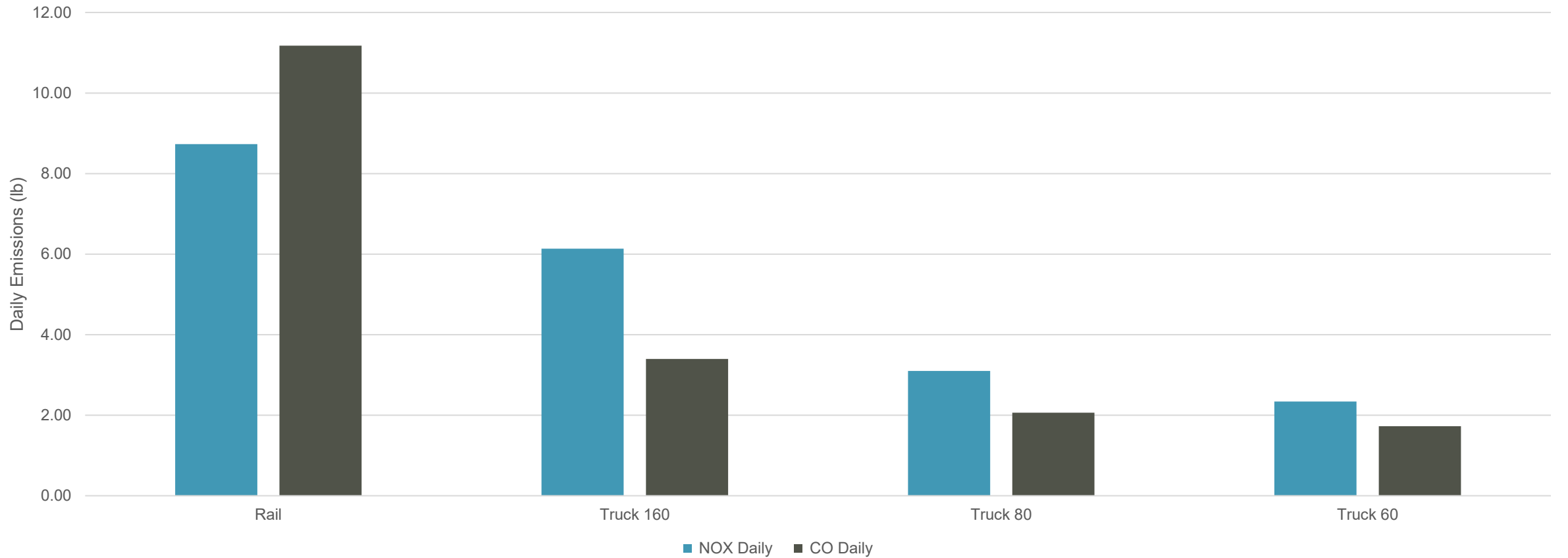
--	Daily Trips	PM	HC	NOX	CO	VOC	PM25
--	Rail Tier 4	0.1310	0.3492	8.7303	11.1748	0.3677	0.1270
b)	Truck 80	0.0378	--	3.0971	2.0619	0.0497	0.0361
--	Total	0.1688	0.3492	11.8274	13.2367	0.4174	0.1631
--	<b>Threshold</b>	150.0000	N/A	100.0000	550.0000	75.0000	55.0000

--	Daily Trips	PM	HC	NOX	CO	VOC	PM25
--	Rail Tier 4	0.1310	0.3492	8.7303	11.1748	0.3677	0.1270
c)	Truck 60	0.0287	--	2.3382	1.7278	0.0410	0.0274
--	Total	0.1597	0.3492	11.0685	12.9026	0.4087	0.1544
--	<b>Threshold</b>	150.0000	N/A	100.0000	550.0000	75.0000	55.0000

With Tier 4 engines, the Project is within SCAQMD thresholds for all truck daily trips.

# Comparison between Truck and Rail daily emissions: Tier 4 Engines

Tier 4 Engines Daily Emissions



# Total Rail Emissions Tier 4 Engines (1 Weekly Trip, 54-week Project) Values in Metric Tons

Rail Movement	PM Year	HC Year	NOX Year	CO Year	VOC Year	PM25 Year
Tier 4 Trip	0.0024	0.0063	0.1568	0.2007	0.0066	0.0023
Tier 4 Idling	0.0009	0.0023	0.0570	0.0730	0.0024	0.0008
<b>Total</b>	<b>0.0032</b>	<b>0.0086</b>	<b>0.2138</b>	<b>0.2737</b>	<b>0.0090</b>	<b>0.0031</b>

The Project produces 0.214 MT of NOX and 0.274 MT of CO per year as main pollutants with Tier 4 engines.

# Emission Calculation with current Engines

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- › For comparison purposes, the calculations for current distribution of engines both for Union Pacific and BNSF is provided.
- › It is expected to see increase in emissions specially in NOX and PM, which have improved by a relevant factor in newer locomotives.

# Emissions per Trip: Current Engines, Travel

Tier	% of total	PM	HC	NOX	CO	BHP	Hr	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
Pre Tier 0	0.15%	0.32	0.48	13	1.28	4400	0.66	929.28	1393.92	37752	3717.12	1467.798	901.4016
Tier 0	2.30%	0.32	0.48	8.6	1.28	4400	0.66	929.28	1393.92	24974.4	3717.12	1467.798	901.4016
Tier 1	45.39%	0.32	0.47	6.7	1.28	4400	0.66	929.28	1364.88	19456.8	3717.12	1437.219	901.4016
Tier 2	28.35%	0.18	0.26	4.95	1.28	4400	0.66	522.72	755.04	14374.8	3717.12	795.0571	507.0384
Tier 3	18.58%	0.08	0.13	4.95	1.28	4400	0.66	232.32	377.52	14374.8	3717.12	397.5286	225.3504
Tier 4	5.22%	0.015	0.04	1	1.28	4400	0.66	43.56	116.16	2904	3717.12	122.3165	42.2532
Average (grams)	--	0.22	0.33	5.63	1.28	--	--	638.3258	944.1179	16363.68	3717.12	994.1562	619.176
Daily (lb)	--	--	--	--	--	--	--	1.407268	2.081424	36.07574	8.194847	2.191739	1.36505

# Emissions per Trip: Current Engines, Idling

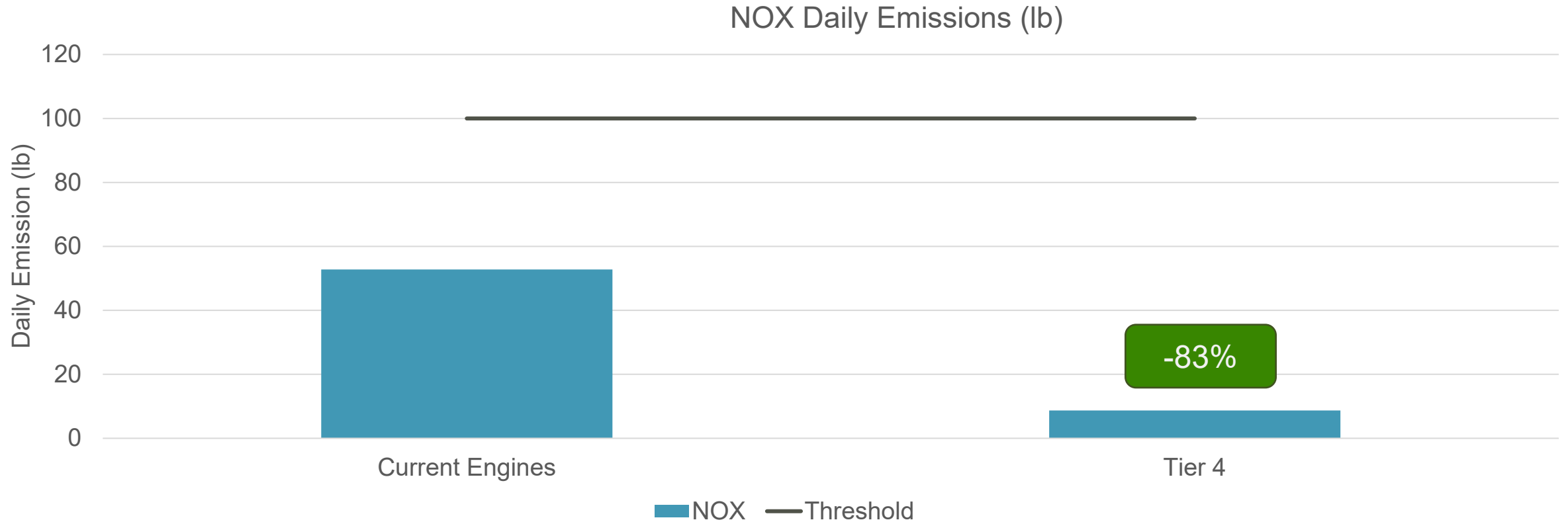
Tier	% of total	PM	HC	NOX	CO	BHP	Hr	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
Pre Tier 0	0.15%	0.32	0.48	13	1.28	4400	0.66	450.56	675.84	18304	1802.24	711.6595	437.0432
Tier 0	2.30%	0.32	0.48	8.6	1.28	4400	0.66	450.56	675.84	12108.8	1802.24	711.6595	437.0432
Tier 1	45.39%	0.32	0.47	6.7	1.28	4400	0.66	450.56	661.76	9433.6	1802.24	696.8333	437.0432
Tier 2	28.35%	0.18	0.26	4.95	1.28	4400	0.66	253.44	366.08	6969.6	1802.24	385.4822	245.8368
Tier 3	18.58%	0.08	0.13	4.95	1.28	4400	0.66	84.48	137.28	5227.2	1351.68	144.5558	81.9456
Tier 4	5.22%	0.015	0.04	1	1.28	4400	0.66	15.84	42.24	1056	1351.68	44.47872	15.3648
Average (grams)	--	0.22	0.33	5.63	1.28	--	--	303.9845	448.5187	7591.854	1695.037	472.2902	294.865
Daily (lb)	--	--	--	--	--	--	--	0.670171	0.988814	16.73717	3.736916	1.041222	0.650066

# Emissions per Trip, Total Current Engines

	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
Travel (grams)	638.32582	944.117903	16363.68268	3717.12	994.156152	619.17605
Idling (grams)	303.98451	448.518704	7591.853767	1695.03654	472.290195	294.86497
Total (grams)	942.3103	1,392.6366	23,955.5364	5,412.1565	1,466.4463	914.0410
Daily (lb)	2.0774	3.0702	52.8129	11.9318	3.2330	2.0151
Threshold (lb)	150	N/A	100	550	75	55

With current engines, the Project is within SCAQMD thresholds. There is an important increase in NOX emissions, which reach 52.81 lb per day, but are still halfway from the total threshold.

# Comparison: Daily NOX Emissions



NOX is the closest pollutant to the threshold according to the calculation. Other pollutants are well within the threshold

# Total Daily Emissions: Adding Project Trucks Values in Lb, Rail Averages

--	Rail and Truck Trips	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
--	Rail Avg	2.0804	3.0746	52.8524	11.9327	3.2376	2.0180
a)	Truck 160	0.0742		6.1324	3.3983	0.0846	0.0709
--	Total	2.1546	3.0746	58.9848	15.3310	3.3222	2.0889
--	<b>Threshold</b>	<b>150.0000</b>	<b>N/A</b>	<b>100.0000</b>	<b>550.0000</b>	<b>75.0000</b>	<b>55.0000</b>

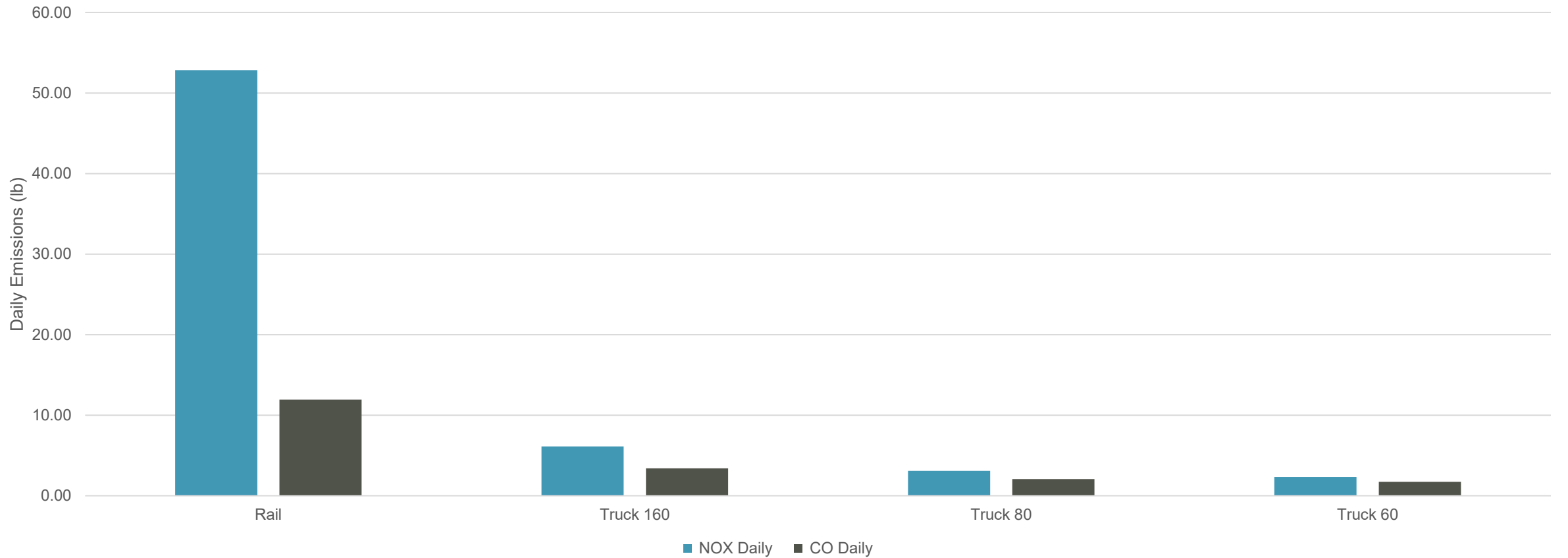
--	Rail and Truck Trips	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
--	Rail Avg	2.0804	3.0746	52.8524	11.9327	3.2376	2.0180
b)	Truck 80	0.0378		3.0971	2.0619	0.0497	0.0361
--	Total	2.1182	3.0746	55.9495	13.9946	3.2873	2.0541
--	<b>Threshold</b>	<b>150.0000</b>	<b>N/A</b>	<b>100.0000</b>	<b>550.0000</b>	<b>75.0000</b>	<b>55.0000</b>

--	Rail and Truck Trips	PM Trip	HC Trip	NOX Trip	CO Trip	VOC Trip	PM25 Trip
--	Rail Avg	2.0804	3.0746	52.8524	11.9327	3.2376	2.0180
c)	Truck 60	0.0287		2.3382	1.7278	0.0410	0.0274
--	Total	2.1091	3.0746	55.1906	13.6605	3.2786	2.0454
--	<b>Threshold</b>	<b>150.0000</b>	<b>N/A</b>	<b>100.0000</b>	<b>550.0000</b>	<b>75.0000</b>	<b>55.0000</b>

With Current engines, the Project is within SCAQMD thresholds combining truck and rail emissions for all truck scenarios.

# Comparison between Truck and Rail daily emissions: Current Engines

Current Engines Daily Emissions



# Comparison: Rail and Truck Emissions

Vehicle	Truck 160	Truck 160	Truck 160	Truck 160	Truck 80	Truck 80	Truck 80	Truck 80	Truck 80	Truck 60	Truck 60	Truck 60	Truck 60
Rail and Truck	NOX Daily	% NOX	CO Daily	% CO	NOX Daily	% NOX	CO Daily	% CO	NOX Daily	% NOX	CO Daily	% CO	NOX Daily
Rail Tier 4	8.7303	58.74%	11.1748	76.68%	8.7303	73.81%	11.1748	84.42%	8.7303	78.88%	11.1748	86.61%	8.7303
Truck	6.1324	41.26%	3.3983	23.32%	3.0971	26.19%	2.0619	15.58%	2.3382	21.12%	1.7278	13.39%	2.3382

Vehicle	Truck 160	Truck 160	Truck 160	Truck 160	Truck 80	Truck 80	Truck 80	Truck 80	Truck 80	Truck 60	Truck 60	Truck 60	Truck 60
Rail and Truck	NOX Daily	% NOX	CO Daily	% CO	NOX Daily	% NOX	CO Daily	% CO	NOX Daily	% NOX	CO Daily	% CO	NOX Daily
Rail Current Fleet	52.8524	89.60%	11.9327	77.83%	52.8524	89.60%	11.9327	77.83%	52.8524	95.76%	11.9327	87.35%	52.8524
Truck	6.1324	10.40%	3.3983	22.17%	6.1324	10.40%	3.3983	22.17%	2.3382	4.24%	1.7278	12.65%	2.3382

In daily emissions, rail emissions are important for CO and NOX for this project.

The equivalent emissions per day with rail Tier 4 and truck are with 228 trucks for NOX. To move the same cargo than a 100-car rail service, it usually would need around 600 trucks, therefore rail emissions are close to 3 times lower in rate to move the same load.

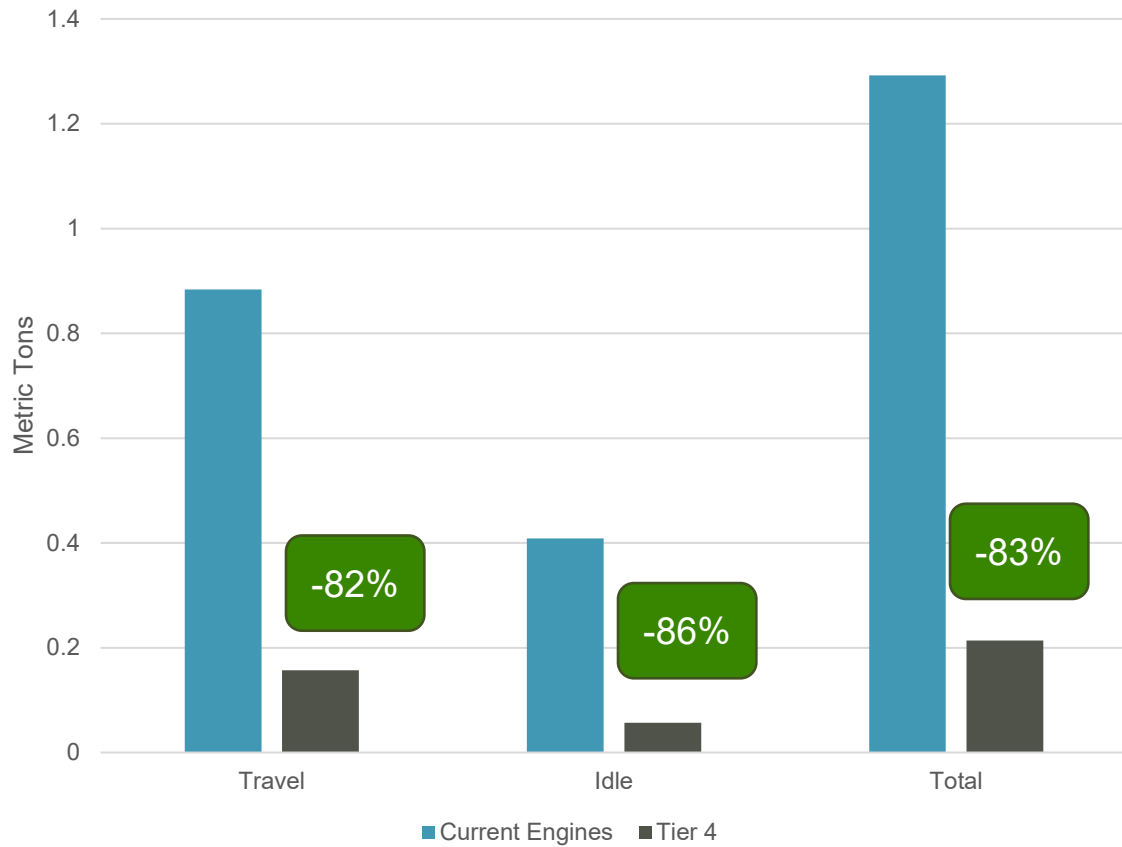
# Total Rail Emissions Current Fleet (1 weekly trip, 54-week Project) Values in Metric Tons

Fleet Activity	PM Year	HC Year	NOX Year	CO Year	VOC Year	PM25 Year
Current Fleet Trip	0.0345	0.0510	0.8836	0.2007	0.0537	0.0334
Current Fleet Idle	0.0164	0.0242	0.4084	0.0914	0.0254	0.0159
<b>Total</b>	<b>0.0508</b>	<b>0.0751</b>	<b>1.2921</b>	<b>0.2921</b>	<b>0.0791</b>	<b>0.0493</b>

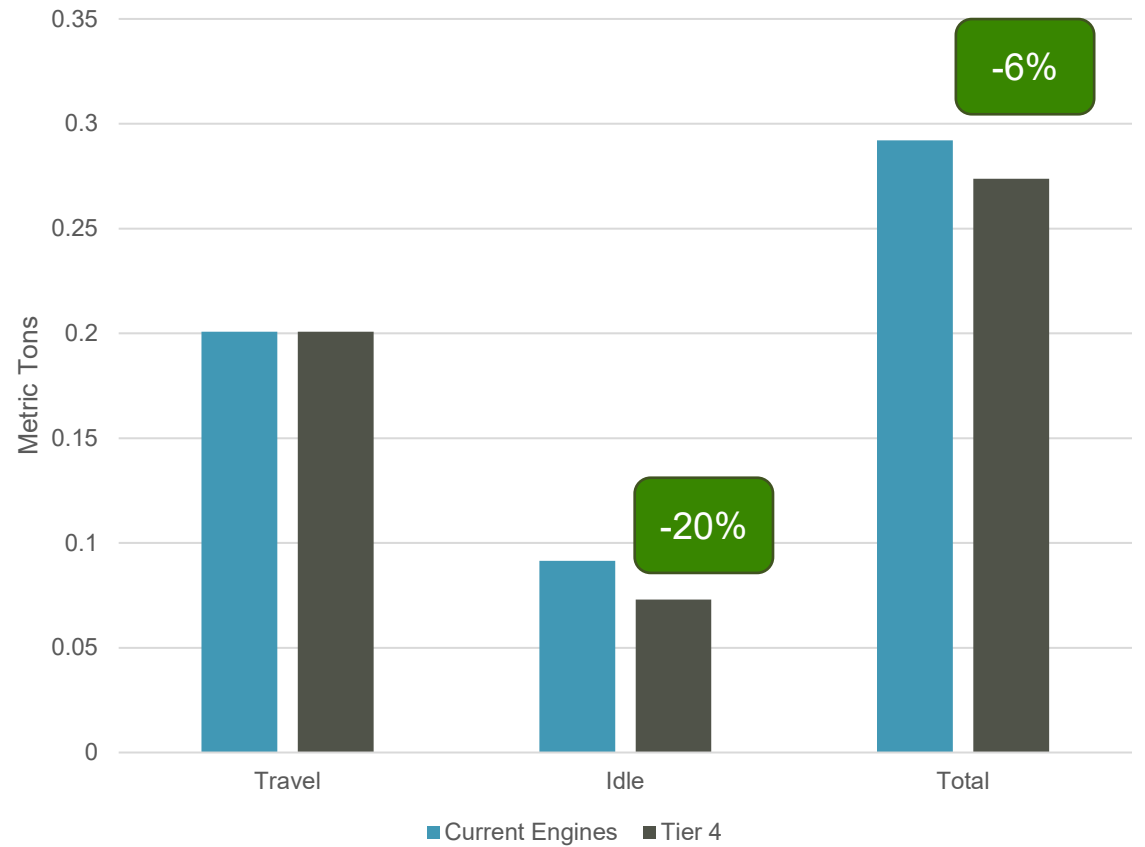
The Project produces 1.292 MT of NOX and 0.292 MT of CO per year as main pollutants with current fleet engines. PM and PM25 emissions would increase by 58.75%.

# Total Rail Emission Comparison Current Fleet vs. Tier 4: NOX, CO

NOX Total Emissions (metric tons)



CO Total Emissions (metric tons)



# CO2 Emissions: Emissions in Metric Tons

Calculation Values	Value
Fuel consumption travel	1 gal/mile
Fuel consumption idling	3.5 gal/hour
Fuel density	3,200 g/gal
Carbon content of fuel	87%
Emission factor CO2	10,217 g/gal
Fuel consumption travel	19.8 gal
Fuel consumption idling	28 gal
Total fuel consumption	47.8 gal

Emissions	Metric Tons
Emissions per travel trip	0.2023
Emissions per idling (trip)	0.2861
Total emissions per trip (daily)	0.4884
Total emissions Project (54 weeks)	26.3721

# Conclusions

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- › An emission analysis was performed using available data, assumptions on characteristics of the rail service for a construction project and standardized methodology provided by EPA.
- › Calculations show that either case, i.e., the project by rail-only or combined with the trucking operation, is within SCAQMD thresholds.
- › An assumption of the project is the use of newer Tier 4 engines. By using an engine weighted from the current fleet available for cargo rail in California, as per CARB data, some pollutants such as NOX and PM increase considerably. The calculation shows that the project using the current engine fleet is still within SCAQMD thresholds.

**Thank you**