

APPENDIX D
AIR QUALITY CALCULATIONS

CALCULATION SHEET-COMBUSTION EMISSIONS-CONSTRUCTION

Assumptions for Combustion Emissions

Type of Construction Equipment	Num. of Units	HP Rated	Hrs/day	Days/yr	Total hp-hrs
Water Truck	1	300	8	320	768,000
Diesel Road Compactors	1	100	8	320	256,000
Diesel Dump Truck	2	300	8	160	768,000
Diesel Excavator	1	300	8	480	1,152,000
Diesel Hole Trenchers	1	175	8	320	448,000
Diesel Bore/Drill Rigs	1	300	8	320	768,000
Diesel Cement & Mortar Mixers	2	300	8	160	768,000
Diesel Cranes	1	175	8	320	448,000
Diesel Graders	1	300	8	160	384,000
Diesel Tractors/Loaders/Backhoes	0	100	8	0	-
Diesel Bulldozers	1	300	8	160	384,000
Diesel Front-End Loaders	1	300	8	320	768,000
Diesel Forklifts	1	100	8	160	128,000
Diesel Generator Set	0	40	8	0	-

Emission Factors¹

Type of Construction Equipment	VOC g/hp-hr	CO g/hp-hr	NOx g/hp-hr	PM-10 g/hp-hr	PM-2.5 g/hp-hr	SO2 g/hp-hr	CO2 g/hp-hr
Water Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Road Compactors	0.370	1.480	4.900	0.340	0.330	0.740	536.200
Diesel Dump Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Excavator	0.340	1.300	4.600	0.320	0.310	0.740	536.300
Diesel Trenchers	0.510	2.440	5.810	0.460	0.440	0.740	535.800
Diesel Bore/Drill Rigs	0.600	2.290	7.150	0.500	0.490	0.730	529.700
Diesel Cement & Mortar Mixers	0.610	2.320	7.280	0.480	0.470	0.730	529.700
Diesel Cranes	0.440	1.300	5.720	0.340	0.330	0.730	530.200
Diesel Graders	0.350	1.360	4.730	0.330	0.320	0.740	536.300
Diesel Tractors/Loaders/Backhoes	1.850	8.210	7.220	1.370	1.330	0.950	691.100
Diesel Bulldozers	0.360	1.380	4.760	0.330	0.320	0.740	536.300
Diesel Front-end Loaders	0.380	1.550	5.000	0.350	0.340	0.740	536.200
Diesel Forklifts	1.980	7.760	8.560	1.390	1.350	0.950	690.800
Diesel Generator Set	1.210	3.760	5.970	0.730	0.710	0.810	587.300

1. Emission factors (EF) were generated using USEPA's preferred model for nonroad sources, the NONROAD2008 model. Emissions were modeled for the 2007 calendar year. The VOC EFs include exhaust and evaporative emissions. The VOC evaporative components included in the NONROAD2008 model are diurnal, hotsoak, running loss, tank permeation, hose permeation, displacement, and spillage. The construction equipment age distribution in the NONROAD2008 model is based on the population in U.S. for the 2007 calendar year.

CALCULATION SHEET-COMBUSTION EMISSIONS-CONSTRUCTION

Emission Calculations

Type of Construction Equipment	VOC tons/yr	CO tons/yr	NOx tons/yr	PM-10 tons/yr	PM-2.5 tons/yr	SO ₂ tons/yr	CO ₂ tons/yr
Water Truck	0.372	1.752	4.646	0.347	0.339	0.626	453.636
Diesel Road Paver	0.104	0.418	1.382	0.096	0.093	0.209	151.268
Diesel Dump Truck	0.372	1.752	4.646	0.347	0.339	0.626	453.636
Diesel Excavator	0.432	1.650	5.840	0.406	0.394	0.939	680.835
Diesel Hole Cleaners\Trenchers	0.252	1.205	2.868	0.227	0.217	0.365	264.522
Diesel Bore/Drill Rigs	0.508	1.938	6.051	0.423	0.415	0.618	448.304
Diesel Cement & Mortar Mixers	0.516	1.963	6.161	0.406	0.398	0.618	448.304
Diesel Cranes	0.217	0.642	2.824	0.168	0.163	0.360	261.758
Diesel Graders	0.148	0.576	2.002	0.140	0.135	0.313	226.945
Diesel Tractors/Loaders/Backhoes	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel Bulldozers	0.152	0.584	2.014	0.140	0.135	0.313	226.945
Diesel Front-end Loaders	0.322	1.312	4.232	0.296	0.288	0.626	453.805
Diesel Forklift	0.279	1.095	1.207	0.196	0.190	0.134	97.441
Diesel Generator Set	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Emissions	3.675	14.886	43.875	3.192	3.105	5.749	4167.401

MOVES2010a MODEL ON-ROAD TRANSPORTATION AIR EMISSIONS-
DELIVERY MATERIALS AND COMMUTING DURING CONSTRUCTION ACTIVITIES

MOVES 2010a

Source	Fuel type	Number of vehicles	Miles traveled per day	Days of travel per year	Miles traveled per year
Passenger cars	Gasoline	48	60	60	172,800
Passenger truck	Gasoline	48	60	60	172,800
Light commercial truck	Diesel	32	60	60	115,200
Short-haul truck	Diesel	64	80	6	30,720
Long-haul truck	Diesel	16	80	6	7,680

Emission Factors (MOVES 2010a Emission Rates)¹

Source	VOC (g/mile)	CO (g/mile)	NOx (g/mile)	PM-10 (g/mile)	PM-2.5 (g/mile)	SO ₂ (g/mile)	CO ₂ and CO ₂ Equivalents (g/mile)
Passenger cars	8.497	2.892	0.576	0.019	0.018	0.005	320
Passenger truck	3.645	5.449	1.168	0.027	0.025	0.007	439
Light commercial truck	4.460	2.158	2.986	0.164	0.190	0.005	609
Short-haul truck	2.438	2.273	6.095	0.270	0.313	0.007	929
Long-haul truck	2.519	3.610	14.776	0.625	0.726	0.016	2,020

Total Emission for On-Road Construction Activities (tons/year)

Source	VOC	CO	NOx	PM-10	PM-2.5	SO ₂	CO ₂ and CO ₂ Equivalents
Passenger cars	1.618	0.551	0.110	0.004	0.003	0.001	61
Passenger truck	0.694	1.038	0.222	0.005	0.005	0.001	84
Light commercial truck	0.566	0.274	0.379	0.021	0.024	0.001	77
Short-haul truck	0.083	0.077	0.206	0.009	0.011	0.000	31
Long-haul truck	0.021	0.031	0.125	0.005	0.006	0.000	17
Total	2.982	1.970	1.043	0.044	0.049	0.003	271

Key:

Short-haul trucks category includes trucks such as dump trucks and cement trucks.

Long-haul trucks category includes trucks such as semi-trailers (18-wheelers).

1. Emission factors were generated by the USEPA preferred model MOVES2010a. MOVES simulates daily motor vehicle operations and produces emission rates. MOVES emission rates include sources from engine combustion, tire wear, brake wear, evaporative fuel permeation, vapor venting and leaking (running and parking), and crankcase loss. Emission rates are daily averages for each of the criteria pollutants. The averages are from a combination of vehicle operations such as stop and go, highway travel, acceleration at on-ramps, parking, start-up, extended idle, etc.

MOVES2010a MODEL ON-ROAD TRANSPORTATION AIR EMISSIONS-ONGOING OPERATIONS

MOVES 2010a

Source	Fuel type	Number of vehicles	Miles traveled per day	Days of travel per year	Miles traveled per year
Passenger cars	Gasoline	32	60	24	46,080
Passenger truck	Gasoline	32	60	24	46,080
Light commercial truck	Diesel	16	60	24	23,040
Short-haul truck	Diesel	16	60	24	23,040
Long-haul truck	Diesel	16	60	24	23,040

Emission Factors (MOVES 2010a Emission Rates)¹

Source	VOC (g/mile)	CO (g/mile)	NOx (g/mile)	PM-10 (g/mile)	PM-2.5 (g/mile)	SO ₂ (g/mile)	CO ₂ and CO ₂ Equivalents (g/mile)
Passenger cars	8.497	2.892	0.576	0.019	0.018	0.005	320
Passenger truck	3.645	5.449	1.168	0.027	0.025	0.007	439
Light commercial truck	4.460	2.158	2.986	0.164	0.190	0.005	609
Short-haul truck	2.438	2.273	6.095	0.270	0.313	0.007	929
Long-haul truck	2.519	3.610	14.776	0.625	0.726	0.016	2,020

Total Emission for On-Road Commuter Activities (tons/year)

Source	VOC	CO	NOx	PM-10	PM-2.5	SO ₂	CO ₂ and CO ₂ Equivalents
Passenger cars	0.43	0.15	0.03	0.00	0.00	0.00	16
Passenger truck	0.19	0.28	0.06	0.00	0.00	0.00	22
Light commercial truck	0.11	0.05	0.08	0.00	0.00	0.00	15
Short-haul truck	0.06	0.06	0.15	0.01	0.01	0.00	24
Long-haul truck	0.06	0.09	0.38	0.02	0.02	0.00	51
Total	0.86	0.63	0.69	0.03	0.03	0.00	129

Key:

Short-haul trucks category includes trucks such as dump trucks and cement trucks.

Long-haul trucks category includes trucks such as semi-trailers (18-wheelers).

1. Emission factors were generated by the USEPA preferred model MOVES2010a. MOVES simulates daily motor vehicle operations and produces emission rates. MOVES emission rates include sources from engine combustion, tire wear, brake wear, evaporative fuel permeation, vapor venting and leaking (running and parking), and crankcase loss. Emission rates are daily averages for each of the criteria pollutants. The averages are from a combination of vehicle operations such as stop and go, highway travel, acceleration at on-ramps, parking, start-up, extended idle, etc.

CALCULATION SHEET-FUGITIVE DUST-CONSTRUCTION

Assumptions for Combustion Emissions

Construction Fugitive Dust Emission Factors	Emission Factor	Units	Source
General Construction Activities	0.19	ton PM-10/acre-month	MRI 1996; EPA 2001; EPA 2006
New Road Construction	0.42	ton PM-10/acre-month	MRI 1996; EPA 2001; EPA 2006
PM-2.5 Emissions			
PM-2.5 Multiplier	0.10	(10% of PM-10 emissions assumed to be PM-2.5)	EPA 2001; EPA 2006
Control Efficiency	0.50	(assume 50% control efficiency for PM-10 and PM-2.5 emissions)	EPA 2001; EPA 2006

Project Assumptions

Construction Area (0.19 ton PM-10/acre-month)		
Duration of Soil Disturbance in Project	12	months
Length	2	miles
Length (converted)	10560	feet
Width	45	feet
Area	10.91	acres
Staging Areas		
Duration of Construction Project	12	months
Length		miles
Length (converted)		feet
Width		feet
Area	1.00	acres

*Assume that construction activities during road modification are limited to 10 miles area during any given construction day.

Project Emissions (tons/years)

	PM-10 uncontrolled	PM-10 controlled	PM-2.5 uncontrolled	PM-2.5 controlled
Construction Area (0.19 ton PM-10/acre-month)	24.87	12.44	2.49	1.24
Staging Areas	0.19	0.10	0.02	0.01
Total	25.06	12.53	2.51	1.25

References:

USEPA 2001. Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999. EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

USEPA 2006. Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants. Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. Improvement of Specific Emission Factors (BACM Project No. 1). Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

Assumptions for Fugitive Emissions

General Construction Activities Emission Factor

0.19 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The area-based emission factor for construction activities is based on a study completed by the Midwest Research Institute (MRI) Improvement of Specific Emission Factors (BACM Project No. 1), March 29, 1996. The MRI study evaluated seven construction projects in Nevada and California (Las Vegas, Coachella Valley, South Coast Air Basin, and the San Joaquin Valley). The study determined an average emission factor of 0.11 ton PM-10/acre-month for sites without large-scale cut/fill operations. A worst-case emission factor of 0.42 ton PM-10/acre-month was calculated for sites with active large-scale earth moving operations. The monthly emission factors are based on 168 work-hours per month (MRI 1996). A subsequent MRI Report in 1999, Estimating Particulate Matter Emissions from Construction Operations, calculated the 0.19 ton PM-10/acre-month emission factor by applying 25% of the large-scale earthmoving emission factor (0.42 ton PM-10/acre-month) and 75% of the average emission factor (0.11 ton PM-10/acre-month).

The 0.19 ton PM-10/acre-month emission factor is referenced by the EPA for non-residential construction activities in recent procedures documents for the National Emission Inventory (EPA 2001; EPA 2006). The 0.19 ton PM-10/acre-month emission factor represents a refinement of EPA's original AP-42 area-based total suspended particle (TSP) emission factor in Section 13.2.3 Heavy Construction Operations. In addition to the EPA, this methodology is also supported by the South Coast Air Quality Management District and the Western Regional Air Partnership (WRAP) which is funded by the EPA and is administered jointly by the Western Governor's Association and the National Tribal Environmental Council. The emission factor is assumed to encompass a variety of non-residential construction activities including building construction (commercial, industrial, institutional, governmental), public works, and travel on unpaved roads. The EPA National Emission Inventory documentation assumes that the emission factors are uncontrolled and recommends a control efficiency of 50% for PM-10 and PM-2.5 in PM nonattainment areas.

New Road Construction Emission Factor

0.42 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The emission factor for new road construction is based on the worst-case conditions emission factor from the MRI 1996 study described above (0.42 tons PM-10/acre-month). It is assumed that road construction involves extensive earthmoving and heavy construction vehicle travel resulting in emissions that are higher than other general construction projects. The 0.42 ton PM-10/acre-month emission factor for road construction is referenced in recent procedures documents for the EPA National Emission Inventory (EPA 2001; EPA 2006).

PM-2.5 Multiplier

0.10 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

PM-2.5 emissions are estimated by applying a particle size multiplier of 0.10 to PM-10 emissions. This methodology is consistent with the procedures documents for the National Emission Inventory (EPA 2006).

Control Efficiency for PM-10 and PM-2.5

0.50 ton PM-10/acre-month Source: MRI 1996; EPA 2001; EPA 2006

The EPA National Emission Inventory documentation recommends a control efficiency of 50% for PM-10 and PM-2.5 in PM nonattainment areas. Wetting controls will be applied during project construction (EPA 2006).

References:

EPA 2001. Procedures Document for National Emissions Inventory, Criteria Air Pollutants, 1985-1999. EPA-454/R-01-006. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. March 2001.

EPA 2006. Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants. Prepared for: Emissions Inventory and Analysis Group (C339-02) Air Quality Assessment Division Office of Air Quality Planning and Standards, United States Environmental Protection Agency. July 2006.

MRI 1996. Improvement of Specific Emission Factors (BACM Project No. 1). Midwest Research Institute (MRI). Prepared for the California South Coast Air Quality Management District, March 29, 1996.

GENERATOR EMISSIONS

Assumptions for Combustion Emissions

Type of Construction Equipment	Num. of Units	HP Rated	Hrs/day	Days/yr	Total hp-hrs
Propane Generator Set Back-up	0	25	0	0	0
Propane Generator Set-Primary	16	25	5	24	48000

Emission Factors¹

Type of Construction Equipment	VOC g/hp-hr	CO g/hp-hr	NOx g/hp-hr	PM-10 g/hp-hr	PM-2.5 g/hp-hr	SO ₂ g/hp-hr	CO ₂ g/hp-hr
Propane Generator Set Back-up	2.03	31.91	9.93	0.06	0.06	0.01	653.9
Propane Generator Set-Primary	2.03	31.91	9.93	0.06	0.06	0.01	653.9

Emission Calculations

Type of Construction Equipment	VOC tons/yr	CO tons/yr	NOx tons/yr	PM-10 tons/yr	PM-2.5 tons/yr	SO ₂ tons/yr	CO ₂ tons/yr
Propane Generator Set Back-up	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propane Generator Set-Primary	0.11	1.69	0.53	0.00	0.00	0.00	34.59
Total Emissions	0.11	1.69	0.53	0.00	0.00	0.00	34.59

1. Emission factors (EF) were generated using USEPA's preferred model for nonroad sources, the NONROAD2008 model. Emissions were modeled for the 2007 calendar year. The VOC EFs includes exhaust and evaporative emissions. The VOC evaporative components included in the NONROAD2008 model are diurnal, hotsoak, running loss, tank permeation, hose permeation, displacement, and spillage. The construction equipment age distribution in the NONROAD2008 model is based on the population in U.S. for the 2007 calendar year.

CALCULATION SHEET-SUMMARY OF EMISSIONS

Summary of Emissions (tons/year/16 towers)

Emission Source	VOC	CO	NOx	PM-10	PM-2.5	SO ₂	CO ₂	CO ₂ Equivalents	Total CO ₂
Combustion Emissions	3.68	14.89	43.87	3.19	3.11	5.75	4167.40	13,737	17,904
Construction Site-Fugitive PM-10	NA	NA	NA	12.53	1.25	NA	NA	NA	NA
Construction Workers Commuter & Trucking	2.98	1.97	1.04	0.04	0.05	0.00	NA	271	271
Total Emissions-CONSTRUCTION	6.66	16.86	44.92	15.77	4.41	5.75	4167	14,007	18,175
Operational Emissions	0.86	0.63	0.69	0.03	0.03	0.00	NA	129	129
Generators	0.11	1.69	0.53	0.00	0.00	0.00	34.59	166	201
Total Operational Emissions	0.96	2.32	1.22	0.03	0.04	0.00	35	295	330
<i>De minimis</i> Threshold (1)	100	100	100	70	100	100	NA	NA	25,000

1. Note that Pima County is a moderate non-attainment area for PM-10 area for CO (USEPA 2013b).

Carbon Equivalents	Conversion Factor
N ₂ O or NOx	311
Methane or VOCs	25

Source: EPA 2010 Reference, Tables and Conversions, Inventory of U.S. Greenhouse Gas Emissions and Sinks;
<http://www.epa.gov/climatechange/emissions/usinventoryreport.html>