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Appendix I

Detailed Construction Emissions Calculations

Summary of Potential Construction Emissions for the Denver Expansion Project in Arapahoe County, Colorado										
Source	NO _x (tons)	CO (tons)	SO ₂ (tons)	TSP (tons)	PM ₁₀ (tons)	PM _{2.5} (tons)	VOC (tons)	CO ₂ e (tons)	Formaldehyde (tons)	Total HAP (tons)
Cat Track-hoes (8)	8.571	7.429	0.014	0.429	0.429	0.429	0.857	1,484.459	1.07E-02	3.44E-02
HDD Rig (2)	0.813	0.440	0.001	0.025	0.025	0.025	0.081	87.968	6.34E-04	2.04E-03
D6 Bulldozers (8)	7.143	6.190	0.012	0.357	0.357	0.357	0.714	1,237.049	8.92E-03	2.87E-02
Side-Booms (8)	10.457	9.063	0.017	0.523	0.523	0.523	1.046	1,811.040	1.31E-02	4.20E-02
D6 Tack Rig (2)	1.571	1.362	0.003	0.079	0.079	0.079	0.157	272.151	1.96E-03	6.30E-03
CRC 30" Field Bender (2)	0.583	0.617	0.001	0.050	0.050	0.050	0.058	86.593	6.24E-04	2.01E-03
Barbco Auger Boring Machine (2)	0.096	0.102	0.000	0.008	0.008	0.008	0.010	14.318	1.03E-04	3.32E-04
Welding Rigs (10)	3.333	2.440	0.003	0.268	0.268	0.268	0.333	309.262	2.23E-03	7.16E-03
X-Ray Rigs (Pickups) (6)	4.286	3.714	0.007	0.214	0.214	0.214	0.429	742.230	5.35E-03	1.72E-02
Sandblaster Units (4)	1.667	1.762	0.002	0.143	0.143	0.143	0.167	247.410	1.78E-03	5.73E-03
6" Water Pumps (4)	1.167	1.233	0.002	0.100	0.100	0.100	0.117	173.187	1.25E-03	4.01E-03
Haul Trucks (2)	3.393	2.940	0.006	0.170	0.170	0.170	0.339	587.598	4.24E-03	1.36E-02
Skid Trucks (2)	1.786	1.548	0.003	0.089	0.089	0.089	0.179	309.262	2.23E-03	7.16E-03
Boom Truck (2)	2.143	1.857	0.004	0.107	0.107	0.107	0.214	371.115	2.68E-03	8.60E-03
Pickup Trucks (20)	21.429	18.571	0.004	1.071	1.071	1.071	2.143	3711.148	2.68E-03	8.60E-02
Mechanic Rig (4)	5.000	4.333	0.008	0.250	0.250	0.250	0.500	865.934	6.24E-03	2.01E-02
Flatbeds (2)	2.857	2.476	0.005	0.143	0.143	0.143	0.286	494.820	3.57E-03	1.15E-02
Stringing Trucks (10)	13.492	11.693	0.022	0.675	0.675	0.675	1.349	2336.648	1.69E-02	5.41E-02
Tractor Trailer Tanker (2)	2.011	1.743	0.003	0.101	0.101	0.101	0.201	348.206	2.51E-03	8.07E-03
Cat Model 14 Graders (2)	1.714	1.486	0.003	0.086	0.086	0.086	0.171	296.892	2.14E-03	6.88E-03
Ingersoll Compressors (8)	3.333	3.524	0.005	0.286	0.286	0.286	0.333	494.820	3.57E-03	1.15E-02
HydroVac Trucks (2)	1.366	1.184	0.002	0.068	0.068	0.068	0.137	236.528	1.71E-03	5.48E-03
Dust from Unpaved Roads	--	--	--	6.619	1.891	0.189	--	--	--	--
Land Clearing	--	--	--	0.631	0.473	0.066	--	--	--	--
TOTALS (tons)	98.21	85.71	0.13	12.49	7.61	5.50	9.82	16,518.64	0.10	0.38

Table 1
Diesel Fired Equipment Emissions
Cat Track-hoes (8)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 300 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 15 gal/hr each [7,000 bsfc (Btu/hp-hr) x 300 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 8,640 hours 8 units, on site for 108 days of construction, operating 10 hours per day

<u>Emission Rates</u>				
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.984 lbs/hr	8.571 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.720 lbs/hr	7.429 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.003 lbs/hr	1.43E-02 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.099 lbs/hr	0.429 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.198 lbs/hr	0.857 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0020 lbs/hr	8.46E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0009 lbs/hr	3.71E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0006 lbs/hr	2.59E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	3.55E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0025 lbs/hr	1.07E-02 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0016 lbs/hr	6.96E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	8.39E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	7.69E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.008 lbs/hr	3.44E-02 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	342 lbs/hr	1479.478 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.014 lbs/hr	6.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	1.20E-02 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	344 lbs/hr	1484.459 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned} \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton}) \end{aligned}$$

**Table 2
Diesel Fired Equipment Emissions
HDD Rigs (2)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 800 HP estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 41 gal/hr [7,000 bsfc (Btu/hp-hr) x 800 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 192 hours 2 units, each on site for 4 days of construction, operating 24 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	4.8 g/hp-hr	8.466 lbs/hr	0.813 tons	EPA Tier 3 Off-Road Standards (>750 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	4.586 lbs/hr	0.440 tons	EPA Tier 3 Off-Road Standards (>750 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.009 lbs/hr	8.47E-04 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.265 lbs/hr	0.025 tons	EPA Tier 3 Off-Road Standards (>750 hp)
Total Organic Compounds (TOC)	0.48 g/hp-hr	0.847 lbs/hr	0.081 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0052 lbs/hr	5.02E-04 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0023 lbs/hr	2.20E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0016 lbs/hr	1.53E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0002 lbs/hr	2.10E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0066 lbs/hr	6.34E-04 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0043 lbs/hr	4.12E-04 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0005 lbs/hr	4.97E-05 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0005 lbs/hr	4.56E-05 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.021 lbs/hr	2.04E-03 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	913 lbs/hr	87.673 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.037 lbs/hr	3.56E-03 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.007 lbs/hr	7.11E-04 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	916 lbs/hr	87.968 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 3
Diesel Fired Equipment Emissions
D6 Bulldozers (8)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 250 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 13 gal/hr each [7,000 bsfc (Btu/hp-hr) x 250 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 8,640 hours 8 units, onsite for 108 days of construction, operating 10 hours per day

Criteria Pollutants	Emission Factor	Emission Rates		Basis of Estimate
		Average Hourly Emissions	Project Emissions	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.653 lbs/hr	7.143 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.433 lbs/hr	6.190 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.003 lbs/hr	1.19E-02 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.083 lbs/hr	0.357 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.165 lbs/hr	0.714 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0016 lbs/hr	7.05E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0007 lbs/hr	3.09E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0005 lbs/hr	2.15E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	2.96E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0021 lbs/hr	8.92E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0013 lbs/hr	5.80E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	6.99E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	6.41E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.007 lbs/hr	2.87E-02 tons	

Greenhouse Gases	Emission Factor	Average Hourly Emissions		Basis of Estimate
		Average Hourly Emissions	Project Emissions	
Carbon Dioxide (CO2)	73.96 kg/MMBtu	285 lbs/hr	1232.898 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.012 lbs/hr	5.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.002 lbs/hr	1.00E-02 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	286 lbs/hr	1237.049 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/hp-hr) x (Engine's Horsepower Rate, hp)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

**Table 4
Diesel Fired Equipment Emissions
Side-Booms (8)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 366 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 19 gal/hr each [7,000 bsfc (Btu/hp-hr) x 366 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 8,640 hours 8 units, each onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Emission Rates</u>		<u>Basis of Estimate</u>
		<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.421 lbs/hr	10.457 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	2.098 lbs/hr	9.063 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	1.74E-02 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.121 lbs/hr	0.523 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.242 lbs/hr	1.046 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0024 lbs/hr	1.03E-02 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0010 lbs/hr	4.53E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0007 lbs/hr	3.15E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	4.33E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0030 lbs/hr	1.31E-02 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0020 lbs/hr	8.49E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	1.02E-03 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	9.39E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.010 lbs/hr	4.20E-02 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO2)	73.96 kg/MMBtu	418 lbs/hr	1804.963 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.017 lbs/hr	7.32E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	1.46E-02 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	419 lbs/hr	1811.040 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned}\text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton})\end{aligned}$$

**Table 5
Diesel Fired Equipment Emissions
D6 Tack-Rig (2)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating:	220 HP each	estimated
Estimated Heat Rate (BSFC)	7000 Btu/hp-hr	Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption	11 gal/hr each	[7,000 bsfc (Btu/hp-hr) x 220 HP / 137,300 Btu/gal]
Fuel Type:	Diesel	
Hours of Operation:	2,160 hours total	2 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u> <u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.455 lbs/hr	1.571 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.261 lbs/hr	1.362 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.002 lbs/hr	2.62E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.073 lbs/hr	0.079 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.146 lbs/hr	0.157 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0014 lbs/hr	1.55E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0006 lbs/hr	6.80E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0004 lbs/hr	4.74E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	6.50E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0018 lbs/hr	1.96E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0012 lbs/hr	1.28E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0001 lbs/hr	1.54E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	1.41E-04 tons	AP-42 Table 3.3-2 (10/96)
	Total HAP:	0.006 lbs/hr	6.30E-03 tons	
<u>Greenhouse Gases</u>				
	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	251 lbs/hr	271.238 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.010 lbs/hr	1.10E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.002 lbs/hr	2.20E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	252 lbs/hr	272.151 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 6
Diesel Fired Equipment Emissions
CRC 30" Field Bender (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 70 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 4 gal/hr each [7,000 bsfc (Btu/hp-hr) x 70 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours total 2 units, onsite for 108 days of construction, operating 10 hours per day

Criteria Pollutants	Emission Factor	Average Hourly Emissions	Emission Rates	Basis of Estimate
			Project Emissions	
Nitrogen Oxides (NOx)	3.5 g/hp-hr	0.540 lbs/hr	0.583 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Carbon Monoxide (CO)	3.7 g/hp-hr	0.571 lbs/hr	0.617 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	8.33E-04 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.30 g/hp-hr	0.046 lbs/hr	0.050 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Total Organic Compounds (TOC)	0.35 g/hp-hr	0.054 lbs/hr	0.058 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0005 lbs/hr	4.94E-04 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0002 lbs/hr	2.16E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0001 lbs/hr	1.51E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	2.07E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0006 lbs/hr	6.24E-04 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0004 lbs/hr	4.06E-04 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0000 lbs/hr	4.90E-05 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0000 lbs/hr	4.49E-05 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.002 lbs/hr	2.01E-03 tons	

Greenhouse Gases	Emission Factor	Average Hourly Emissions	Project Emissions	Basis of Estimate
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	80 lbs/hr	86.303 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.003 lbs/hr	3.50E-03 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.001 lbs/hr	7.00E-04 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	80 lbs/hr	86.593 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 7
Diesel Fired Equipment Emissions
Barbco Augar Bore Machine (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 50 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 3 gal/hr each [7,000 bsfc (Btu/hp-hr) x 50 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 500 hours total 2 units, onsite for 45 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u>	
			<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.5 g/hp-hr	0.386 lbs/hr	0.096 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Carbon Monoxide (CO)	3.7 g/hp-hr	0.408 lbs/hr	0.102 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	1.38E-04 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.30 g/hp-hr	0.033 lbs/hr	0.008 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Total Organic Compounds (TOC)	0.35 g/hp-hr	0.039 lbs/hr	0.010 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0003 lbs/hr	8.16E-05 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0001 lbs/hr	3.58E-05 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0001 lbs/hr	2.49E-05 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	3.42E-06 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0004 lbs/hr	1.03E-04 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0003 lbs/hr	6.71E-05 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0000 lbs/hr	8.09E-06 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0000 lbs/hr	7.42E-06 tons	AP-42 Table 3.3-2 (10/96)
	Total HAP:	0.001 lbs/hr	3.32E-04 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	57 lbs/hr	14.270 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.002 lbs/hr	5.79E-04 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.000 lbs/hr	1.16E-04 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	57 lbs/hr	14.318 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned} \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton}) \end{aligned}$$

**Table 8
Diesel Fired Equipment Emissions
Welding Rigs (10)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 50 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 3 gal/hr each [7,000 bsfc (Btu/hp-hr) x 30 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 10,800 hours 10 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u> <u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	5.6 g/hp-hr	0.617 lbs/hr	3.333 tons	EPA Tier 3 Off-Road Standards (25-50 hp)
Carbon Monoxide (CO)	4.1 g/hp-hr	0.452 lbs/hr	2.440 tons	EPA Tier 3 Off-Road Standards (25-50 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	2.98E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.45 g/hp-hr	0.050 lbs/hr	0.268 tons	EPA Tier 3 Off-Road Standards (25-50 hp)
Total Organic Compounds (TOC)	0.56 g/hp-hr	0.062 lbs/hr	0.333 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0003 lbs/hr	1.76E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0001 lbs/hr	7.73E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0001 lbs/hr	5.39E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	7.39E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0004 lbs/hr	2.23E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0003 lbs/hr	1.45E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0000 lbs/hr	1.75E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0000 lbs/hr	1.60E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.001 lbs/hr	7.16E-03 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	57 lbs/hr	308.225 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.002 lbs/hr	1.25E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.000 lbs/hr	2.50E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	57 lbs/hr	309.262 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 9
Diesel Fired Equipment Emissions
X-Ray Rigs (6)

Project Name:	Denver Expansion Project			
County, State:	Arapahoe County, CO			
Equipment Rating:	200 HP each	estimated		
Estimated Heat Rate (BSFC)	7000 Btu/hp-hr	Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.		
Estimated Fuel Consumption	10 gal/hr each	[7,000 bsfc (Btu/hp-hr) x 200 HP / 137,300 Btu/gal]		
Fuel Type:	Diesel			
Hours of Operation:	6,480 hours total	6 units, onsite for 108 days of construction, operating 10 hours per day		
<u>Emission Rates</u>				
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.323 lbs/hr	4.286 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.146 lbs/hr	3.714 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.002 lbs/hr	7.14E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.066 lbs/hr	0.214 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.132 lbs/hr	0.429 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0013 lbs/hr	4.23E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0006 lbs/hr	1.86E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0004 lbs/hr	1.29E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	1.77E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0017 lbs/hr	5.35E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0011 lbs/hr	3.48E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0001 lbs/hr	4.20E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	3.85E-04 tons	AP-42 Table 3.3-2 (10/96)
	Total HAP:	0.005 lbs/hr	1.72E-02 tons	
<u>Greenhouse Gases</u>				
	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	228 lbs/hr	739.739 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.009 lbs/hr	3.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.002 lbs/hr	6.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	229 lbs/hr	742.230 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 10
Diesel Fired Equipment Emissions
Sandblaster Unit (8)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 100 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 5 gal/hr each [7,000 bsfc (Btu/hp-hr) x 100 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 4,320 hours total 8 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u> <u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.5 g/hp-hr	0.772 lbs/hr	1.667 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Carbon Monoxide (CO)	3.7 g/hp-hr	0.816 lbs/hr	1.762 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	2.38E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.30 g/hp-hr	0.066 lbs/hr	0.143 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Total Organic Compounds (TOC)	0.35 g/hp-hr	0.077 lbs/hr	0.167 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0007 lbs/hr	1.41E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0003 lbs/hr	6.18E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0002 lbs/hr	4.31E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	5.91E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0008 lbs/hr	1.78E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0005 lbs/hr	1.16E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0001 lbs/hr	1.40E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	1.28E-04 tons	AP-42 Table 3.3-2 (10/96)
	Total HAP:	0.003 lbs/hr	5.73E-03 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	114 lbs/hr	246.580 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.005 lbs/hr	1.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.001 lbs/hr	2.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	115 lbs/hr	247.410 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned}\text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton})\end{aligned}$$

Table 11
Diesel Fired Equipment Emissions
6" Water Pumps (4)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 70 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 4 gal/hr each [7,000 bsfc (Btu/hp-hr) x 70 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 4,320 hours total 4 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u>	<u>Basis of Estimate</u>
			<u>Project Emissions</u>	
Nitrogen Oxides (NOx)	3.5 g/hp-hr	0.540 lbs/hr	1.167 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Carbon Monoxide (CO)	3.7 g/hp-hr	0.571 lbs/hr	1.233 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	1.67E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.30 g/hp-hr	0.046 lbs/hr	0.100 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Total Organic Compounds (TOC)	0.35 g/hp-hr	0.054 lbs/hr	0.117 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0005 lbs/hr	9.87E-04 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0002 lbs/hr	4.33E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0001 lbs/hr	3.02E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	4.14E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0006 lbs/hr	1.25E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0004 lbs/hr	8.12E-04 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0000 lbs/hr	9.79E-05 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0000 lbs/hr	8.98E-05 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.002 lbs/hr	4.01E-03 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	80 lbs/hr	172.606 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.003 lbs/hr	7.00E-03 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.001 lbs/hr	1.40E-03 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	80 lbs/hr	173.187 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 12
Diesel Fired Equipment Emissions
Haul Trucks (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 475 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 24 gal/hr each [7,000 bsfc (Btu/hp-hr) x 475 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours 2 units, onsite for 108 days of construction, operating 10 hours per day

		<u>Emission Rates</u>		
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.0 g/hp-hr	3.142 lbs/hr	3.393 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	2.723 lbs/hr	2.940 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.005 lbs/hr	5.65E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.157 lbs/hr	0.170 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.314 lbs/hr	0.339 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0031 lbs/hr	3.35E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0014 lbs/hr	1.47E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0009 lbs/hr	1.02E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	1.40E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0039 lbs/hr	4.24E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0026 lbs/hr	2.75E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0003 lbs/hr	3.32E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0003 lbs/hr	3.05E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.013 lbs/hr	1.36E-02 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO2)	73.96 kg/MMBtu	542 lbs/hr	585.627 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.022 lbs/hr	2.38E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.004 lbs/hr	4.75E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	544 lbs/hr	587.598 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 13
Diesel Fired Equipment Emissions
Skid Trucks (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 250 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 13 gal/hr each [7,000 bsfc (Btu/hp-hr) x 250 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours total 2 units, onsite for 108 days of construction, operating 10 hours per day

		<u>Emission Rates</u>		
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.653 lbs/hr	1.786 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.433 lbs/hr	1.548 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.003 lbs/hr	2.98E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.083 lbs/hr	0.089 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.165 lbs/hr	0.179 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0016 lbs/hr	1.76E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0007 lbs/hr	7.73E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0005 lbs/hr	5.39E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	7.39E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0021 lbs/hr	2.23E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0013 lbs/hr	1.45E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	1.75E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	1.60E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.007 lbs/hr	7.16E-03 tons	

Greenhouse Gases

	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	285 lbs/hr	308.225 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.012 lbs/hr	1.25E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.002 lbs/hr	2.50E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	286 lbs/hr	309.262 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 14
Diesel Fired Equipment Emissions
Boom Trucks (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 300 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 15 gal/hr each [7,000 bsfc (Btu/hp-hr) x 300 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours 2 units, onsite for 108 days of construction, operating 10 hours per day

Criteria Pollutants	Emission Factor	Emission Rates		Basis of Estimate
		Average Hourly Emissions	Project Emissions	
Nitrogen Oxides (NO _x)	3.0 g/hp-hr	1.984 lbs/hr	2.143 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.720 lbs/hr	1.857 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SO _x)	0.005 g/hp-hr	0.003 lbs/hr	3.57E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.15 g/hp-hr	0.099 lbs/hr	0.107 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.198 lbs/hr	0.214 tons	Assumed 10% of total NMHC + NO _x Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0020 lbs/hr	2.12E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0009 lbs/hr	9.28E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0006 lbs/hr	6.46E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	8.87E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0025 lbs/hr	2.68E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0016 lbs/hr	1.74E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	2.10E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	1.92E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.008 lbs/hr	8.60E-03 tons	

Greenhouse Gases	Emission Factor	Average Hourly Emissions	Project Emissions	Basis of Estimate
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	342 lbs/hr	369.870 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.014 lbs/hr	1.50E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	3.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	344 lbs/hr	371.115 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/hp-hr) x (Engine's Horsepower Rate, hp)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

**Table 15
Diesel Fired Equipment Emissions
Pickup Trucks (20)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 300 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 15 gal/hr each [7,000 bsfc (Btu/hp-hr) x 300 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 21,600 hours 20 units, onsite for 108 days of construction, operating 10 hours per day

Criteria Pollutants	Emission Factor	Emission Rates		Basis of Estimate
		Average Hourly Emissions	Project Emissions	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	1.984 lbs/hr	21.429 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.720 lbs/hr	18.571 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.003 lbs/hr	3.57E-02 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.099 lbs/hr	1.071 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.198 lbs/hr	2.143 tons	Assumed 10% of total NMHC + NOx Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0020 lbs/hr	2.12E-02 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0009 lbs/hr	9.28E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0006 lbs/hr	6.46E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	8.87E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0025 lbs/hr	2.68E-02 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0016 lbs/hr	1.74E-02 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	2.10E-03 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	1.92E-03 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.008 lbs/hr	8.60E-02 tons	

Greenhouse Gases	Emission Factor	Average Hourly Emissions	Project Emissions	Basis of Estimate
Carbon Dioxide (CO2)	73.96 kg/MMBtu	342 lbs/hr	3698.695 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.014 lbs/hr	1.50E-01 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	3.00E-02 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	344 lbs/hr	3711.148 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/hp-hr) x (Engine's Horsepower Rate, hp)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 16
Diesel Fired Equipment Emissions
Mechanic Rigs (4)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 350 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 18 gal/hr each [7,000 bsfc (Btu/hp-hr) x 350 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 4,320 hours 4 units, each onsite for 108 days of construction, operating 10 hours per day

		<u>Emission Rates</u>			
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.315 lbs/hr	5.000 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Carbon Monoxide (CO)	2.6 g/hp-hr	2.006 lbs/hr	4.333 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	8.33E-03 tons	ULSD Combustion per Off-Road Stds	
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.116 lbs/hr	0.250 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.231 lbs/hr	0.500 tons	Assumed 10% of total NMHC + NOx Limit	

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0023 lbs/hr	4.94E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0010 lbs/hr	2.16E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0007 lbs/hr	1.51E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	2.07E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0029 lbs/hr	6.24E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0019 lbs/hr	4.06E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	4.90E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	4.49E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.009 lbs/hr	2.01E-02 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	400 lbs/hr	863.029 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.016 lbs/hr	3.50E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	7.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	401 lbs/hr	865.934 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned} \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton}) \end{aligned}$$

Table 17
Diesel Fired Equipment Emissions
Flatbeds (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 400 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 20 gal/hr each [7,000 bsfc (Btu/hp-hr) x 400 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours 2 units, onsite for 108 days of construction, operating 10 hours per day

		<u>Emission Rates</u>			
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.646 lbs/hr	2.857 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Carbon Monoxide (CO)	2.6 g/hp-hr	2.293 lbs/hr	2.476 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	4.76E-03 tons	ULSD Combustion per Off-Road Stds	
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.132 lbs/hr	0.143 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.265 lbs/hr	0.286 tons	Assumed 10% of total NMHC + NOx Limit	

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0026 lbs/hr	2.82E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0011 lbs/hr	1.24E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0008 lbs/hr	8.62E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	1.18E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0033 lbs/hr	3.57E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0021 lbs/hr	2.32E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0003 lbs/hr	2.80E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	2.56E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.011 lbs/hr	1.15E-02 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	457 lbs/hr	493.159 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.019 lbs/hr	2.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.004 lbs/hr	4.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	458 lbs/hr	494.820 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

**Table 18
Diesel Fired Equipment Emissions
Stringing Trucks (10)**

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 400 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 20 gal/hr each [7,000 bsfc (Btu/hp-hr) x 400 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 10,200 hours 10 units, onsite for 102 days of construction, operating 10 hours per day

		<u>Emission Rates</u>			
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.646 lbs/hr	13.492 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Carbon Monoxide (CO)	2.6 g/hp-hr	2.293 lbs/hr	11.693 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	2.25E-02 tons	ULSD Combustion per Off-Road Stds	
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.132 lbs/hr	0.675 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.265 lbs/hr	1.349 tons	Assumed 10% of total NMHC + NOx Limit	

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0026 lbs/hr	1.33E-02 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0011 lbs/hr	5.84E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0008 lbs/hr	4.07E-03 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	5.58E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0033 lbs/hr	1.69E-02 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0021 lbs/hr	1.10E-02 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0003 lbs/hr	1.32E-03 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	1.21E-03 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.011 lbs/hr	5.41E-02 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	457 lbs/hr	2328.808 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.019 lbs/hr	9.45E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.004 lbs/hr	1.89E-02 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	458 lbs/hr	2336.648 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 19
Diesel Fired Equipment Emissions
Tractor Trailer Tanker (2)

Project Name:	Denver Expansion Project	
County, State:	Arapahoe County, CO	
Equipment Rating:	400 HP each	estimated
Estimated Heat Rate (BSFC)	7000 Btu/hp-hr	Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption	20 gal/hr each	[7,000 bsfc (Btu/hp-hr) x 400 HP / 137,300 Btu/gal]
Fuel Type:	Diesel	
Hours of Operation:	1,520 hours	2 units, onsite for 76 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Emission Rates</u>		<u>Basis of Estimate</u>
		<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.646 lbs/hr	2.011 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	2.293 lbs/hr	1.743 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	3.35E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.132 lbs/hr	0.101 tons	EPA Tier 3 Off-Road Standards (300-600 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.265 lbs/hr	0.201 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0026 lbs/hr	1.99E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0011 lbs/hr	8.70E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0008 lbs/hr	6.06E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	8.32E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0033 lbs/hr	2.51E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0021 lbs/hr	1.63E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0003 lbs/hr	1.97E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	1.80E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.011 lbs/hr	8.07E-03 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO2)	73.96 kg/MMBtu	457 lbs/hr	347.038 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.019 lbs/hr	1.41E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.004 lbs/hr	2.82E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	458 lbs/hr	348.206 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

$$\begin{aligned} \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, g/hp-hr}) \times (\text{Engine's Horsepower Rate, hp}) \times (1 \text{ lb} / 453.6 \text{ g}) \\ \text{Pollutant Emission Rate (lbs/hr)} &= (\text{Emission Factor, lb/MMBtu}) \times (\text{BSFC, 7,000 Btu/hp-hr}) \times (\text{HP}) / \text{MM} \\ \text{Pollutant Emission Rate (tons/yr)} &= (\text{Pollutant Emission Rate, lbs/hr}) \times (\text{Maximum Annual Operating Time}) / (2000 \text{ lbs/ton}) \end{aligned}$$

Table 20
Diesel Fired Equipment Emissions
Cat Model 14 Graders (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 240 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 12 gal/hr each [7,000 bsfc (Btu/hp-hr) x 240 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 2,160 hours 2 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Emission Rates</u>		<u>Basis of Estimate</u>
		<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	
Nitrogen Oxides (NO _x)	3.0 g/hp-hr	1.587 lbs/hr	1.714 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Carbon Monoxide (CO)	2.6 g/hp-hr	1.376 lbs/hr	1.486 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Sulfur Oxides (SO _x)	0.005 g/hp-hr	0.003 lbs/hr	2.86E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.15 g/hp-hr	0.079 lbs/hr	0.086 tons	EPA Tier 3 Off-Road Standards (175-300 hp)
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.159 lbs/hr	0.171 tons	Assumed 10% of total NMHC + NO _x Limit

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0016 lbs/hr	1.69E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0007 lbs/hr	7.42E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0005 lbs/hr	5.17E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	7.09E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0020 lbs/hr	2.14E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0013 lbs/hr	1.39E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	1.68E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	1.54E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.006 lbs/hr	6.88E-03 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	274 lbs/hr	295.896 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.011 lbs/hr	1.20E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.002 lbs/hr	2.40E-03 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	275 lbs/hr	296.892 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/hp-hr) x (Engine's Horsepower Rate, hp)
Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM
Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 21
Diesel Fired Equipment Emissions
Ingersoll Rand Compressors (8)

Project Name: Denver Expansion Project
 Parish, State: Arapahoe County, CO

Equipment Rating: 100 HP each estimated
 Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
 Estimated Fuel Consumption 5 gal/hr each [7,000 bsfc (Btu/hp-hr) x 100 HP / 137,300 Btu/gal]
 Fuel Type: Diesel
 Hours of Operation: 8,640 hours total 8 units, onsite for 108 days of construction, operating 10 hours per day

<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Emission Rates</u>	<u>Basis of Estimate</u>
			<u>Project Emissions</u>	
Nitrogen Oxides (NOx)	3.5 g/hp-hr	0.772 lbs/hr	3.333 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Carbon Monoxide (CO)	3.7 g/hp-hr	0.816 lbs/hr	3.524 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.001 lbs/hr	4.76E-03 tons	ULSD Combustion per Off-Road Stds
Particulate Matter (PM ₁₀ / PM _{2.5})	0.30 g/hp-hr	0.066 lbs/hr	0.286 tons	EPA Tier 3 Off-Road Standards (50-100 hp)
Total Organic Compounds (TOC)	0.35 g/hp-hr	0.077 lbs/hr	0.333 tons	Assumed 10% of total NMHC + NOx Limit
<u>Hazardous Air Pollutants (HAPs)</u>				
Benzene	9.33E-04 lb/MMBtu	0.0007 lbs/hr	2.82E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0003 lbs/hr	1.24E-03 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0002 lbs/hr	8.62E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0000 lbs/hr	1.18E-04 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0008 lbs/hr	3.57E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0005 lbs/hr	2.32E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0001 lbs/hr	2.80E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0001 lbs/hr	2.56E-04 tons	AP-42 Table 3.3-2 (10/96)
	Total HAP:	0.003 lbs/hr	1.15E-02 tons	
<u>Greenhouse Gases</u>				
Carbon Dioxide (CO ₂)	73.96 kg/MMBtu	114 lbs/hr	493.159 tons	40 CFR 98, Table C-1
Methane (CH ₄)	3.00E-03 kg/MMBtu	0.005 lbs/hr	2.00E-02 tons	40 CFR 98, Table C-2
Nitrous Oxide (N ₂ O)	6.00E-04 kg/MMBtu	0.001 lbs/hr	4.00E-03 tons	40 CFR 98, Table C-2
Total GHG in CO ₂ e	74.21 kg/MMBtu	115 lbs/hr	494.820 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 22
Diesel Fired Equipment Emissions
Hydro-Vac Trucks (2)

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Equipment Rating: 350 HP each estimated
Estimated Heat Rate (BSFC) 7000 Btu/hp-hr Standard assumption for industrial diesel-fired engines. Matches that published by US EPA in AP-42, Table 3.3-1.
Estimated Fuel Consumption 18 gal/hr each [7,000 bsfc (Btu/hp-hr) x 350 HP / 137,300 Btu/gal]
Fuel Type: Diesel
Hours of Operation: 1180 hours 2 units, each onsite for 59 days of construction, operating 10 hours per day

		<u>Emission Rates</u>			
<u>Criteria Pollutants</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>	
Nitrogen Oxides (NOx)	3.0 g/hp-hr	2.315 lbs/hr	1.366 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Carbon Monoxide (CO)	2.6 g/hp-hr	2.006 lbs/hr	1.184 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Sulfur Oxides (SOx)	0.005 g/hp-hr	0.004 lbs/hr	2.28E-03 tons	ULSD Combustion per Off-Road Stds	
Particulate Matter (PM10 / PM2.5)	0.15 g/hp-hr	0.116 lbs/hr	0.068 tons	EPA Tier 3 Off-Road Standards (300-600 hp)	
Total Organic Compounds (TOC)	0.30 g/hp-hr	0.231 lbs/hr	0.137 tons	Assumed 10% of total NMHC + NOx Limit	

Hazardous Air Pollutants (HAPs)

Benzene	9.33E-04 lb/MMBtu	0.0023 lbs/hr	1.35E-03 tons	AP-42 Table 3.3-2 (10/96)
Toluene	4.09E-04 lb/MMBtu	0.0010 lbs/hr	5.91E-04 tons	AP-42 Table 3.3-2 (10/96)
Xylenes	2.85E-04 lb/MMBtu	0.0007 lbs/hr	4.12E-04 tons	AP-42 Table 3.3-2 (10/96)
1,3-Butadiene	3.91E-05 lb/MMBtu	0.0001 lbs/hr	5.65E-05 tons	AP-42 Table 3.3-2 (10/96)
Formaldehyde	1.18E-03 lb/MMBtu	0.0029 lbs/hr	1.71E-03 tons	AP-42 Table 3.3-2 (10/96)
Acetaldehyde	7.67E-04 lb/MMBtu	0.0019 lbs/hr	1.11E-03 tons	AP-42 Table 3.3-2 (10/96)
Acrolein	9.25E-05 lb/MMBtu	0.0002 lbs/hr	1.34E-04 tons	AP-42 Table 3.3-2 (10/96)
Naphthalene	8.48E-05 lb/MMBtu	0.0002 lbs/hr	1.23E-04 tons	AP-42 Table 3.3-2 (10/96)
Total HAP:		0.009 lbs/hr	5.48E-03 tons	

<u>Greenhouse Gases</u>	<u>Emission Factor</u>	<u>Average Hourly Emissions</u>	<u>Project Emissions</u>	<u>Basis of Estimate</u>
Carbon Dioxide (CO2)	73.96 kg/MMBtu	400 lbs/hr	235.735 tons	40 CFR 98, Table C-1
Methane (CH4)	3.00E-03 kg/MMBtu	0.016 lbs/hr	9.56E-03 tons	40 CFR 98, Table C-2
Nitrous Oxide (N2O)	6.00E-04 kg/MMBtu	0.003 lbs/hr	1.91E-03 tons	40 CFR 98, Table C-2
Total GHG in CO2e	74.21 kg/MMBtu	401 lbs/hr	236.528 tons	GWP from 40 CFR 98, Table A-1

Note: The average hourly emission rates are for each piece of equipment. The total project emission rates are for all such units associated with construction of the Denver Expansion Project in Arapahoe County.

Example of Calculations:

Pollutant Emission Rate (lbs/hr) = (Emission Factor, g/hp-hr) x (Engine's Horsepower Rate, hp) x (1 lb / 453.6 g)

Pollutant Emission Rate (lbs/hr) = (Emission Factor, lb/MMBtu) x (BSFC, 7,000 Btu/hp-hr) x (HP) / MM

Pollutant Emission Rate (tons/yr) = (Pollutant Emission Rate, lbs/hr) x (Maximum Annual Operating Time) / (2000 lbs/ton)

Table 23
Particulate Emissions from Vehicles on Unpaved Roads

Project Name: Denver Expansion Project
Parish, State: Arapahoe County, CO

Emission Estimates for Semi-Trucks on Unpaved Roads

	Constants from Table 13.2.2-2			Silt Content (%)	Mean Vehicle Weight (tons)	Pollutant Emission Rate (lb/VMT)	Daily Vehicle Miles (miles/day)	Total Project Time (days)	Vehicle Miles Traveled (miles/project)	Control Efficiency from Mitigation (%)	Pollutant Emissions (tons/project)
Pollutant	k (lb/VMT)	a	b	s	W	E			VMT		
TSP	4.9	0.7	0.45	8.5	13	7.45	20	108	2160	50%	4.02
PM ₁₀	1.5	0.9	0.45	8.5	13	2.13	20	108	2160	50%	1.15
PM _{2.5}	0.15	0.9	0.45	8.5	13	0.21	20	108	2160	50%	0.11

Emission Estimates for Pickup Trucks and Commuter Vehicles on Unpaved Roads

	Constants from Table 13.2.2-2			Silt Content (%)	Mean Vehicle Weight (tons)	Pollutant Emission Rate (lb/VMT)	Daily Vehicle Miles (miles/day)	Total Project Time (days)	Vehicle Miles Traveled (miles/project)	Control Efficiency from Mitigation (%)	Pollutant Emissions (tons/project)
Pollutant	k (lb/VMT)	a	b	s	W	E			VMT		
TSP	4.9	0.7	0.45	8.5	2	3.21	30	108	3240	50%	2.60
PM ₁₀	1.5	0.9	0.45	8.5	2	0.92	30	108	3240	50%	0.74
PM _{2.5}	0.15	0.9	0.45	8.5	2	0.092	30	108	3240	50%	0.07

Notes:

$E \text{ (lb pollutant/VMT)} = [k (s/12)^a (W/3)^b]$ --> Eqn 1a from Section 13.2.2, where:

k, a & b are all constants taken from Table 13.2.2-2 for each particle size;

s = surface material silt content in %, taken from Table 13.2.2-1 for construction sites;

W = mean vehicle weight in tons, assumed based on typical vehicles

The daily vehicle miles and total project time are estimated based on the scope of the project and experience with similar projects. These yield the estimate of VMT for the project.

It is conservatively assumed that no rain will fall during the project period. Based on information found in EPA Document EPA-450/3-88-908 (Control of Open Fugitive Dust Sources), it is assumed that the planned roadway watering program and other mitigation measures will result in a 50% reduction of particulate emissions from unpaved road. This assumption is taken from Section 5.3.1.1 of the referenced document (page 5-10).

Pollutant	Pollutant Emissions (tons/project)
TSP	6.62
PM ₁₀	1.89
PM _{2.5}	0.19

Table 24
Land Clearing Emissions

Project Name: Denver Expansion Project
County, State: Arapahoe County, CO

Hours of Operation: 320 hours total One dozer conducting land clearing for 32 days (10 hours/day)

Using AP-42 Section 11.9 (10/98) Western Surface Coal Mining
From Table 11.9-1 for Bulldozing of Overburden:

$$\text{TSP Emission Rate (lb/hr)} = [5.7 \text{ (s)}^{1.2}] / (\text{M})^{1.3}$$

s = material silt content (%) s = 6.9 (AP-42, Table 11.9-3; bulldozers, Overburden)

M = material moisture content (%) M = 7.9 (AP-42, Table 11.9-3; bulldozers, Overburden)

TSP (lb/hr) = 3.94 lb/hr (TSP)
0.63 tons/project (TSP)

From Table 11.9-1 for Bulldozing of Overburden, Scaling Factors:

PM ₁₀ =	0.75	2.96 lb/hr (PM ₁₀) 0.47 tons/project (PM ₁₀)
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PM _{2.5} =	0.105	0.41 lb/hr (PM _{2.5}) 0.07 tons/project (PM _{2.5})
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