APPENDIX A
Project Emissions Inventory

Table F.1.1: Proposed Action Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C) of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42* , Volume I, Section 13.2.3 Heavy Construction	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Total number of pads in 2016	1861	EOG Resources	
Number wells to estimate construction emissions in 2016	186	EOG Resources	
Compression per well	200	EOG Resources	
Average HP of the central compressor station	50,000	EOG Resources	
Total number of well head compressors in 2013.	23	EOG Resources	
Total number of well head compressors in 2021.	56	EOG Resources	

Well Emission Assumptions:

Emission factors derived from AP-42 or otherwise noted.

Gas compressors assumed to be BACT equipped.

Assume diesel fuel sulfur content of 0.05% for diesel engines.

Well condensate production assumed to be from wells with Best Available Control Technology (BACT).

Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10} for the following categories, heavy equipment traffic, natural gas compression, dehydrators, separators and flashing emissions.

Hazardous Air Pollutants (HAPS) assumed to be 10% of VOCs and formaldehyde added for gas compression emissions

For well head compressors, assume 200 Hp/compressor, installed on 30 of every 1,000 wells.

Assume natural gas heating value of 1,020 Btu/scf (BLM, 2003).

Assume that natural gas compressors would operate at full capacity.

Short term represents a seven year time period through the year 2013.

Long term represents a ten year time period through the year 2016.

86 is the total number of precipitation days for Kemmerer WY, Western Regional Climate Center.

In this analysis, total wells constructed in a year were used to calculate construction emissions. These wells include abandoned, as well as operating. For the operations of natural gas wells (total of wells in the ground), the BLM used total wells (existing plus number of wells drilled) minus 12% abandoned wells(multiplied by .88). Therefore only operational wells are used to calculate operating emissions.

Table F.1.2: Proposed Action Natural Gas Pad Construction Fugitive Dust Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C)of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42* , Volume I, Section 13.2.3 Heavy Construction Operations (1/95)	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Number of wells drilled by 2016	**1861**	**EOG Resources**	
Total number of pads in 2016	**1861**	**EOG Resources**	
Number of wells to estimate construction emissions in 2016	**186**	**EOG Resources**	
Number of well head compressors in 2021	**56**	**EOG Resources**	
HP compression per well	**200**	**EOG Resources**	
HP of central compressor stations	**50,000**	**EOG Resources**	

Table F1.1.3: Proposed Action, Natural Gas Pad Construction, Fugitive Dust Calculations

Area Disturbed for NG Wells	Emission Estimation Basis	Disturbed Area (acre) [a]	Avg. Number of Days to Complete	Total # of Well Pads or Stations	Total Disturbed Area (acre)	Emissions								
						(lb/well pad or lb/stn)			(ton/project)			lb/hr/source		ton/year/source
						TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Drilling Roads, Producing Roads, Drilling Well Pad & Producing Well Pad, New Pipeline and Electric Line	per Well Pad	2.75	7	1,861	5,118	770	200	30	716	186	28	1.19	0	0
Central Compressor Station	per station	1.50	4	1	2	240	62	9	0	0	0	0.65	0	0
Totals					5,119	**Total**			**717**	**186**	**28**			

[a] From gross surface disturbance projections BLM

Note: number of compressor stations are for new construction

TSP= 1.2 tpy/acre-month x 5,118 acres x 7/30 days x 0.5 dust control efficiency = 716 tons

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation

hours per day = 24

Table F1.1.4: Proposed Action Gas Analysis

Pinedale Frontier Formation Gas Analysis

Gas Component	Mol%	Mol%/100	Molecular Weight	Molecular Weight of each Component
N_2	1.2953	0.012953	28.01	0.363
Methane (C1)	83.3591	0.833591	16.04	13.371
CO_2	0.1265	0.001265	44.01	0.056
Ethane (C2)	8.7362	0.087362	30.07	2.627
Propane (C3)	4.1642	0.041642	44.10	1.836
I-Butane (iC4)	0.6661	0.006661	58.12	0.387
N-Butane (nC4)	0.9106	0.009106	58.12	0.529
I-pentane (iC5)	0.2129	0.002129	72.15	0.154
N-pentane (nC5)	0.1908	0.001908	72.15	0.138
Hexanes (C6)	0.1454	0.001454	84.18	0.122
Heptanes (C7)	0.1317	0.001317	100.20	0.132
Octanes (C8)	0.058	0.00058	114.23	0.066
Nonanes	0.0032	0.000032	114.23	0.004
TOTAL	**100**			**19.785**

MW = Mol%/100*MW

Methane (C1) = 0.833591*16.04 = 13.371

VOC = C_3^+ components = 3.368

VOC Weight Percent = 3.368/19.785*100 = 17.02%

BTU Value 1,189

Pinedale Frontier Formation Condensate Analysis

WELL NAME:	**Frontier Well**
COMPONENT	**MOL%**
H2S	0.0000
O2	0.0000
CO2	0.0000
N2	0.0000
C1	0.4064
C2	1.7056
C3	3.3635
IC4	2.2423
NC4	3.0113
IC5	3.8486
NC5	3.5648
Hexanes	14.1300
Heptanes	44.6335
Benzene	1.8256
Toluene	8.5229
E-Benzene	0.7922
Xylene	6.2070
n-C6	5.7245
2,2,4-Trimethylpentane	0.0219
Total	**100.000**

Table F1.1.5: Proposed Action Emissions Factors for Construction Equipment

Emission Factors for Construction Equipment						
Equipment	Emission Factors (g/hp-hr)					Equipment Category in AP-42 [a]
	NO_x	PM_{10}	SO_2	CO	VOCs	
Backhoe	8.81	0.81	0.86	2.71	0.97	Wheeled Loader
Dozer	7.81	0.69	0.85	2.15	0.75	Track-Type Tractor
Blade	7.14	0.63	0.87	1.54	0.36	Motor Grader
Trencher	11.01	0.90	0.93	4.60	1.01	Miscellaneous
Trackhoe	9.30	0.66	0.85	2.26	1.11	Track-Type Loader

[a] BLM, 2003, table APP_A21.

Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (9/85).

Table F1.1.6: Proposed Action Well Pad Construction Emissions

Construction Site	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Oper. Hrs per Day	# of Oper. Days per Well Pad or per Station	# of Oper. Hrs per Well Pad or per Station	# of Well Pads or Stations	Emissions (lb/well pad, lb/station, or lb/project)					Emissions (ton/equipment type)					Emissions (ton/construction site)					Emissions lb/hour/source			Emissions ton/year/source	
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_2	CO	VOC	NO_x	PM_{10}	SO_2	CO	VOC	PM_{10}	SO_2	CO	NO_x	SO_2
Drilling Roads	Blade	100	1	80	10	3	30	1,861	38	3.3	4.6	8	1.9	35	3.1	4.3	7.6	1.8	67.7	6.1	7.5	17.6	5.4	0.1	0	0.3	0	0.0
	Backhoe	80	1	75	10	3	30	1,861	35	3.2	3.4	11	3.8	33	3.0	3.2	10.0	3.6						0.1	0	0.4	0	0.0
Producing Roads	Blade	100	1	80	10	3	30	1,861	38	3.3	4.6	8	1.9	35	3.1	4.3	7.6	1.8	67.7	6.1	7.5	17.6	5.4	0.1	0	0.3	0	0.0
	Backhoe	80	1	75	10	3	30	1,861	35	3.2	3.4	11	3.8	33	3.0	3.2	10.0	3.6						0.1	0	0.4	0	0.0
Drilling Well Pad	Backhoe	80	1	75	10	2	20	1,861	23	2.1	2.3	7	2.6	22	2.0	2.1	7	2.4	21.7	2.0	2.1	6.7	2.4	0.1	0	0.4	0	0.0
Producing Well Pad	Backhoe	80	1	75	10	2	20	1,861	23	2.1	2.3	7	2.6	22	2.0	2.1	7	2.4	21.7	2.0	2.1	6.7	2.4	0.1	0	0.4	0	0.0
New Pipeline	Blade	100	1	80	10	1	10	1,861	13	1.1	1.5	3	0.6	12	1.0	1.4	2.5	0.6	54	4.6	5.2	19	4.7	0.1	0	0.3	0	0.0
	Trencher	175	1	80	10	1	10	1,861	34	2.8	2.9	14	3.1	32	3	3	13	3						0.3	0	1.4	0	0
	Backhoe	80	1	75	10	1	10	1,861	12	1.1	1.1	4	1.3	11	1.0	1.1	3.3	1.2						0.1	0	0.4	0	0.0
Well Head Compressors	Dozer	350	1	80	8	2	16	56	77	6.8	8.4	21	7.4	2	0.19	0.24	0.6	0.2	3.3	0.3	0.3	0.9	0.3	0.4	1	1.3	0	0.00
	Backhoe	80	2	80	8	2	16	56	40	3.7	3.9	12	4.4	1	0.10	0.11	0.34	0.12						0.2	0	0.8	0	0.00
Central Compressor Station	Dozer	350	1	80	8	2	16	1	77	6.8	8.4	21	7.4	0	0.00	0.00	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.4	1	1.3	0	0.00
	Backhoe	80	2	80	8	2	16	1	40	3.7	3.9	12	4.4	0	0.00	0.00	0.01	0.00						0.2	0	0.8	0	0.00
																		Subtotal	**236**	**21.1**	**24.7**	**68.5**	**20.5**					

Table F1.1.7: Proposed Action Emissions Factors for Tier O Industrial Engines

Emission Factors for Industrial Engines (Tier 0)

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	lb/hp-hr	2.83E-02	2.20E-03	1.70E-03	4.40E-04	7.60E-04
Industrial Engine [b]	Diesel	lb/hp-hr	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

[a] WDEQ, taken from field tests on Detroit Engines, 12 V71T and 16V71T equally mixed in the field, 2007

[b] EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table F1.1.8: Proposed Action Emissions Estimates for Industrial Engines

Emissions Estimation for Industrial Engines

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions (lb/well)					Emissions (ton/equipment type)					Emissions (ton/project activity)					Emissions lb/hr/source			Emissions ton/yr/source	
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC	PM_{10} [a]	SO_x	CO	NO_x	SO_x
Rig-up, Drilling, and Rig-down	Main Deck	1,000	2	42	24	15	360	1,861	8,558	665	514	1,663	230	7,963	619	478	1,548	214	9,328	725.2	560.4	1,711	251	2	1	5	4	0
	Auxiliary Pump	600	1	42	8	15	120	1,861	856	67	51	166	23	796	62	48	155	21						1	0	1	0	0
	Generator	150	1	75	24	8	192	1,861	611	48	37	10	16	569	44	34	9	15						0	0	0	0	0
Well Completion & Testing	Main Deck	600	1	42	11	5	55	1,861	392	30	24	6	11	365	28	22	6	10	452	35	27	7	12	1	0	0	0	0
	Auxiliary Pump	225	1	42	8	2	16	1,861	43	3	3	1	1	40	3	2	1	1						0	0	0	0	0
	Power Swivel	150	1	75	8	2	16	1,861	51	4	3	1	1	47	4	3	1	1						0	0	0	0	0
									1.05E+04	**817**	**631**	**1,847**					**Subtotal**		**9,780**	**760**	**588**	**1,718**	**263**					

Table F1.1.9: Proposed Action Field Generator Emissions

Emission Factors for Field Generators

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	g/hp-hr	4.90E+00	2.20E-01	9.30E-01	3.70E+00	4.90E+00
Industrial Engine	Diesel	lbs/hp-hr	1.08E-02	4.80E-04	2.05E-03	8.20E-03	1.08E-02

[a] From USA - Nonroad Diesel Engines Tier 2 Emission Standards

Emission factors for a < 600 hp generator, (NOx & VOC = 4.9 g/bhp-hr)

Table F1.1.10: Proposed Action Temporary Emissions Estimates for Field Generators

Temporary Emissions Estimation for Field Generators

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions (lb/well)					Emissions (ton/equipment type)					Emissions lb/hr/source			Emissions ton/yr/source	
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC	PM_{10}	SO_2	CO	NO_x	SO_2
Field Generators	Field Generators for Pumps & Lighting	175	1	75	12	8	96	186	136	6	26	103	136	13	1	2	10	13	0	0	1	0	0
													TOTALS	**13**	**0.6**	**2**	**10**	**13**					

Table F1.1.11: Proposed Action Estimate of Emissions Factors for Emissions from Well Construction Flaring

Emission Factors for Flaring

Unit	NO_x	PM_{10}	SO_2	CO
lb/MMscf	76.0	7.6	0.6	413.3
lb/MMBtu	6.80E-02	6.80E-03	5.37E-04	3.70E-01

Emission factors for NOx & CO Source: EPA, *AP-42* , Volume I, Section 13.5 Industrial Flares

Emission factors for PM10 & SO2 from EPA, AP-42, Volume I, Section 1.4 Natural Gas Combustion

Table F1.1.12: Proposed Action Emissions from Well Completion Flaring

Well Completion Flaring	Gas Production Estimate (MMSCF) per day	# of Days of Flaring	Av. Heat Content of Gas btu/scf	# of Wells	Emissions (lb/well)				Emissions (tons)				Emissions lb/hr/source			Emissions ton/yr/source	
					NO_x	PM_{10}	SO_2	CO	NO_x	PM_{10} [a]	SO_x	CO	PM_{10}	SO_2	CO	NO_x	SO_2
Flaring	1	2	1020	186	139	15.2	1.2	755	13	1	0.1	70	0.3	0.0	15.7	0	0
								TOTALS	**13**	**1**	**0.1**	**70**					

Emissions = EVH where E= emission factor; V= gas volume; H= heat content
NOx= 0.068lbs/MMBtu*1.0 MMSCFD*1020 Btu/scf = 69.5 lbs per well* 2 days = 139 lbs per well
PM10 & SO2 Emissions = EV where E= emission factor; V= gas volume
PM10 = 7.6 lbs/MMSCF*1.0 MMSCFD = 7.6 lbs/well*2days = 15.2 lbs per well

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per day = 24

Table F1.1.13: Proposed Action VOC Emissions from Well Completion Flaring

Well Completion Flaring	VOC Emission Factor lbs per well	# of Wells	VOC Emissions tons
Flaring	8,863	1,861	8,247

Assume average VOC content 17 %
Average Mole Weight 19.785
Gas production rate of 1.0 MMSCF per well per day
Assume 2 days of flaring

$$\text{Flare Gas wt} = \frac{2.0\ \text{MMSCF}*1{,}000{,}00\text{scf/MMSCF}*19.785\ \text{lbs/lbs-mole}}{379.49\text{scf/mole}}$$

VOC Emissions= 104,272 lbs/well*0.17VOC wt%*0.5 efficiency destruction = 8,863 lbs/well

HAPs are estimated at 10% of VOC amounts and are shown on total spread sheets
Assume same gas production rate for short term and long term new constructed wells of 1.0 MMSCFD

Table F1.1.14: Proposed Action Well Pad Construction Wind Erosion

Emission Factor: 0.3733 llb/hr/100m^2

Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meterological data.

Control Efficiency: 50%

Disturbed Area:

Well Pad Construction:	2.75 acres	11128.87 m^2
Central Compressor Construction:	1.50 acres	6070.29 m^2
Access Road Construction:	3.00 acres	12140.58 m^2
Pipeline Construction:	0.50 acres	2023.43 m^2

Source Parameters
147 1-km area sources
sigma z=2.33 m

PM_{10} Emission Calculations:

	PM_{10} Emission Factor (llb/hr/100m^2)	$PM_{2.5}$ Emission Factor (llb/hr/100m^2)	Area 100 m^2	Control Efficiency (%)	PM_{10} Emissions (lb/hr)	$PM_{2.5}$ Emissions (lb/hr)	PM_{10} Emissions (g/sec)	$PM_{2.5}$ Emissions (g/sec)
Well Pad Construction:	0.3733	0.1493	111.29	50	20.77	8.31	2.62	1.05
Central Compressor Construction	0.3733	0.1493	60.70	50	11.33	4.53	1.43	0.57
Resource Road Construction:	0.3733	0.1493	121.41	50	22.66	9.06	2.86	1.14
Pipeline Construction:	0.3733	0.1493	20.23	50	3.78	1.51	0.48	0.19
Total:					**58.54**	**23.41**	**7.38**	**2.95**

Assumptions for converting emissions to tons per year; used in AERMOD calculation
8760 = hours per year

Table F1.1.15: Proposed Action Fugitive Dust Emissions from Commuting Vehicles. Emission Factors for Road Traffic.

Emission Factors for Road Traffic

$$E\ (lb/VMT) = \frac{k\ (s/12)^a\ (W/3)^d}{(M/0.2)^c}$$

Parameter	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)

Function/Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	Listed in the table below	
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.1.16: Proposed Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	PM_{10}				$PM_{2.5}$				Emissions		
							Controlled Em. Factor (lb/VMT)	Emissions			Controlled Em. Factor (lb/VMT)	Emissions			lb/hr/source		ton/year/ source
								(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)		(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Drilling Roads	Semi Trucks	60,000	6	2	12	1,861	1.21	15	14	14	0.18	2.2	2.0	2.0	0	0	0
Producing Roads	Semi Trucks	60,000	6	2	12	1,861	1.21	15	14	14	0.18	2.2	2.0	2.0	0	0	0
Drilling Well Pad	Haul Trucks	45,000	6	2	12	1,861	1.05	13	12	16	0.16	1.9	1.8	2.4	0	0	0
	Pickup Trucks	7,000	6	2	12	1,861	0.41	5.0	5		0.06	0.7	0.7		0	0	0
Producing Well Pad	Haul Trucks	45,000	6	2	12	1,861	1.05	13	12	16	0.16	1.9	1.8	2.4	0	0	0
	Pickup Trucks	7,000	6	2	12	1,861	0.41	5.0	5		0.06	0.7	0.7		0	0	0
New Pipeline	Haul Trucks	45,000	6	2	12	1,861	1.05	13	12	16	0.16	1.9	1.8	2	0	0	0
	Pickup Trucks	7,000	6	2	12	1,861	0.41	5	5		0.06	0.7	0.7		0	0	0
Electric Line	Haul Trucks	45,000	6	2	12	1,861	1.05	12.6	12	16	0.16	1.9	1.8	2.4	0	0	0
	Pickup Trucks	7,000	6	2	12	1,861	0.41	5.0	5		0.06	0.7	0.7		0	0	0
Well Head Compressors	Semi Trucks	60,000	6	2	12	56	1.21	15	0.4	1	0.18	2	0.1	0	0	0	0
	Haul Trucks	45,000	6	2	12	56	1.05	13	0		0.16	2	0.1		0	0	0
	Pickup Trucks	7,000	6	2	12	56	0.41	5	0		0.06	1	0.0		0	0	0
Central Compressor Station	Semi Trucks	60,000	6	2	12	1	1.21	15	0.0	0	0.18	2	0.0	0	0	0	0
	Haul Trucks	45,000	6	2	12	1	1.05	13	0		0.16	2	0.0		0	0	0
	Pickup Trucks	7,000	6	2	12	1	0.41	5	0		0.06	1	0.0		0	0	0
								Subtotal		**93**				**14**			

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per day = 10
days per source = 21

Table F1.1.17: Proposed Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station [a]	Miles Traveled per Well Pad or per Station	Total # of Wells or Stations	PM_{10} Controlled Em. Factor (lb/VMT)	PM_{10} Emissions (lb/well)	PM_{10} Emissions (ton/veh. type)	PM_{10} Emissions (ton/proj. activity)	$PM_{2.5}$ Controlled Em. Factor (lb/VMT)	$PM_{2.5}$ Emissions (lb/well)	$PM_{2.5}$ Emissions (ton/veh. type)	$PM_{2.5}$ Emissions (ton/proj. activity)	Emissions lb/hr/source PM_{10}	Emissions lb/hr/source $PM_{2.5}$	Emissions ton/year/source $PM_{2.5}$
Rig-up, Drilling, and Rig-down	Semi Rig Transport & Drill Rig	80,000	6	5	30	186	1.40	42	4	22	0.21	6.3	0.6	3	0	0	0
	Fuel Haul Truck	50,000	6	5	30	186	1.10	33	3.1		0.17	5.0	0.5		0	0	0
	Mud Haul Truck, Water Hauling	60,000	6	5	30	186	1.21	36	3		0.18	5	0.5		0	0	0
	Rig Crew	7,000	6	5	30	186	0.41	12	1.2		0.06	1.9	0.2		0	0	0
	Rig Mechanics	12,000	6	5	30	186	0.54	16	1.5		0.08	2.4	0.2		0	0	0
	Co. Supervisor	7,000	6	5	30	186	0.41	12	1		0.06	1.9	0.2		0	0	0
	Tool Pusher	7,000	6	5	30	186	0.41	12	1.2		0.06	1.9	0.2		0	0	0
	Mud Logger	7,000	6	5	30	186	0.41	12	1.2		0.06	1.9	0.2		0	0	0
	Mud Engineer	7,000	6	5	30	186	0.41	12	1.2		0.06	1.9	0.2		0	0	0
	Logger, Engr Truck	45,000	6	5	30	186	1.05	31.4	2.9		0.16	4.7	0.4		0	0	0
	Drill Bit Delivery	7,000	6	5	30	186	0.41	12	1		0.06	1.9	0.2		0	0	0
Well Completion & Testing	Semi Casing Haulers	60,000	6	2	12	186	1.21	14.5	1	50	0.18	2.2	0.2	7	0	0	0
	Semi Completion, Unit Rig	120,000	6	8	48	186	1.71	82	7.6		0.26	12.3	1.1		0	0	0
	Semi Fracing Blender	85,000	6	2	12	186	1.44	17	1.6		0.22	2.6	0.2		0	0	0
	Semi Pumping Tank Battery	80,000	6	2	12	186	1.40	17	1.6		0.21	2.5	0.2		0	0	0
	Tubing Truck	60,000	6	2	12	186	1.21	14.5	1.3		0.18	2.2	0.2		0	0	0
	Haul Cementer, Pump Truck	85,000	6	2	12	186	1.44	17	1.6		0.22	2.6	0.2		0	0	0
	Haul Cementer, Cement Truck	60,000	6	8	48	186	1.21	58	5.4		0.18	8.7	0.8		0	0	0
	Haul Completion, Equip Truck	45,000	6	2	12	186	1.05	12.6	1.2		0.16	1.9	0.2		0	0	0
	Haul Service Tools	7,000	6	2	12	186	0.41	5.0	0.5		0.06	0.7	0.1		0	0	0
	Haul Perforators Logging Truck	45,000	6	2	12	186	1.05	12.6	1.2		0.16	1.9	0.2		0	0	0
	Haul Anchor Installation	40,000	6	2	12	186	0.99	11.9	1.1		0.15	1.8	0.2		0	0	0
	Haul Anchor Testing	12,000	6	2	12	186	0.54	6.5	0.6		0.08	1.0	0.1		0	0	0
	Haul Fracing Tank	40,000	6	2	12	186	0.99	11.9	1.1		0.15	1.8	0.2		0	0	0
	Haul Fracing Pump	85,000	6	2	12	186	1.44	17.3	1.6		0.22	2.6	0.2		0	0	0
	Haul Fracing Chemical	45,000	6	2	12	186	1.05	12.6	1.2		0.16	1.9	0.2		0	0	0
	Haul Fracing Sand	60,000	6	2	12	186	1.21	14.5	1.3		0.18	2.2	0.2		0	0	0
	Haul Fracing Other	85,000	6	2	12	186	1.44	17.3	1.6		0.22	2.6	0.2		0	0	0
	Haul Welders	12,000	6	2	12	186	0.54	6.5	0.6		0.08	1.0	0.1		0	0	0
	Haul Water Truck	60,000	6	8	48	186	1.21	58	5		0.18	9	0.8		0	0	0
	Pickup Cementer, Engineer	7,000	6	2	12	186	0.41	5.0	0.5		0.06	0.7	0.1		0	0	0
	Pickup Chasing Crew	10,000	6	2	12	186	0.49	5.9	0.6		0.07	0.9	0.1		0	0	0
	Pickup Completion Crew	10,000	6	8	48	186	0.49	23.7	2.2		0.07	3.6	0.3		0	0	0
	Pickup Completion Pusher	7,000	6	8	48	186	0.41	19.8	1.8		0.06	3.0	0.3		0	0	0
	Pickup Perforators Engineer	7,000	6	8	48	186	0.41	19.8	1.8		0.06	3.0	0.3		0	0	0
	Pickup Fracing Engineer	10,000	6	2	12	186	0.49	5.9	0.6		0.07	0.9	0.1		0	0	0
	Pickup Co. Supervisor	7,000	6	8	48	186	0.41	19.8	1.8		0.06	3.0	0.3		0	0	0
	Miscellaneous Supplies	7,000	6	8	48	186	0.41	19.8	1.8		0.06	3.0	0.3		0	0	0
	Pickup Roustabout Crew	12,000	6	2	12	186	0.54	6	0.6		0.08	1.0	0.1		0	0	0
Well Head Compressors	Semi Trucks	60,000	6	2	12	1	1.21	15	0.0		0.18	2	0.0		0	0	0
	Haul Trucks	45,000	6	2	12	1	1.05	13	0		0.16	2	0.0		0	0	0
	Pickup Trucks	7,000	6	2	12	1	0.41	5	0		0.06	1	0.0		0	0	0
Central Compressor Staton	Semi Trucks	60,000	6	2	12	1	1.21	15	0.0		0.18	2	0.0		0	0	0
	Haul Trucks	45,000	6	2	12	1	1.05	13	0		0.16	2	0.0		0	0	0
	Pickup Trucks	7,000	6	2	12	1	0.41	5	0		0.06	1	0.0		0	0	0
								Subtotal		**71**				**11**			
								TOTAL		**164**				**25**			

Table F1.1.18: Proposed Action Exhaust Emission Factors from Commuting Vehicles.

Emission Factors for Road Traffic

Vehicle		Emission Factors (g/mi)					
Type	**Class**	**NO_x**	**PM_{10} [a,b]**	**$PM_{2.5}$ [a,b]**	**SO_x [a]**	**CO**	**VOC**
Light-Duty Gasoline Truck	LDGT2	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck	HDDV	8.13	1.96	1.81	1.63	17.09	4.83

[a] From BLM, 2003, APP_A21, table 1.1.2.2, estimated using EPA PART5 Model (1995)
[b] Including tire and brake wear emissions.
Source: EPA, *AP-42* , Volume II, Appendix H-117, Table 3.1A.2 Light Duty Gasoline Powered Trucks II and Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehicles (High Altitude; Model Year 1991-1997; 50,000 mileage)

Table F1.1.19: Proposed Action Exhaust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle		Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	Emissions																										
							(lb/well pad, lb/station, or lb/project)						(ton/vehicle type)						(ton/construction site)						lb/hr/source				ton/year/source		
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO	NO_x	$PM_{2.5}$	SO_2
Drilling Roads	Semi Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.05	0.04	0.04	0.4	0.1	0.2	0.05	0.04	0.04	0.4	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Producing Roads	Semi Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.05	0.04	0.04	0.4	0.1	0.2	0.05	0.04	0.04	0.4	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Drilling Well Pad	Haul Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.05	0.04	0.04	0.4	0.1	0.2	0.05	0.05	0.04	0.7	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	2	12	1,861	0.03	0.003	0.002	0.003	0.31	0.02	0.0	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.001	0.00	0.00	0.0
Producing Well Pad	Haul Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.05	0.04	0.04	0.4	0.1	0.2	0.05	0.05	0.04	0.7	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	2	12	1,861	0.03	0.003	0.002	0.003	0.31	0.02	0.0	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.001	0.00	0.00	0.0
New Pipeline	Haul Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.0	0.0	0.04	0.4	0.1	0.2	0.1	0.0	0.0	0.7	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	2	12	1,861	0.03	0.00	0.00	0.00	0.31	0.02	0.0	0.002	0.002	0.003	0.3	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
Electric Line	Haul Trucks	HDDV	6	2	12	1,861	0.22	0.05	0.05	0.04	0.45	0.13	0.2	0.05	0.04	0.04	0.4	0.12	0.2	0.05	0.05	0.04	0.7	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	2	12	1,861	0.03	0.003	0.002	0.003	0.31	0.02	0.0	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.001	0.00	0.00	0.0
Central Compressor Station	Semi Trucks	HDDV	6	2	12	1	0.22	0.05	0.05	0.04	0.45	0.13	0.0	0.000	0.000	0.000	0.00	0.000	0.0	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Trucks	HDDV	6	2	12	1	0.22	0.05	0.05	0.04	0.45	0.13	0.0	0.000	0.000	0.000	0.00	0.00							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	2	12	1	0.03	0.00	0.00	0.00	0.31	0.02	0.0	0.000	0.000	0.000	0.0	0.00							0.00	0.00	0.00	0.00	0.00	0.00	0.0
																	Subtotal		**1.3**	**0.3**	**0.3**	**0.3**	**3.7**	**0.8**							

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per day = 10
days per source = 21

Table F1.1.20: Proposed Action Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Vehicle Class	Round Trip Distance (mi)	# of Round Trips per Well Pad or	Miles Traveled per Well or per Station	Total # of Wells or Stations	Emissions (lb/well)						Emissions (ton/vehicle type)						Emissions (ton/project activity)						Emissions (lb/hr/source)				Emissions (ton/year/source)		
							NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO	NO_x	$PM_{2.5}$	SO_2
Rig-up, Drilling, and Rig-down	Semi Rig Transport	HDDV	6	12	72	186	1.29	0.31	0.29	0.26	2.71	0.77	0.1	0.03	0.03	0.02	0.3	0.07	0.6	0.1	0.1	0.1	2.1	0.4	0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Fuel Haul Truck	HDDV	6	12	72	186	1.29	0.31	0.29	0.26	2.71	0.77	0.1	0.03	0.03	0.02	0.3	0.1							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Mud Haul Truck, Water	HDDV	6	12	72	186	1.29	0.31	0.29	0.26	2.71	0.77	0.1	0.0	0.0	0.0	0.3	0.1							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Rig Crew	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.001	0.001	0.002	0.2	0.01							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Rig Mechanics	HDDV	6	2	12	186	0.22	0.05	0.05	0.04	0.45	0.13	0.0	0.005	0.004	0.004	0.0	0.01							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Co. Supervisor	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.00	0.00	0.00	0.2	0.01							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Tool Pusher	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.0	0.0	0.0	0.2	0.0							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Mud Logger	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.0	0.0	0.0	0.2	0.0							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Mud Engineer	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.0	0.0	0.0	0.2	0.0							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Logger, Engr Truck	HDDV	6	12	72	186	1.29	0.31	0.29	0.26	2.71	0.77	0.1	0.0	0.0	0.0	0.3	0.1							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Drill Bit Delivery	LDGT2	6	12	72	186	0.16	0.02	0.01	0.02	1.85	0.12	0.0	0.00	0.00	0.00	0.2	0.01							0.00	0.00	0.00	0.01	0.00	0.00	0.0
Well Completion & Testing	Semi Casing Haulers	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04	1.9	0.4	0.4	0.4	5.2	1.0	0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Semi Completion, Unit Rig	HDDV	6	20	120	186	2.15	0.52	0.48	0.43	4.52	1.28	0.2	0.05	0.04	0.04	0.4	0.12							0.00	0.00	0.00	0.02	0.00	0.00	0.0
	Semi Fracing Blender	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Semi Pumping Tank Battery	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Tubing Truck	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Cementer, Pump Truck	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Cementer, Cement Truck	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Completion Equip Truck	HDDV	6	20	120	186	2.15	0.52	0.48	0.43	4.52	1.28	0.2	0.05	0.04	0.04	0.4	0.12							0.00	0.00	0.00	0.02	0.00	0.00	0.0
	Haul Service Tools	LDGT2	6	6	36	186	0.08	0.01	0.01	0.01	0.92	0.06	0.0	0.00	0.00	0.00	0.1	0.01							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Perforators Logging Truck	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Anchor Installation	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Anchor Testing	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.04							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Haul Fracing Tank	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Fracing Pump	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Fracing Chemical	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Fracing Sand	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Fracing Other	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Welders	HDDV	6	4	24	186	0.43	0.10	0.10	0.09	0.90	0.26	0.0	0.01	0.01	0.01	0.1	0.02							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Haul Water Truck	HDDV	6	20	120	186	2.15	0.52	0.48	0.43	4.52	1.28	0.2	0.05	0.04	0.04	0.4	0.12							0.00	0.00	0.00	0.02	0.00	0.00	0.0
	Pickup Cementer, Engineer	LDGT2	6	6	36	186	0.08	0.01	0.01	0.01	0.92	0.06	0.0	0.00	0.00	0.00	0.1	0.01							0.00	0.00	0.00	0.00	0.00	0.00	0.0
	Pickup Chasing Crew	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.0	0.0	0.0	0.1	0.0							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Pickup Completion Crew	HDDV	6	20	120	186	2.15	0.52	0.48	0.43	4.52	1.28	0.2	0.0	0.0	0.0	0.4	0.1							0.00	0.00	0.00	0.02	0.00	0.00	0.0
	Pickup Completion Pusher	LDGT2	6	20	120	186	0.27	0.026	0.020	0.030	3.08	0.20	0.02	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.015	0.00	0.00	0.00
	Pickup Perforations Engineer	LDGT2	6	20	120	186	0.27	0.026	0.020	0.030	3.08	0.20	0.02	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.015	0.00	0.00	0.00
	Pickup Fracing Engineer	HDDV	6	4	24	186	0.43	0.104	0.096	0.086	0.90	0.26	0.04	0.010	0.009	0.008	0.1	0.02							0.00	0.000	0.000	0.004	0.00	0.00	0.00
	Pickup Co. Supervisor	LDGT2	6	20	120	186	0.27	0.026	0.020	0.030	3.08	0.20	0.02	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.015	0.00	0.00	0.00
	Pickup Misc Supplies	LDGT2	6	20	120	186	0.27	0.026	0.020	0.030	3.08	0.20	0.02	0.002	0.002	0.003	0.3	0.02							0.00	0.000	0.000	0.015	0.00	0.00	0.00
	Pickup Roustabout Crew	HDDV	6	6	36	186	0.65	0.16	0.14	0.13	1.36	0.38	0.1	0.01	0.01	0.01	0.1	0.0							0.00	0.00	0.00	0.01	0.00	0.00	0.0
Well Head Compressors	Semi Trucks	HDDV	6	6	150	56	2.69	0.65	0.60	0.54	5.65	1.60	0.1	0.018	0.017	0.015	0.16	0.045							0.00	0.00	0.00	0.03	0.00	0.00	0.0
	Haul Trucks	HDDV	6	6	36	56	0.65	0.16	0.14	0.13	1.36	0.38	0.0	0.004	0.004	0.004	0.04	0.01							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	6	36	56	0.08	0.01	0.01	0.01	0.92	0.06	0.0	0.000	0.000	0.000	0.0	0.00							0.00	0.00	0.00	0.00	0.00	0.00	0.0
Central Compressor Station	Semi Trucks	HDDV	6	6	150	1	2.69	0.65	0.60	0.54	5.65	1.60	0.0	0.000	0.000	0.000	0.00	0.001							0.00	0.00	0.00	0.03	0.00	0.00	0.0
	Haul Trucks	HDDV	6	6	36	1	0.65	0.16	0.14	0.13	1.36	0.38	0.0	0.000	0.000	0.000	0.00	0.00							0.00	0.00	0.00	0.01	0.00	0.00	0.0
	Pickup Trucks	LDGT2	6	6	36	1	0.08	0.01	0.01	0.01	0.92	0.06	0.0	0.000	0.000	0.000	0.0	0.00							0.00	0.00	0.00	0.00	0.00	0.00	0.0
																		Subtotal	2.5	0.6	0.5	0.5	7	1.4							
																		TOTAL	3.8	0.9	0.8	0.7	11	2.1							

Table F1.1.21: Proposed Action Emission Factors for Central Compressor Stations

Emission Factors for Natural Gas-Fired Compressors

Compressor		Horse-Power Rating	Emission Factors (g/hp-hr) [a,d]						
			NOx [a,]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO	Formaldehyde
Central Compressor Station	Rich Burn	50,000	1.00	5.2E-03	2.0E-03	2.00	1.00	0.07	0.08

[a] From State of Wyoming AQD BACT for all except Formaldehyde
[b] From BLM, 2003. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.
[d] Formaldehyde emission factor is from Table B.2.10 of Johah Infill Drilling Project Technical Support Document, which references the Bird Canyon Permit

Table F1.1.22: Proposed Action Emissions Estimates for Central Compressor Stations

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)							Emissions (lb/hr)				
			NOx	PM_{10}	SO_2	CO	VOC	HCHO	Formaldehyde	PM_{10}	SO_2	CO	VOC	Formal-dehyde
Central Compressor Station	4	8,760	1,931	10	4	3,862	1,931	135	39	2	1	882	441	9
		Total	**1,931**	**10**	**4**	**3,862**	**1,931**	**135**						

Emissions per Compressor = emission factor g/hp-hr*compressor engine hp rating*(453.6g/lb)

NOX Emissions= (1.0 g/hp-hr*50,000 hp)/453.6g/lb = 110.23 lb per hour*8760 hours*4 stations/2000lb per ton = 1,931 tpy

482.8042328 for one compressor

Table F1.1.23: Proposed Action Emission Factors for Well Head Compressors

Emission Factors for Natural Gas-Fired Compressors

Compressor			Make	Model	Capacity (hp)	Emission Factors (g/hp-hr)						
						NOx [a, d]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO	CH_2O [e]
Well Head Compressors	Lean Burn	50%	Caterpillar	G3516LE	200	1.00	6.6E-02	2.0E-03	0.50	1.0E+00	0.07	0.08
	Rich Burn	50%	Waukesha	7044GSI	200	1.00	6.6E-02	2.0E-03	2.00	1.0E+00	0.05	0.08

[a] BACT
[b] From BLM Rawlins RMP, 2005. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM Rawlins RMP, 2005. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.
[d] Equipped with oxidizing catalyst and from Caterpillar gas engine technical data
[e] Formaldehyde emission factor is from Table B.2.10 of Johah Infill Drilling Project Technical Support Document, which references the Bird Canyon Permit

Table F1.1.24: Proposed Action Emissions Estimates for Well Head Compressors

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)							Total Emissions (lb/hr)				
			NOx	PM_{10}	SO_2	CO	VOC	HCHO*	CH_2O	PM_{10}	SO_2	CO	VOC	CH_2O
Well Head Compressors	56	8,760	108.15	7.14	0.22	135.19	108.15	6.49	8.65	1.63	0.05	30.86	24.69	1.98
		Total	**108.15**	**7.14**	**0.22**	**135.19**	**108.15**	**6.49**	**8.65**					

Total conventional well production based on 50,000 CF/day/well
*HCHO= formaldehyde

Table F1.125: Proposed Action VOC Emission Factors for Dehydration and Condensate Tank Flashing During Production Operations

VOC Emission Factors Dehydration and Condensate Tank Flashing

	(lb/hr/source)[b]						(ton/year/source)[b]					
Dehydration VOC Emissions	**VOC**	**Benzene**	**Toluene**	**Ethyl-benzene**	**Hexane**	**Xylene**	**VOC**	**Benzene**	**Toluene**	**Ethyl-benzene**	**Hexane**	**Xylene**
0.3759 lb/hr per MMSCF per day [a]	2.79	0.20	0.68	0.05	0.03	0.66	12.22	0.86	2.99	0.24	0.15	2.87

[a] Generated from GRI-GLYCalc Version 4.0 and South Piney AQ Analysis
[b] Generated from GRI-GLYCalc Version 4.0
Emission factor changed from 0.2164 lb/hr to 0.3759 lb/hr due to adding C9 and C10 components from S. Piney gas analysis

Flashing Emissions	
0.023 lb/hr controlled [a]	0.387 lb/hr uncontrolled [a]

[a] from E&P Tank Version 2.0 as per South Piney AQ Analysis

Table F1.1.26: Proposed Action VOC Emissions for Dehydration and Condensate Tank Flashing During Production Operations

Estimate for Dehydration VOC Emissions per year

VOC Emission Factor lb/hr	Total Number of Wells	Hours of Operation per year	Total VOC Emissions tpy	(lb/hr/source)						ton/year/source				
				VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
0.3759	1861	8760	3064	700	49	171	14	8	164	216	748	60	37	720

Assume 0.9 MMSCF gas production per well per day, based on input from EOG

Estimate for VOC Controlled Condensate Tank Flashing and Flaring Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Controlled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy	(lb/hr/source)						ton/year/source				
					VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
13,027	1,303	0.023	8760	131	30	2	7	1	0	7	9	32	3	2	31

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 70% of condensate tanks operate with a combustion chamber emission control device

Estimate for VOC Uncontrolled Condensate Tank Flashing Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Uncontrolled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy	(lb/hr/source)						ton/year/source				
					VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
5,583	558	0.387	8760	946	216	15	53	4	3	51	67	231	19	11	222

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 30% of condensate tanks operate without an emission control device
Assume one tank per well

<u>Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation</u>
hours per year = 8760

Table F1.1.27: Proposed Action Emissions Factors for Dehydrator Heaters for Production Operations

Production Emissions

Emission Factors for Dehydrator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

[a] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.

[b] From BLM, 2003. Assumed a fuel heating value of 1,020 Btu/scf.

Source: EPA, *AP-42* , Volume I, Section 1.4 Natural Gas Combustion (7/98).

Table F1.1.28: Proposed Action Emissions Estimates for Dehydrator Heaters for Production Operations

Emission Estimate for Dehydrator Heaters

Operating Hours per Year [a]	Dehydrator Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)										Total Emissions (lb/hr)								
				NOx	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
2,190	0.50	1.07	1861	100	8	1	84	5	0	0	0	0	0	7	1	77	5	0	0	0	0	0

[a] Assumed operating 15 minutes per hour per day
Assume Dehydrator Heater Operation at each well site
HAP emissions represented on summary tables

Table F1.1.29: Proposed Action Emission Factors for Three-Phase Separator Heaters

Emission Factors for Three-Phase Separator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

Table F1.130: Proposed Action Emission Estimates for Three-Phase Separator Heaters

Emission Estimates for Three Phase Separator Heaters

Operating Hours per Year [a]	Separator Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)										Total Emissions (lb/hr)								
				NOx	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
2,190	0.50	1.07	1861	100	8	1	84	5	0	0	0	0	0	7	1	77	5	0	0	0	0	0

[a] Assumed operating 15 minutes per hour per day
Assume Dehydrator Heater Operation at each well site

Table F1.1.31: Proposed Action Emission Factors for Condensate Tank Heaters

Emission Estimates for Condensate Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Condensate Tanks	Total Emissions (ton/year)										Total Emissions (lb/hr)								
				NOx	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
2,190	0.50	1.07	1861	100	8	1	84	5	0	0	0	0	0	7	1	77	5	0	0	0	0	0

[a] Assumed operating 15 minutes per hour per day
Assume a separator and heater for each well

Table F1.1.32: Proposed Action Emission Estimates for Produced Water Tank Heaters

Emission Estimates for Produced Water Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Produced Water Tanks	Total Emissions (ton/year)										Total Emissions (lb/hr)								
				NOx	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	SO_2	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
2,190	0.50	1.07	1861	100	8	1	84	5	0	0	0	0	0	7	1	77	5	0	0	0	0	0

[a] Assumed operating 15 minutes per hour per day
Assume a heater for each tank

Table F1.1.33: Proposed Action Fugitive Dust Emission Factors for Production Operations Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces

Table F1.1.34: Proposed Action Fugitive Dust Emissions Estimates for Production Operations Road Traffic

Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	PM_{10}			$PM_{2.5}$			Emissions (lb/hr/stn)	
									Emissions			Emissions			
								Em. Factor (lb/VMT) a	(lb/stn-yr)	(ton/proj.)	Em. Factor (lb/VMT)	(lb/stn-yr)	(ton/proj.)	PM_{10}	$PM_{2.5}$
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	4	52	208	10	0.63	6.3	0.7	0.09	0.9	0.10	0.0050609	0.000526
								Total		**0.7**			**0.1**		

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation

hours per inspection = 24

Table F1.1.35: Proposed Action Exhaust Emission Factors for Production Operations Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] Including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table F1.1.36: Proposed Action Exhaust Emission Estimates for Production Operations Road Traffic

Exhaust Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	Emissions (lb/station-yr)						Emissions (ton/project)										Emissions (lb/hr/stn)									
								NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	4	52	208	10	0.02	0.00	0.00	0.00	0.26	0.02	0.002	0.000	0.000	0.000	0.027	0.002	0	0	0	0	0	1.7E-06	1.3E-06	1.99E-06	0.00021	1.3E-05	0	0	0	0	0
													Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.00**															

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Emissions per well = emission factor g/mile*total miles per inspection/453.6 g/lb

Table F1.1.37: Proposed Action Fugitive Dust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
s = surface material silt content (%)	5.1	
W= mean vehicle weight (tons)	60	Assume workover rig 120,000 lbs
W= mean vehicle weight (tons)	30	Assume haul truck 60,000 lbs
W = mean vehicle weight (tons)	3.5	Assume pickup truck weight of 7,000 lbs
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* ,

Table F1.1.38: Proposed Action Fugitive Dust Emission Estimates for Well Workover Road Traffic

Fugitive Dust Emissions Estimation for Road Traffic															
Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well	Miles Traveled per Well	Total # of Wells Drilled	PM_{10}			$PM_{2.5}$			lb/hr/well		ton/year/well
							Emission Factor (lb/VMT)	Emissions (lb/well)	Emissions ton/proj.	Emission Factor (lb/VMT)	Emissions (lb/well)	Emissions (ton/proj.)	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Well Workover	Workover Rig	120,000	3	2	6	186	2.6	16	1	0.1	1	0.1	0.32689	0.012	0.0003
	Haul Truck	60,000	3	2	6	186	1.8	11	1	0.4	2	0.2	0.23114	0.044	0.0011
	Pickup Truck	7,000	3	2	6	186	0.6	4	0	0.2	1	0.1	0.07895	0.022	0.0005
								Total	**3**			**0.3**			

[a] BLM, 2003. Table APP_A21.
[b] BLM, 2003. No dust control measures would be applied.

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per round trip (driving time only, Workover Rig) = 24
hours per round trip (driving time only, Haul Truck) = 24
hours per round trip (driving time only, Pickup Truck) = 24

Table F1.1.39: Proposed Action Exhaust Emission Factors for Well Workover On-Site Industrial Engines

Emission Factors for Industrial Engines					
Fuel Type	**Emission Factors (lb/hp-hr)**				
	NO_x	**PM_{10}**	**SO_x**	**CO**	**VOC**
Diesel	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table F1.1.40: Proposed Action Exhaust Emission Estimates for Well Workover On-Site Industrial Engines

On-Site Exhaust Emissions Estimation for Industrial Engines

Activity	Equipment	Capacity (hp)	Ave. Operating Load Factor (%)	Operating Hours per well	Total # of Wells Drilled	Emissions (lb/well)					Emissions (ton/project)					Emissions lb/hr/source									Emissions ton/year/source)							
						NO_x	PM_{10}	SO_x	CO	VOC	NO_x	PM_{10}	SO_x	CO	VOC	PM_{10}	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	NO_x	SO_x	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Well Workover	Truck-Mounted Unit	600	0.7	30	186	302	7	5	69	9	28	0.7	0.5	6.4	0.8	0.2	0.2	2.3	0.3	0	0	0	0	0	0.17	2.31	0.2961	0	0	0	0	0

Emissions per well = emission factor lb/hp-hr*engine hp rating*operating hours*engine load factor %

NOx Emissions= $\frac{302 \text{ lb/well*186 wells}}{2000 \text{lb/ton}}$ = 28 tons

Table F1.1.41: Proposed Action Exhaust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light Duty Gasoline Truck (LDGT2)	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck (HDDV)	8.13	1.96	1.81	1.63	17.09	4.83

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).
[b] BLM, 2003. Including tire and brake wear emissions.
Source: EPA (1985), AP-42, Volume II, Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehicles (High Altitude; Model Year 1991-1997; 50,000 mileage).

Table F1.1.42: Proposed Action Exhaust Emission Estimates for Well Workover Road Traffic

On-Road Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi)	Round Trip Per Well	Miles Traveled per Well	Total # of Wells Drilled	Emissions																																
							(lb/well)						(ton/project)						(lb/hr/source)										(tons/year/source)										
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	NO_x	$PM_{2.5}$	SO_x	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Well Workover	Workover Rig	HDDV	3	2	6	186	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0.0	0.0	0.0	0.0	0	0	0	0	0
	Haul Truck	HDDV	3	2	6	186	0.1	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0.0	0.0	0.0	0.0	0	0	0	0	0
	Pickup Truck	LDGT2	3	2	6	186	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0	0.0	0.0	0.0	0.0	0	0	0	0	0
						TOTAL							**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**																			

Workover Rig
Emissions per well = emission factor g/mile*distance in miles / (453.6 g/lb)

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation

hours per round trip (driving time only, Workover Rig) = 24
hours per round trip (driving time only, Haul Truck) = 24
hours per round trip (driving time only, Pickup Truck) = 24

Table F1.1.43: Proposed Action Fugitive Dust Emission Factors for Well and Pipeline Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.1.44: Proposed Action Fugitive Dust Emission Estimates for Well and Pipeline Road Traffic

Well & Pipeline Fugitive Dust Emissions Estimation for Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	PM_{10}			$PM_{2.5}$			lb/hr/well		ton/year/well
								Em. Factor (lb/VMT) [c]	Emissions (lb/well-yr)	Emissions (ton/proj.)	Em. Factor (lb/VMT)	Emissions (lb/well-yr)	Emissions (ton/proj.)	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Visits for Inspection and Repair	200-hp Pickup	7,000	75	120	2	1.25	186	0.63	0.8	0	0.09	0.1	0.0	0.0164	0.0025	0.0001

[a] BLM, 2003. Table APP_A21.xls
[b] BLM, 2003. Table APP_A21.xls
[c] BLM, 2003. Table APP_A21.xls

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per round trip (driving time only,200-hp Pickup) = 24

Table F1.1.45: Proposed Action Exhaust Emission Factors for Well and Pipeline Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] From BLM, 2003, table 1.1.2.2; including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table F1.1.46: Proposed Action Exhaust Emission Estimates for Well and Pipeline Road Traffic

Well & Pipeline Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	Emissions																													
								(lb/well-yr)						(ton/project)						(lb/hr/source)												(ton/year/source)							
	Type	Class						NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	NO_x	$PM_{2.5}$	SO_x	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Visits for Inspection and Repair	200-hp Pickup	LDGT2	75	120	2	1.25	186	0.00	0.000	0.000	0.000	0.0	0.00	0.00	0.000	0.000	0.000	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0	0.00	0.00	0.00	0.00	0	0	0	0	0

[a] From BLM, 2003, APP_A21, table 1.2.5.2
[b] Wells visited once per month

Assumptions for converting emissions to lbs/hr/source: used in AERMOD calculation
hours per round trip (driving time only,200-hp Pickup) = 24

Table F1.1.47: Proposed Action Road Maintenance Emissions Estimation Information

Maintenance [a]	Equipment/Vehicle			Road Length Worked On per Day	# of Operating Hours per Day
	Type	Fuel	Capacity (hp)		
Summer	Heavy Equipment [b]	Diesel	135 [c]	6	10
	Commuting Vehicle	Gasoline	225	6 [d]	1 [e]
Winter	Heavy Equipment [b]	Diesel	135 [c]	5	10
	Commuting Vehicle	Gasoline	225	6 [d]	1.5 [e]

[a] BLM, 2003. Road maintenance would be made twice in summer and once in winter every year.
[b] BLM, 2003. Assume a motor grader.
[c] BLM, 2003. Assume 135 hp.
[d] BLM, 2003. Average round trip mileage on unpaved road.
[e] BLM, 2003. Assume one round trip per day.

Estimation of Total and Cumulative Length of Roads

Total Length of Roads Built (mi/pad) [a,b]	0.9
Cumulative Length of Roads Maintained [c] (mi)	1,675

[a] Reflects combination of drilling and producing roads
[b] = drilling roads 0.5 mile per well and access roads are 0.4 mile per well for a total of 0.9 mile per well pad
[c] = 0.9 miles of road built per pad*1861 well pads = 1,675 miles of roads to maintain

Estimation of Total Operation Days and Hours

Season	# of Operation per Year	Cumulative Length of Roads (mi-yr)	Road Length Worked On (mi/day)	# of Operating Hours per Day	Total # of Operating Days	Total # of Operating Hours
Summer	2	1,675	6	10	558	5,583
Winter	1	1,675	5	10	335	3,350
				Total	**893**	**8,933**

Table F1.1.48: Proposed Action Road Maintenance Fugitive Dust Emissions Factors for Grader

Emission Factors for Grader

Pollutant	Emission Factor Equation (lb/VMT)	S [a] (mph)	Emission Factor (lb/VMT)
PM_{10}	$E = (0.6)(0.051)\ S^{2}$	5	0.765
$PM_{2.5}$	$E = (0.031)(0.04)\ S^{2.5}$	5	0.069

[a] Assumed a mean vehicle speed (S) of 5 mph. (BLM, 2003)
Source: EPA, *AP-42* , Volume I, Section 11.9 Western Surface Coal Mining (10/98).

Table F1.1.49: Proposed Action Road Maintenance Fugitive Dust Emissions Estimates for Grader

Fugitive Dust Emissions Estimation for Grader

Activity	Equipment	Total # of Operating Hours [a]	Mean Vehicle Speed (mph)	Total Miles Maintained	PM_{10}		$PM_{2.5}$		lb/hr/well		ton/year/ well
					Em. Factor (lb/VMT)	Emissions (ton/proj.)	Em. Factor (lb/VMT)	Emissions (ton/proj.)	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Road Maintenance	Grader	5,360	5	26,798	0.765	10	0.069	0.9	0.153	0.013864	0.0005

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM, 200

Table F1.1.50: Proposed Action Road Maintenance Exhaust Emission Factors for Grader
Emission Factors for Grader

Equipment		Emission Factors (g/hp-hr)			
	NO_x	PM_{10} [a]	SO_2	CO	VOC
Grader	7.14	0.63	0.87	1.54	0.36

[a] Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}. (BLM, 2003)
Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (1985).

Table F1.1.51: Proposed Action Road Maintenance Exhaust Emission Estimates for Grader

Exhaust Emissions Estimation for Grader

Activity	Vehicle Type	Capacity (hp)	Total # of Operating Hours [a]	Emissions																						
				(lb/hr)					(ton/project)					(ton/year/source)							(lb/hour/source)				
				NO_x	PM_{10} [b]	SO_x	CO	VOC	NO_x	PM_{10} [b]	SO_x	CO	VOC	NO_x	SO_x	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Road Maintenance	Grader	135	5,360	2.13	0.19	0.26	0.46	0.11	6	0.5	0.7	1.2	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM, 2003)
[b] Emissions of $PM_{2.5}$ were assumed to be the same as those for PM_{10}.

Table F1.1.52: Proposed Action Fugitive Dust Emission Factors for Commuting Maintenance Vehicles

Emission Factors for Commuting Maintenance Vehicles Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	BLM, 2003. Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	BLM, 2003. EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.1.53: Proposed Action Fugitive Dust Emission Estimates for Commuting Maintenance Vehicles

Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	PM_{10}		$PM_{2.5}$		lb/hr/well		ton/year/well
						Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [a]	Emissions (ton/proj	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Road Maintenance	Pickup Truck	7,000	6	893	5,360	0.63	1.7	0.09	0.3	0.126321	0.018948	0.0001

[a] No dust control measures would be applied (BLM, 2003).

Table F1.1.54: Proposed Action Exhaust Emission Factors for Commuting Maintenance Vehicles

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).

[b] BLM, 2003. Including tire and brake wear emissions.

Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table F1.1.55: Proposed Action Exhaust Emission Estimates for Commuting Maintenance Vehicles

Exhaust Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	Emissions (ton/project)						(lb/hr/source)										ton/year/source								
	Type	Class				NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	NO_x	$PM_{2.5}$	SO_x	VOC	0	0	0	0	0
Road Maintenance	Pickup Truck	LDGT2	6	893	5,360	0.01	0.001	0.000	0.001	0.07	0.00	0.00024	0.00019	0.00028	0.0289	0.0019	0	0	0	0	0	6.0119E-06	4.494E-07	6.6964E-07	4.4575E-06	0	0	0	0	0

Emissions = $\frac{\text{emission factor g/mile*total distance in miles}}{(453.6\ \text{g/lb})(2000\text{lb/ton})}$

Table F1.1.56: Proposed Action Fugitive Emissions Factors for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Emission Factors for Compressor Maintenance Vehicles Road Traffic: Long-term Production

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces

Table F1.1.57: Proposed Action Fugitive Emissions Estimates for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Fugitive Dust Emissions Estimation for Compressor Maintenance Vehicles Road Traffic: Long-term Production

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		PM2.5				
									Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [d]	Emissions (ton/proj.	lb/hr/well		ton/year/ well
Maintenance Visits to Central Compressor Stations	Pickup Truck	7,000	Central Compressor Station	4	3	12	3	36	0.63	0.0	0.09	0.0	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
								Total		**0.0**		**0.0**	0.07895	0.011843	0.0000

[a] No dust control measures would be applied (BLM, 2003, table APP_A21.xls).

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation

hours per round trip (driving time only, Pickup) = 24

Table F1.1.58: Proposed Action Exhaust Emissions Factors for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic: Long-term Production

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).

[b] BLM, 2003. Including tire and brake wear emissions.

Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table F1.1.59: Proposed Action Exhaust Emissions Estimates for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Emissions Estimation for Road Traffic

Activity	Vehicle		Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	Emissions (ton/project)											Emissions (lb/hr/source)									
	Type	Class							NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Maintenance Visits to Compressor Stations	Pickup Truck	LDGT2	Central Compressor Station	4	2	8	10	80	0.000	0.0000	0.0000	0.0000	0.001	0.000	0	0	0	0	0	9.05E-05	6.94E-05	0.000103	0.010691	0.000688	0	0	0	0	0
Total									**0.000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.000**															

Emissions per Station = $\frac{\text{emission factor g/mile*total distance in miles}}{(453.6\ \text{g/lb})(2000\text{lb/ton})}$

Assumptions for converting emissions to lbs/hr/source: used in AERMOD calculation

hours per round trip (driving time only, Pickup) = 24

Table F1.1.60: Proposed Action Natural Gas Well Condensate VOC Emissions

Tanks 4.0 Natural Gas Well Condensate VOC Emissions

City: Price, Utah
Type of Tank: Vertical Fixed Roof
Size: 400 bbl
Shell height: 20 ft Diameter: 12 ft
Ave. Liquid height: 10 ft Turnovers: 12
Color: White
Assume 9 bbl per MMCF gas production

Natural Gas Well Condensate VOC Emissions

-

	VOC Losses					lb/hr/source						ton/year/source				
Components	Working Loss (lbs)[a]	Breathing Loss (lbs)[a]	Total Emissions per tank (tons)	Total Number of Tanks	Total Tank Emissions (tpy)	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
Gasoline (RVP8)	**1082.95**	**985**	**2068**	**88**	**91.07**	0.23626	0.0006	2.4E-05	0.00033	0.01046	0.00042	**0.0025**	**0.0001**	**0.0014**	**0.0458**	**0.0019**

Meteorological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.27 psia)
[a] Calculated from Tanks 4.0

Table F1.1.61: Proposed Action Natural Gas Well Condensate Truck Loadout VOC and HAP Emissions

Natural Gas Well Condensate Truck Loadout VOC Emissions

Emissions were estimated based on Equation (1) of AP-42, Section 5.2

$$L_L = 12.46 \frac{SPM}{T}$$

L_L = Loading Loss pounds per 1000 gallons (lb/10^3 gal) of liquid loaded
S = a saturation factor
P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia)
M = molecular weight of vapors, pounds per pounds-mole (lb/lb-mole)
T = temperature of bulk liquid loaded (F+460)

S = 1.45 (From Table 5.2-1, splash loading into tanker truck)
P = 8.0 psia
M = 68 lbs/lb-mole
T = 512.62, liquid bulk temp is 52.95 (from Tanks 4.0)

L_L = 12.46 (1.45*8*68)/512.62 **19.17297023**

L_L = 19.17 lbs/1,000 gal

Natural Gas Well Condensate Truck Loadout VOC Emissions

					lb/hr/source						ton/year/source				
Pollutant	Emission Factor (lbs/1,000 gallons)	Annual Condensate Volume bbl [a]	Condensate (1,000 gallons)	Total Emissions tpy	VOC	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene	Benzene	Toluene	Ethyl-benzene	Hexane	Xylene
VOCs	**19.17**	**4,075,590**	**171,175**	**3**	0.67131073	2.8E-06	2E-07	1.7E-06	5.2E-05	2.1E-06	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

a Assume 50,000CFY conventional gas production, 9 bbl condensate per MMCF gas production

Assumptions for converting emissions to lbs/hr/source; used in AERMOD calculation
hours per year that condensate tank has working and breathing losses (total emissions) = 8760
hours per year that condensate truck loadout occurs (used in calculation) = 8760

VOC and HAP emissions from Table B.2.8 of Jonah Technical Support Document; listed for Condensate Storage Tank

Compound	TPY per tank	
	Controlled 98%	Uncontrolled
VOC	1	15.9
HAP	0.1	0.8
Benzene	0.0024	0.0367
Toluene	0.0001	0.0021
Ethylbenzene	0.0014	0.022
n-Hexane	0.0443	0.6891
Xylene	0.0018	0.0279

Table F1.1.62: Proposed Action Project Emissions Summary

Moxa Arch Proposed Action Alternative Annual Emissions Summary 2016

Activity	PM_{10} Tons	$PM_{2.5}$ Tons	NOx Tons	SO2 Tons	CO Tons	VOC Tons	HAPs[b] Tons
Well Pad Construction	186	28	---	---	---	---	---
Heavy Equipment Vehicle Traffic & Well Flaring [a]	783	783	10042	615	1867	8543	854
Commuting Vehicles - Construction	165	25	4	1	11	2	0
Wind Erosion	2564	1025	---	---	---	---	---
Sub-total: Construction [c]	**370**	**186**	**1,005**	**62**	**188**	**854**	**85**
Natural Gas Compression - Operations [a]	10	10	1931	4	3862	1931	328
Well Head Compression - Operations*	7	7	108	0	135	108	17
Dehydrator & Separator Heater - Operations [a]	15	15	200	1	168	11	1
Condensate & Produced Water Tank Heaters - Operations [a]	15	15	200	1	168	11	1
Dehydrator VOC, Condensate Tank Flashing & Flaring - Operations [a]	---	---	---	---	---	4142	414
Station Visits - Operations	1	0	0	0	0	0	0
Well Workover - Operations	4	0	28	0	7	1	0
Well & Pipeline visits for Inspection & Repair - Operations	0	0	0	0	0	0	0
Tank Condensate & Truck Loadout	---	---	---	---	---	0	0
Sub-total: Operations	**52**	**48**	**2,467**	**7**	**4,340**	**6,204**	**762**
Road Maintenance	12	2	6	1	1	0	0
Compressor Maintenance	0	0	0	0	0	0	0
Sub-total: Maintenance	**12**	**2**	**6**	**1**	**1**	**0**	**0**
Grand Total: Natural Gas Long-term Development	**434**	**236**	**3,477**	**69**	**4,529**	**7,059**	**848**

[a] $PM_{2.5}$ assumed = PM_{10} for this source.

[b] HAPs = Hazardous Air Pollutants; assumed = VOCs * 0.1, and formaldehyde HAP added for gas compression

[c] Construction emissions divided by 20 (for 20 years) to represent annual emission totals

Table F1.2.1: No Action Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C) of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42*, Volume I, Section 13.2.3 Heavy Construction	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Total number of pads in 2016	601	EOG Resources	
Number wells to estimate construction emissions in 2016	601	EOG Resources	
Compression per well	200	EOG Resources	
Average HP of the central compressor station	50,000	EOG Resources	
Total number of well head compressors in 2013.	23	EOG Resources	
Total number of well head compressors in 2021.	18	EOG Resources	

Well Emission Assumptions:

Emission factors derived from AP-42 or otherwise noted.

Gas compressors assumed to be BACT equipped.

Assume diesel fuel sulfur content of 0.05% for diesel engines.

Well condensate production assumed to be from wells with Best Available Control Technology (BACT).

Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10} for the following categories, heavy equipment traffic, natural gas compression, dehydrators, separators and flashing emissions.

Hazardous Air Pollutants (HAPS) assumed to be 10% of VOCs and formaldehyde added for gas compression emissions

For well head compressors, assume 200 Hp/compressor, installed on 30 of every 1,000 wells.

Assume natural gas heating value of 1,020 Btu/scf (BLM, 2003).

Assume that natural gas compressors would operate at full capacity.

Short term represents a seven year time period through the year 2013.

Long term represents a ten year time period through the year 2016.

86 is the total number of precipitation days for Kemmerer WY, Western Regional Climate Center.

In this analysis, total wells constructed in a year were used to calculate construction emissions. These wells include abandoned, as well as operating. For the operations of natural gas wells (total of wells in the ground), the BLM used total wells (existing plus number of wells drilled) minus 12% abandoned wells(multiplied by .88). Therefore only operational wells are used to calculate operating emissions.

Table F1.2.2: No Action, Natural Gas Pad Construction, Fugitive Dust Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C)of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42* , Volume I, Section 13.2.3 Heavy Construction Operations (1/95)	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Number of wells drilled by 2016	**601**	**EOG Resources**	
Total number of pads in 2016	**601**	**EOG Resources**	
Number of wells to estimate construction emissions in 2016	**601**	**EOG Resources**	
Number of well head compressors in 2021	**18**	**EOG Resources**	
HP compression per well	**200**	**EOG Resources**	
HP of central compressor stations	**50,000**	**EOG Resources**	

Table F1.2.3: No Action, Natural Gas Pad Construction Fugitive Dust Emissions

Emissions Estimation for Construction Activities: Long-Term Development

Area Disturbed for NG Wells	Emission Estimation Basis	Disturbed Area (acre) [a]	Avg. Number of Days to Complete	Total # of Well Pads or Stations	Total Disturbed Area (acre)	Emissions					
						(lb/well pad or lb/stn)			(ton/project)		
						TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Drilling Roads, Producing Roads, Drilling Well Pad & Producing Well Pad, New Pipeline and Electric Line	per Well Pad	2.75	7	601	1,653	770	200	30	231	60	9
Central Compressor Station	per station	1.50	2	0	0	120	31	5	0	0	0
Totals					1,653	**Total**			**231**	**60**	**9**

[a] From gross surface disturbance projections BLM

Note: number of compressor stations are for new construction

TSP= 1.2 tpy/acre-month x 1,653 acres x 7/30 days x 0.5 dust control efficiency = 231 tons

Table F1.2.4: No Action Gas Analysis

Pinedale Frontier Formation Gas Analysis

Gas Component	Mol%	Mol%/100	Molecular Weight	Molecular Weight of each Component
N_2	1.2953	0.012953	28.01	0.363
Methane (C1)	83.3591	0.833591	16.04	13.371
CO_2	0.1265	0.001265	44.01	0.056
Ethane (C2)	8.7362	0.087362	30.07	2.627
Propane (C3)	4.1642	0.041642	44.10	1.836
I-Butane (iC4)	0.6661	0.006661	58.12	0.387
N-Butane (nC4)	0.9106	0.009106	58.12	0.529
I-pentane (iC5)	0.2129	0.002129	72.15	0.154
N-pentane (nC5)	0.1908	0.001908	72.15	0.138
Hexanes (C6)	0.1454	0.001454	84.18	0.122
Heptanes (C7)	0.1317	0.001317	100.20	0.132
Octanes (C8)	0.058	0.00058	114.23	0.066
Nonanes	0.0032	0.000032	114.23	0.004
TOTAL	**100**			**19.785**

MW = Mol%/100*MW

Methane (C1) = 0.833591*16.04 = 13.371

VOC = C_3^+ components = 3.368

VOC Weight Percent = 3.368/19.785*100 = 17.02%

BTU Value 1,189

Pinedale Frontier Formation Condensate Analysis

WELL NAME:	**Frontier Well**
COMPONENT	**MOL%**
H2S	0.0000
O2	0.0000
CO2	0.0000
N2	0.0000
C1	0.4064
C2	1.7056
C3	3.3635
IC4	2.2423
NC4	3.0113
IC5	3.8486
NC5	3.5648
Hexanes	14.1300
Heptanes	44.6335
Benzene	1.8256
Toluene	8.5229
E-Benzene	0.7922
Xylene	6.2070
n-C6	5.7245
2,2,4-Trimethylpentane	0.0219
Total	**100.000**

Table F1.2.5: No Action Exhaust Emissions Factors for Construction Equipment

Emission Factors for Construction Equipment						
Equipment		**Emission Factors (g/hp-hr)**				**Equipment Category in AP-42 [a]**
	NO_x	**PM_{10}**	**SO_2**	**CO**	**VOCs**	
Backhoe	8.81	0.81	0.86	2.71	0.97	Wheeled Loader
Dozer	7.81	0.69	0.85	2.15	0.75	Track-Type Tractor
Blade	7.14	0.63	0.87	1.54	0.36	Motor Grader
Trencher	11.01	0.90	0.93	4.60	1.01	Miscellaneous
Trackhoe	9.30	0.66	0.85	2.26	1.11	Track-Type Loader

[a] BLM, 2003, table APP_A21.

Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (9/85).

Table 63: No Action Well Pad Construction Exhaust Emissions

Construction Site	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Oper. Hrs per Day	# of Oper. Days per Well Pad or per Station	# of Oper. Hrs per Well Pad or per Station	# of Well Pads or Stations	Emissions (lb/well pad, lb/station, or lb/project)					Emissions (ton/equipment type)					Emissions (ton/construction site)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_2	CO	VOC	NO_x	PM_{10}	SO_2	CO	VOC
Drilling Roads	Blade	100	1	80	10	3	30	601	38	3.3	4.6	8	1.9	11	1.0	1.4	2.4	0.6	21.9	2.0	2.4	5.7	1.7
	Backhoe	80	1	75	10	3	30	601	35	3.2	3.4	11	3.8	11	1.0	1.0	3.2	1.2					
Producing Roads	Blade	100	1	80	10	3	30	601	38	3.3	4.6	8	1.9	11	1.0	1.4	2.4	0.6	21.9	2.0	2.4	5.7	1.7
	Backhoe	80	1	75	10	3	30	601	35	3.2	3.4	11	3.8	11	1.0	1.0	3.2	1.2					
Drilling Well Pad	Backhoe	80	1	75	10	2	20	601	23	2.1	2.3	7	2.6	7	0.6	0.7	2	0.8	7.0	0.6	0.7	2.2	0.8
Producing Well Pad	Backhoe	80	1	75	10	2	20	601	23	2.1	2.3	7	2.6	7	0.6	0.7	2	0.8	7.0	0.6	0.7	2.2	0.8
New Pipeline	Blade	100	1	80	10	1	10	601	13	1.1	1.5	3	0.6	4	0.3	0.5	0.8	0.2	17	1.5	1.7	6	1.5
	Trencher	175	1	80	10	1	10	601	34	2.8	2.9	14	3.1	10	1	1	4	1					
	Backhoe	80	1	75	10	1	10	601	12	1.1	1.1	4	1.3	4	0.3	0.3	1.1	0.4					
Well Head Compressors	Dozer	350	1	80	8	2	16	18	77	6.8	8.4	21	7.4	1	0.06	0.08	0.2	0.1	1.1	0.1	0.1	0.3	0.1
	Backhoe	80	2	80	8	2	16	18	40	3.7	3.9	12	4.4	0	0.03	0.03	0.11	0.04					
Central Compressor Station	Dozer	350	1	80	8	2	16	1	77	6.8	8.4	21	7.4	0	0.00	0.00	0.0	0.0	0.1	0.0	0.0	0.0	0.0
	Backhoe	80	2	80	8	2	16	1	40	3.7	3.9	12	4.4	0	0.00	0.00	0.01	0.00					
																		Subtotal	**76**	**6.8**	**8.0**	**22.1**	**6.6**

Table 64: No Action Exhaust Emission Factors for Industrial Engines

Emission Factors for Industrial Engines

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	lb/hp-hr	3.10E-02	2.20E-03	2.05E-03	6.68E-03	2.15E-03
Industrial Engine [b]	Diesel	lb/hp-hr	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

[a] EPA, *AP-42* , Volume I, Section 3.3 Gasoline and Diesel Industrial Engines (10/96).

[b] EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table F1.2.8: No Action Emission Estimates for Industrial Engines

Emissions Estimation for Industrial Engines

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions (lb/well)					Emissions (ton/equipment type)					Emissions (ton/project activity)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC
Rig-up, Drilling, and Rig-down	Main Deck	1,000	2	70	24	15	360	601	12,096	289	204	2,772	355	3,635	87	61	833	107	4,251	111.0	81.7	972	133
	Auxiliary Pump	600	1	80	8	15	120	601	1,382	33	23	317	41	415	10	7	95	12					
	Generator	150	1	75	24	8	192	601	670	48	44	144	46	201	14	13	43	14					
Well Completion & Testing	Main Deck	600	1	50	11	5	55	601	396	9	7	91	12	119	3	2	27	3	163	6	5	37	7
	Auxiliary Pump	225	1	80	8	2	16	601	89	6	6	19	6	27	2	2	6	2					
	Power Swivel	150	1	75	8	2	16	601	56	4	4	12	4	17	1	1	4	1					
																		Subtotal	**4,414**	**117**	**87**	**1,008**	**139**

Table F1.2.9: No Action Field Generator Emission Factors

Emission Factors for Field Generators (Tier II)

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	g/hp-hr	4.90E+00	2.20E-01	9.30E-01	3.70E+00	4.90E+00
Industrial Engine	Diesel	lbs/hp-hr	1.08E-02	4.80E-04	2.05E-03	8.20E-03	1.08E-02

[a] From USA - Nonroad Diesel Engines Tier 2 Emission Standards
Emission factors for a < 600 hp generator, (NOx & VOC = 4.9 g/bhp-hr)

Table F1.2.10: No Action Temporary Exhaust Emissions Estimates for Field Generators

Temporary Emissions Estimation for Field Generators

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions									
									(lb/well)					(ton/equipment type)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC
Field Generators	Field Generators for Pumps & Lighting	175	1	75	12	8	96	601	136	6	26	103	136	41	2	8	31	41
													TOTALS	**41**	**2**	**8**	**31**	**41**

Table 65: No Action Estimate of Emission Factors for Emissions From Well Construction Flaring

Emission Factors for Flaring

Unit	NO_x	PM_{10}	SO_2	CO
lb/MMscf	76.0	7.6	0.6	413.3
lb/MMBtu	6.80E-02	6.80E-03	5.37E-04	3.70E-01

Emission factors for NOx & CO Source: EPA, *AP-42* , Volume I, Section 13.5 Industrial Flares

Emission factors for PM10 & SO2 from EPA, AP-42, Volume I, Section 1.4 Natural Gas Combustion

Table F1.2.12: No Action Emissions From Well Completion Flaring

Well Completion Flaring	Gas Production Estimate (MMSCF) per day	# of Days of Flaring	Av. Heat Content of Gas btu/scf	# of Wells	Emissions							
					(lb/well)				(tons)			
					NO_x	PM_{10}	SO_2	CO	NO_x	PM_{10} [a]	SO_x	CO
Flaring	1	2	1020	601	139	15.2	1.2	755	42	5	0.4	227
TOTALS									**42**	**5**	**0.4**	**227**

Emissions = EVH where E= emission factor; V= gas volume; H= heat content
NOx= 0.068lbs/MMBtu*1.0 MMSCFD*1020 Btu/scf = 69.5 lbs per well* 2 days = 139 lbs per well
PM10 & SO2 Emissions = EV where E= emission factor; V= gas volume
PM10 = 7.6 lbs/MMSCF*1.0 MMSCFD = 7.6 lbs/well*2days = 15.2 lbs per well

Table F1.2.13: No Action VOC Emissions from Well Completion Flaring

Well Completion Flaring	VOC Emission Factor lbs per well	# of Wells	VOC Emissions tons
Flaring	8,863	601	2,663

Assume average VOC content 17 %
Average Mole Weight 19.785
Gas production rate of 1.0 MMSCF per well per day
Assume 2 days of flaring

Flare Gas wt= $\frac{\text{2.0 MMSCF*1,000,00scf/MMSCF*19.785 lbs/lbs-mole}}{\text{379.49scf/mole}}$

VOC Emissions= 104,272 lbs/well*0.17VOC wt%*0.5 efficiency destruction = 8,863 lbs/well

HAPs are estimated at 10% of VOC amounts and are shown on total spread sheets
Assume same gas production rate for short term and long term new constructed wells of 1.0 MMSCFD

Table F1.2.14: No Action Well Pad Construction Wind Erosion

Emission Factor: 0.3733 llb/hr/100m^2

Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meterological data.

Control Efficiency: 50%

Disturbed Area:

Well Pad Construction:	2.75 acres	11128.865 m^2
Access Road Construction:	3.00 acres	12140.58 m^2
Pipeline Construction:	0.50 acres	2023.43 m^2

Source Parameters
147 1-km area sources
sigma z=2.33 m

PM_{10} Emission Calculations:

	PM_{10} Emission Factor (llb/hr/100m^2)	$PM_{2.5}$ Emission Factor (llb/hr/100m^2)	Area 100 m^2	Control Efficiency (%)	PM_{10} Emissions (lb/hr)	$PM_{2.5}$ Emissions (lb/hr)	PM_{10} Emissions (g/sec)	$PM_{2.5}$ Emissions (g/sec)
Well Pad Construction:	0.3733	0.1493	111.29	50	20.77	8.31	2.62	1.05
Resource Road Construction:	0.3733	0.1493	121.41	50	22.66	9.06	2.86	1.14
Pipeline Construction:	0.3733	0.1493	20.23	50	3.78	1.51	0.48	0.19
Total:					**47.21**	**18.88**	**5.95**	**2.38**

Table F1.2.15: No Action Fugitive Dust Emissions from Commuting Vehicles. Emission Factors for Road Traffic.

Emission Factors for Road Traffic

$$E\ (lb/VMT) = \frac{k\ (s/12)^a\ (W/3)^d}{(M/0.2)^c}$$

Parameter	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)

Function/Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	Listed in the table below	
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.2.16: No Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	PM_{10}				$PM_{2.5}$			
							Controlled Em. Factor (lb/VMT)	Emissions			Controlled Em. Factor (lb/VMT)	Emissions		
								(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)		(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)
Drilling Roads	Semi Trucks	60,000	6	3	18	601	1.21	22	7	7	0.18	3.3	1.0	1.0
Producing Roads	Semi Trucks	60,000	6	3	18	601	1.21	22	7	7	0.18	3.3	1.0	1.0
Drilling Well Pad	Haul Trucks	45,000	6	3	18	601	1.05	19	6	8	0.16	2.8	0.8	1.2
	Pickup Trucks	7,000	6	3	18	601	0.41	7.4	2		0.06	1.1	0.3	
Producing Well Pad	Haul Trucks	45,000	6	3	18	601	1.05	19	6	8	0.16	2.8	0.8	1.2
	Pickup Trucks	7,000	6	3	18	601	0.41	7.4	2		0.06	1.1	0.3	
New Pipeline	Haul Trucks	45,000	6	3	18	601	1.05	19	6	8	0.16	2.8	0.8	1
	Pickup Trucks	7,000	6	3	18	601	0.41	7	2		0.06	1.1	0.3	
Electric Line	Haul Trucks	45,000	6	3	18	601	1.05	18.9	6	8	0.16	2.8	0.8	1.2
	Pickup Trucks	7,000	6	3	18	601	0.41	7.4	2		0.06	1.1	0.3	
Well Head Compressors	Semi Trucks	60,000	6	3	18	18	1.21	22	0.2	0	0.18	3	0.0	0
	Haul Trucks	45,000	6	3	18	18	1.05	19	0		0.16	3	0.0	
	Pickup Trucks	7,000	6	3	18	18	0.41	7	0		0.06	1	0.0	
Central Compressor Station	Semi Trucks	60,000	6	3	18	1	1.21	22	0.0	0	0.18	3	0.0	0
	Haul Trucks	45,000	6	3	18	1	1.05	19	0		0.16	3	0.0	
	Pickup Trucks	7,000	6	3	18	1	0.41	7	0		0.06	1	0.0	
								Subtotal		**45**				**7**

Table F1.2.17: No Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station [a]	Miles Traveled per Well Pad or per Station	Total # of Wells or Stations	PM_{10} Controlled Em. Factor (lb/VMT)	PM_{10} Emissions (lb/well)	PM_{10} Emissions (ton/veh. type)	PM_{10} Emissions (ton/proj. activity)	$PM_{2.5}$ Controlled Em. Factor (lb/VMT)	$PM_{2.5}$ Emissions (lb/well)	$PM_{2.5}$ Emissions (ton/veh. type)	$PM_{2.5}$ Emissions (ton/proj. activity)
Rig-up, Drilling, and Rig-down	Semi Rig Transport & Drill Rig	80,000	6	5	30	601	1.40	42	13	67	0.21	6.3	1.9	10
	Fuel Haul Truck	50,000	6	5	30	601	1.10	33	10.0		0.17	5.0	1.5	
	Mud Haul Truck, Water Hauling	60,000	6	5	30	601	1.21	36	11		0.18	5	1.6	
	Rig Crew	7,000	6	5	30	601	0.41	12	3.7		0.06	1.9	0.6	
	Rig Mechanics	12,000	6	2	12	601	0.54	6	2.0		0.08	1.0	0.3	
	Co. Supervisor	7,000	6	5	30	601	0.41	12	4		0.06	1.9	0.6	
	Tool Pusher	7,000	6	5	30	601	0.41	12	3.7		0.06	1.9	0.6	
	Mud Logger	7,000	6	5	30	601	0.41	12	3.7		0.06	1.9	0.6	
	Mud Engineer	7,000	6	5	30	601	0.41	12	3.7		0.06	1.9	0.6	
	Logger, Engr Truck	45,000	6	5	30	601	1.05	31.4	9.4		0.16	4.7	1.4	
	Drill Bit Delivery	7,000	6	5	30	601	0.41	12	4		0.06	1.9	0.6	
Well Completion & Testing	Semi Casing Haulers	60,000	6	2	12	601	1.21	14.5	4	153	0.18	2.2	0.7	23
	Semi Completion, Unit Rig	120,000	6	8	48	601	1.71	82	24.7		0.26	12.3	3.7	
	Semi Fracing Blender	85,000	6	2	12	601	1.44	17	5.2		0.22	2.6	0.8	
	Semi Pumping Tank Battery	80,000	6	2	12	601	1.40	17	5.0		0.21	2.5	0.8	
	Tubing Truck	60,000	6	2	12	601	1.21	14.5	4.4		0.18	2.2	0.7	
	Haul Cementer, Pump Truck	85,000	6	2	12	601	1.44	17	5.2		0.22	2.6	0.8	
	Haul Cementer, Cement Truck	60,000	6	2	12	601	1.21	15	4.4		0.18	2.2	0.7	
	Haul Completion, Equip Truck	45,000	6	2	12	601	1.05	12.6	3.8		0.16	1.9	0.6	
	Haul Service Tools	7,000	6	2	12	601	0.41	5.0	1.5		0.06	0.7	0.2	
	Haul Perforators Logging Truck	45,000	6	2	12	601	1.05	12.6	3.8		0.16	1.9	0.6	
	Haul Anchor Installation	40,000	6	2	12	601	0.99	11.9	3.6		0.15	1.8	0.5	
	Haul Anchor Testing	12,000	6	2	12	601	0.54	6.5	2.0		0.08	1.0	0.3	
	Haul Fracing Tank	40,000	6	2	12	601	0.99	11.9	3.6		0.15	1.8	0.5	
	Haul Fracing Pump	85,000	6	2	12	601	1.44	17.3	5.2		0.22	2.6	0.8	
	Haul Fracing Chemical	45,000	6	2	12	601	1.05	12.6	3.8		0.16	1.9	0.6	
	Haul Fracing Sand	60,000	6	2	12	601	1.21	14.5	4.4		0.18	2.2	0.7	
	Haul Fracing Other	85,000	6	2	12	601	1.44	17.3	5.2		0.22	2.6	0.8	
	Haul Welders	12,000	6	2	12	601	0.54	6.5	2.0		0.08	1.0	0.3	
	Haul Water Truck	60,000	6	8	48	601	1.21	58	17		0.18	9	2.6	
	Pickup Cementer, Engineer	7,000	6	2	12	601	0.41	5.0	1.5		0.06	0.7	0.2	
	Pickup Chasing Crew	10,000	6	2	12	601	0.49	5.9	1.8		0.07	0.9	0.3	
	Pickup Completion Crew	10,000	6	8	48	601	0.49	23.7	7.1		0.07	3.6	1.1	
	Pickup Completion Pusher	7,000	6	8	48	601	0.41	19.8	6.0		0.06	3.0	0.9	
	Pickup Perforators Engineer	7,000	6	8	48	601	0.41	19.8	6.0		0.06	3.0	0.9	
	Pickup Fracing Engineer	10,000	6	8	48	601	0.49	23.7	7.1		0.07	3.6	1.1	
	Pickup Co. Supervisor	7,000	6	8	48	601	0.41	19.8	6.0		0.06	3.0	0.9	
	Miscellaneous Supplies	7,000	6	8	48	601	0.41	19.8	6.0		0.06	3.0	0.9	
	Pickup Roustabout Crew	12,000	6	2	12	601	0.54	6	2.0		0.08	1.0	0.3	
Well Head Compressors	Semi Trucks	60,000	6	2	12	0	1.21	15	0.0		0.18	2	0.0	
	Haul Trucks	45,000	6	2	12	0	1.05	13	0		0.16	2	0.0	
	Pickup Trucks	7,000	6	2	12	0	0.41	5	0		0.06	1	0.0	
Central Compressor Staton	Semi Trucks	60,000	6	2	12	1	1.21	15	0.0		0.18	2	0.0	
	Haul Trucks	45,000	6	2	12	1	1.05	13	0		0.16	2	0.0	
	Pickup Trucks	7,000	6	2	12	1	0.41	5	0		0.06	1	0.0	
								Subtotal		**220**				**33**
								TOTAL		**265**				**40**

Table F1.2.18: No Action Exhaust Emission Factors for Commuting Vehicles

Emission Factors for Road Traffic

Vehicle		Emission Factors (g/mi)					
Type	**Class**	**NO_x**	**PM_{10} [a,b]**	**$PM_{2.5}$ [a,b]**	**SO_x [a]**	**CO**	**VOC**
Light-Duty Gasoline Truck	LDGT2	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck	HDDV	8.13	1.96	1.81	1.63	17.09	4.83

[a] From BLM, 2003, APP_A21, table 1.1.2.2, estimated using EPA PART5 Model (1995)
[b] Including tire and brake wear emissions.
Source: EPA, *AP-42* , Volume II, Appendix H-117, Table 3.1A.2 Light Duty Gasoline Powered Trucks II and Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehicles (High Altitude; Model Year 1991-1997; 50,000 mileage) (6/30/95).

Table F1.2.19: No Action Exhaust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle		Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	Emissions																	
							(lb/well pad, lb/station, or lb/project)						(ton/vehicle type)						(ton/construction site)					
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Drilling Roads	Semi Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.02	0.02	0.02	0.2	0.1	0.1	0.02	0.02	0.02	0.2	0.1
Producing Roads	Semi Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.02	0.02	0.02	0.2	0.1	0.1	0.02	0.02	0.02	0.2	0.1
Drilling Well Pad	Haul Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.02	0.02	0.02	0.2	0.1	0.1	0.02	0.02	0.02	0.3	0.1
	Pickup Trucks	LDGT2	6	3	18	601	0.04	0.004	0.003	0.004	0.46	0.03	0.0	0.001	0.001	0.001	0.1	0.01						
Producing Well Pad	Haul Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.02	0.02	0.02	0.2	0.1	0.1	0.02	0.02	0.02	0.3	0.1
	Pickup Trucks	LDGT2	6	3	18	601	0.04	0.004	0.003	0.004	0.46	0.03	0.0	0.001	0.001	0.001	0.1	0.01						
New Pipeline	Haul Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.0	0.0	0.02	0.2	0.1	0.1	0.0	0.0	0.0	0.3	0.1
	Pickup Trucks	LDGT2	6	3	18	601	0.04	0.00	0.00	0.00	0.46	0.03	0.0	0.001	0.001	0.001	0.1	0.01						
Electric Line	Haul Trucks	HDDV	6	3	18	601	0.32	0.08	0.07	0.06	0.68	0.19	0.1	0.02	0.02	0.02	0.2	0.06	0.1	0.02	0.02	0.02	0.3	0.1
	Pickup Trucks	LDGT2	6	3	18	601	0.04	0.004	0.003	0.004	0.46	0.03	0.0	0.001	0.001	0.001	0.1	0.01						
Central Compressor Station	Semi Trucks	HDDV	6	3	18	0	0.32	0.08	0.07	0.06	0.68	0.19	0.0	0.000	0.000	0.000	0.00	0.000	0.0	0.00	0.00	0.00	0.0	0.0
	Haul Trucks	HDDV	6	3	18	0	0.32	0.08	0.07	0.06	0.68	0.19	0.0	0.000	0.000	0.000	0.00	0.00						
	Pickup Trucks	LDGT2	6	3	18	0	0.04	0.00	0.00	0.00	0.46	0.03	0.0	0.000	0.000	0.000	0.0	0.00						

Table F1.2.20: No Action Exhaust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Vehicle Class	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station *	Miles Traveled per Well or per Station	Total # of Wells or Stations	Emissions (lb/well)						Emissions (ton/vehicle type)						Emissions (ton/project activity)					
							NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Rig-up, Drilling, and Rig-down	Semi Rig Transport	HDDV	6	17	102	601	1.83	0.44	0.41	0.37	3.84	1.09	0.5	0.13	0.12	0.11	1.2	0.33	2.7	0.6	0.5	0.5	9.5	1.6
	Fuel Haul Truck	HDDV	6	17	102	601	1.83	0.44	0.41	0.37	3.84	1.09	0.5	0.13	0.12	0.11	1.2	0.3						
	Mud Haul Truck, Water	HDDV	6	17	102	601	1.83	0.44	0.41	0.37	3.84	1.09	0.5	0.1	0.1	0.1	1.2	0.3						
	Rig Crew	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.007	0.005	0.008	0.8	0.05						
	Rig Mechanics	HDDV	6	2	12	601	0.22	0.05	0.05	0.04	0.45	0.13	0.1	0.016	0.014	0.013	0.1	0.04						
	Co. Supervisor	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.01	0.01	0.01	0.8	0.05						
	Tool Pusher	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.0	0.0	0.0	0.8	0.1						
	Mud Logger	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.0	0.0	0.0	0.8	0.1						
	Mud Engineer	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.0	0.0	0.0	0.8	0.1						
	Logger, Engr Truck	HDDV	6	17	102	601	1.83	0.44	0.41	0.37	3.84	1.09	0.5	0.1	0.1	0.1	1.2	0.3						
	Drill Bit Delivery	LDGT2	6	17	102	601	0.23	0.02	0.02	0.03	2.62	0.17	0.1	0.01	0.01	0.01	0.8	0.05						
Well Completion & Testing	Semi Casing Haulers	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17	8.8	2.0	1.9	1.7	23.5	4.5
	Semi Completion, Unit Rig	HDDV	6	29	174	601	3.12	0.75	0.69	0.62	6.56	1.85	0.9	0.23	0.21	0.19	2.0	0.56						
	Semi Fracing Blender	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Semi Pumping Tank Battery	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Tubing Truck	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Cementer, Pump Truck	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Cementer, Cement Truck	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Completion Equip Truck	HDDV	6	29	174	601	3.12	0.75	0.69	0.62	6.56	1.85	0.9	0.23	0.21	0.19	2.0	0.56						
	Haul Service Tools	LDGT2	6	9	54	601	0.12	0.01	0.01	0.01	1.39	0.09	0.0	0.00	0.00	0.00	0.4	0.03						
	Haul Perforators Logging Truck	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Anchor Installation	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Anchor Testing	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.17						
	Haul Fracing Tank	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Fracing Pump	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Fracing Chemical	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Fracing Sand	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Fracing Other	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Welders	HDDV	6	6	36	601	0.65	0.16	0.14	0.13	1.36	0.38	0.2	0.05	0.04	0.04	0.4	0.12						
	Haul Water Truck	HDDV	6	29	174	601	3.12	0.75	0.69	0.62	6.56	1.85	0.9	0.23	0.21	0.19	2.0	0.56						
	Pickup Cementer, Engineer	LDGT2	6	9	54	601	0.12	0.01	0.01	0.01	1.39	0.09	0.0	0.00	0.00	0.00	0.4	0.03						
	Pickup Chasing Crew	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.1	0.1	0.1	0.6	0.2						
	Pickup Completion Crew	HDDV	6	29	174	601	3.12	0.75	0.69	0.62	6.56	1.85	0.9	0.2	0.2	0.2	2.0	0.6						
	Pickup Completion Pusher	LDGT2	6	29	174	601	0.39	0.038	0.029	0.043	4.46	0.29	0.12	0.011	0.009	0.013	1.3	0.09						
	Pickup Perforations Engineer	LDGT2	6	29	174	601	0.39	0.038	0.029	0.043	4.46	0.29	0.12	0.011	0.009	0.013	1.3	0.09						
	Pickup Fracing Engineer	HDDV	6	6	36	601	0.65	0.156	0.143	0.129	1.36	0.38	0.19	0.047	0.043	0.039	0.4	0.12						
	Pickup Co. Supervisor	LDGT2	6	29	174	601	0.39	0.038	0.029	0.043	4.46	0.29	0.12	0.011	0.009	0.013	1.3	0.09						
	Pickup Misc Supplies	LDGT2	6	29	174	601	0.39	0.038	0.029	0.043	4.46	0.29	0.12	0.011	0.009	0.013	1.3	0.09						
	Pickup Roustabout Crew	HDDV	6	9	54	601	0.97	0.23	0.22	0.19	2.03	0.58	0.3	0.07	0.06	0.06	0.6	0.2						
Well Head Compressors	Semi Trucks	HDDV	6	9	150	18	2.69	0.65	0.60	0.54	5.65	1.60	0.0	0.006	0.005	0.005	0.05	0.014						
	Haul Trucks	HDDV	6	9	54	18	0.97	0.23	0.22	0.19	2.03	0.58	0.0	0.002	0.002	0.002	0.02	0.01						
	Pickup Trucks	LDGT2	6	9	54	18	0.12	0.01	0.01	0.01	1.39	0.09	0.0	0.000	0.000	0.000	0.0	0.00						
Central Compressor Station	Semi Trucks	HDDV	6	9	150	1	2.69	0.65	0.60	0.54	5.65	1.60	0.0	0.000	0.000	0.000	0.00	0.001						
	Haul Trucks	HDDV	6	9	54	1	0.97	0.23	0.22	0.19	2.03	0.58	0.0	0.000	0.000	0.000	0.00	0.00						
	Pickup Trucks	LDGT2	6	9	54	1	0.12	0.01	0.01	0.01	1.39	0.09	0.0	0.000	0.000	0.000	0.0	0.00						
																		Subtotal	**11.5**	**2.6**	**2.4**	**2.2**	**33**	**6.1**
																		TOTAL	**12.1**	**2.8**	**2.5**	**2.3**	**35**	**6.5**

Table F1.2.21: No Action Emission Factors and Estimates for Central Compressor Stations

Emission Factors for Natural Gas-Fired Compressors

Compressor		Horse-Power Rating	Emission Factors (g/hp-hr) [a]					
			NOx [a,]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO
Central Compressor Station	Rich Burn	50,000	1.00	1.8E-01	2.0E-03	2.00	1.00	0.07

[a] From State of Wyoming AQD BACT
[b] From BLM, 2003. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)					
			NOx	PM_{10}	SO_2	CO	VOC	HCHO
Central Compressor Station	0	8,760	0	0	0	0	0	0
		Total	**0**	**0**	**0**	**0**	**0**	**0**

Emissions per Compressor = emission factor g/hp-hr*compressor engine hp rating*(453.6g/lb)

NOX Emissions= (1.0 g/hp-hr*50,000 hp)/453.6g/lb = 110.23 lb per hour*8760 hours*0 stations/2000lb per ton = 0 tpy

Table F1.2.22: No Action Emission Factors for Well Head Compressors

Emission Factors for Natural Gas-Fired Compressors

Compressor			Make	Model	Capacity (hp)	Emission Factors (g/hp-hr)					
						NOx [a, d]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO
Well Head Compressors	Lean Burn	50%	Caterpillar	G3516LE	200	1.50	6.6E-02	2.0E-03	0.50	1.00	0.07
	Rich Burn	50%	Waukesha	7044GSI	200	1.00	6.6E-02	2.0E-03	2.00	1.00	0.05

[a] BACT
[b] From BLM Rawlins RMP, 2005. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM Rawlins RMP, 2005. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.
[d] Equipped with oxidizing catalyst and from Caterpillar gas engine technical data

Table F1.2.23: No Action Emissions Estimates for Well Head Compressors

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)					
			NOx	PM_{10}	SO_2	CO	VOC	HCHO*
Well Head Compressors	18	8,760	43.45	2.30	0.07	43.45	34.76	2.09
		Total	**43.45**	**2.30**	**0.07**	**43.45**	**34.76**	**2.09**

Total conventional well production based on 50,000 CF/day/well
*HCHO= formaldehyde

Table F1.2.24: No Action VOC Emission Factors for Dehydration and Condensate Tank Flashing During Production Operations

VOC Emission Factors Dehydration and Condensate Tank Flashing

Dehydration VOC Emissions
0.3759 lb/hr per MMSCF per day [a]

[a] Generated from GRI-GLYCalc Version 4.0 and South Piney AQ Analysis

Emission factor changed from 0.2164 lb/hr to 0.3759 lb/hr due to adding C9 and C10 components from S. Piney gas analysis

Flashing Emissions	
0.023 lb/hr controlled [a]	0.387 lb/hr uncontrolled [a]

[a] from E&P Tank Version 2.0 as per South Piney AQ Analysis

Table F1.2.25: No Action VOC Emissions for Dehydration and Condensate Task Flashing During Production Operations

Estimate for Dehydration VOC Emissions per year

VOC Emission Factor lb/hr	Total Number of Wells	Hours of Operation per year	Total VOC Emissions tpy
0.3759	601	8760	990

Assume 1.0 MMSCF gas production per well per day

Estimate for VOC Controlled Condensate Tank Flashing and Flaring Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Controlled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy
4,207	421	0.023	8760	42

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 70% of condensate tanks operate with a combustion chamber emission control device

Estimate for VOC Uncontrolled Condensate Tank Flashing Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Uncontrolled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy
1,803	180	0.387	8760	306

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 30% of condensate tanks operate without an emission control device
Assume one tank per well

Table F1.2.26: No Action Emission Factors for Dehydrator Heaters for Production Operations

Emission Factors for Dehydrator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

[a] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.

[b] From BLM, 2003. Assumed a fuel heating value of 1,020 Btu/scf.

Source: EPA, *AP-42* , Volume I, Section 1.4 Natural Gas Combustion (7/98).

Table F1.2.27: No Action Emissions Estimates for Dehydrator Heaters for Production Operations

Emission Estimate for Dehydrator Heaters

Operating Hours per Year [a]	Dehydrator Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	601	32	2	0	27	2

[a] Assumed operating 15 minutes per hour per day
Assume Dehydrator Heater Operation at each well site
HAP emissions represented on summary tables

Table 1.2.28: No Action Emission Factors fir Three-Phase Separator Heaters

Emission Factors for Three-Phase Separator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

Table F1.2.29: No Action Emissions Estimates for Three-Phase Separator-Heaters

Emission Estimates for Three Phase Separator Heaters

Operating Hours per Year [a]	Separator Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	601	32	2	0	27	2

[a] Assumed operating 15 minutes per hour per day
Assume Dehydrator Heater Operation at each well site

Table F1.2.30: No Action Emissions Estimates for Condensate Tank Heaters

Emission Estimates for Condensate Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Condensate Tanks	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	601	32	2	0	27	2

[a] Assumed operating 15 minutes per hour per day
Assume a separator and heater for each well

Table F1.2.31: No Action Emission Estimates for Produced Water Tank Heaters

Emission Estimates for Produced Water Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Produced Water Tanks	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	601	32	2	0	27	2

[a] Assumed operating 15 minutes per hour per day

Assume a heater for each tank

Table F1.2.32: No Action Fugitive Dust Emission Factors for Production Operations Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.2.33: No Action Fugitive Dust Emissions Estimates for Production Operations Road Traffic

Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	PM_{10}			$PM_{2.5}$		
									Emissions			Emissions	
								Em. Factor (lb/VMT) a	(lb/stn-yr)	(ton/proj.)	Em. Factor (lb/VMT)	(lb/stn-yr)	(ton/proj.)
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	0	52	0	10	0.63	6.3	0.0	0.09	0.9	0.00
									Total	**0.0**			**0.0**

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Table F1.2.34: No Action Exhaust Emission Factors for Production Operations Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] Including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table F1.2.35: No Action Exhaust Emissions Estimates for Production Operations Road Traffic

Exhaust Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	Emissions											
								(lb/station-yr)						(ton/project)					
								NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	0	52	0	10	0.02	0.00	0.00	0.00	0.26	0.02	0.000	0.000	0.000	0.000	0.000	0.000
													Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Emissions per well = emission factor g/mile*total miles per inspection/453.6 g/lb

Table F1.2.36: No Action Fugitive Dust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W= mean vehicle weight (tons)	60	Assume workover rig 120,000 lbs
W= mean vehicle weight (tons)	30	Assume haul truck 60,000 lbs
W = mean vehicle weight (tons)	3.5	Assume pickup truck weight of 7,000 lbs
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* ,

Table F1.2.37: No Action Fugitive Dust Emissions Estimates for Well Workover Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well	Miles Traveled per Well	Total # of Wells Drilled	PM_{10}			$PM_{2.5}$		
							Emission Factor (lb/VMT) [a]	Emissions (lb/well)	Emissions (ton/proj.)	Emission Factor (lb/VMT) [b]	Emissions (lb/well)	Emissions (ton/proj.)
Well Workover	Workover Rig	120,000	6	3	18	601	2.6	47	14	0.1	2	0.5
	Haul Truck	60,000	6	3	18	601	1.8	33	10	0.4	6	1.9
	Pickup Truck	7,000	6	3	18	601	0.6	11	3	0.2	3	0.9
								Total	**28**			**3.4**

[a] BLM, 2003. Table APP_A21.
[b] BLM, 2003. No dust control measures would be applied.

Table 66: No Action Exhaust Emission Factors for Well Workover On-Site Industrial Engines

Emission Factors for Industrial Engines					
Fuel Type	Emission Factors (lb/hp-hr)				
	NO_x	PM_{10}	SO_x	CO	VOC
Diesel	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table 67: No Action Exhaust Emission Estimates for Well Workover On-Site Industrial Engines

On-Site Exhaust Emissions Estimation for Industrial Engines

Activity	Equipment	Capacity (hp)	Ave. Operating Load Factor (%)	Operating Hours per well	Total # of Wells Drilled	Emissions (lb/well)					Emissions (ton/project)				
						NO_x	PM_{10}	SO_x	CO	VOC	NO_x	PM_{10}	SO_x	CO	VOC
Well Workover	Truck-Mounted Unit	600	0.7	30	601	302	7	5	69	9	91	2.2	1.5	20.8	2.7

Emissions per well = emission factor lb/hp-hr*engine hp rating*operating hours*engine load factor %

NOx Emissions= $\frac{302 \text{ lb/well}*601 \text{ wells}}{2000 \text{lb/ton}}$ = 91 tons

Table 68: No Action Exhaust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light Duty Gasoline Truck (LDGT2)	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck (HDDV)	8.13	1.96	1.81	1.63	17.09	4.83

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).
[b] BLM, 2003. Including tire and brake wear emissions.
Source: EPA (1985), AP-42, Volume II, Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehic
(High Altitude; Model Year 1991-1997; 50,000 mileage).

Table 69: No Action Exhaust Emission Estimates for Well Workover Road Traffic

On-Road Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi)	Round Trip Per Well	Miles Traveled per Well	Total # of Wells Drilled	Emissions											
							(lb/well)						(ton/project)					
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Well Workover	Workover Rig	HDDV	6	3	18	601	0.3	0.1	0.1	0.1	0.7	0.2	0.1	0.0	0.0	0.0	0.2	0.1
	Haul Truck	HDDV	6	3	18	601	0.3	0.1	0.1	0.1	0.7	0.2	0.1	0.0	0.0	0.0	0.2	0.1
	Pickup Truck	LDGT2	6	3	18	601	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0
						TOTAL							**0.2**	**0.0**	**0.0**	**0.0**	**0.5**	**0.1**

Workover Rig Emissions per well = $\frac{\text{emission factor g/mile*distance in miles}}{(453.6\ \text{g/lb})}$

Table 70: No Action Fugitive Dust Emissions for Well and Pipeline Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table 71: No Action Fugitive Dust Emission Estimates for Well and Pipeline Road Traffic

Well & Pipeline Fugitive Dust Emissions Estimation for Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	PM_{10}			$PM_{2.5}$		
								Em. Factor (lb/VMT) [c]	Emissions (lb/well-yr)	Emissions (ton/proj.)	Em. Factor (lb/VMT) [c]	Emissions (lb/well-yr)	Emissions (ton/proj.)
Visits for Inspection and Repair	200-hp Pickup	7,000	75	120	3	1.875	601	0.63	1.2	0	0.09	0.2	0.1

[a] BLM, 2003. Table APP_A21.xls
[b] BLM, 2003. Table APP_A21.xls
[c] BLM, 2003. Table APP_A21.xls

Table 72: No Action Exhaust Emission Factors for Well and Pipeline Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] From BLM, 2003, table 1.1.2.2; including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table 73: No Action Exhaust Emission Estimates for Well and Pipeline Road Traffic

Well & Pipeline Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	Emissions											
								(lb/well-yr)						(ton/project)					
	Type	Class						NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Visits for Inspection and Repair	200-hp Pickup	LDGT2	75	120	3	1.875	601	0.00	0.000	0.000	0.000	0.0	0.00	0.00	0.000	0.000	0.000	0.0	0.00

[a] From BLM, 2003, APP_A21, table 1.2.5.2
[b] Wells visited once per month

Table 74: No Action Road Maintenance Emissions Estimation Information

Maintenance [a]	Equipment/Vehicle			Road Length Worked On per Day	# of Operating Hours per Day
	Type	Fuel	Capacity (hp)		
Summer	Heavy Equipment [b]	Diesel	135 [c]	6	10
	Commuting Vehicle	Gasoline	225	6 [d]	1 [e]
Winter	Heavy Equipment [b]	Diesel	135 [c]	5	10
	Commuting Vehicle	Gasoline	225	6 [d]	1.5 [e]

[a] BLM, 2003. Road maintenance would be made twice in summer and once in winter every year.
[b] BLM, 2003. Assume a motor grader.
[c] BLM, 2003. Assume 135 hp.
[d] BLM, 2003. Average round trip mileage on unpaved road.
[e] BLM, 2003. Assume one round trip per day.

Estimation of Total and Cumulative Length of Roads

Total Length of Roads Built (mi/pad) [a,b]	0.9
Cumulative Length of Roads Maintained [c] (mi)	541

[a] Reflects combination of drilling and producing roads
[b] = drilling roads 0.5 mile per well and access roads are 0.4 mile per well for a total of 0.9 mile per well pad
[c] = 0.9 miles of road built per pad*1861 well pads = 1,675 miles of roads to maintain

Estimation of Total Operation Days and Hours

Season	# of Operation per Year	Cumulative Length of Roads (mi-yr)	Road Length Worked On (mi/day)	# of Operating Hours per Day	Total # of Operating Days	Total # of Operating Hours
Summer	2	541	6	10	180	1,803
Winter	1	541	5	10	108	1,082
				Total	**288**	**2,885**

Table F1.2.47: No Action Road Maintenance Fugitive Dust Emission Factors for Grader

Emission Factors for Grader

Pollutant	Emission Factor Equation (lb/VMT)	S [a] (mph)	Emission Factor (lb/VMT)
PM_{10}	$E = (0.6)(0.051)\ S^{2}$	5	0.765
$PM_{2.5}$	$E = (0.031)(0.04)\ S^{2.5}$	5	0.069

[a] Assumed a mean vehicle speed (S) of 5 mph. (BLM, 2003)
Source: EPA, *AP-42* , Volume I, Section 11.9 Western Surface Coal Mining (10/9

Table 75: No Action Road Maintenance Fugitive Dust Emissions Estimates for Grader

Fugitive Dust Emissions Estimation for Grader

Activity	Equipment	Total # of Operating Hours [a]	Mean Vehicle Speed (mph)	Total Miles Maintained	PM_{10}		$PM_{2.5}$	
					Em. Factor (lb/VMT)	Emissions (ton/proj.)	Em. Factor (lb/VMT)	Emissions (ton/proj.)
Road Maintenance	Grader	1,731	5	8,654	0.765	3	0.069	0.3

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM

Table F1.2.49: No Action Road Maintenance Exhaust Emission Factors for Grader

Emission Factors for Grader

Equipment		Emission Factors (g/hp-hr)			
	NO_x	PM_{10} [a]	SO_2	CO	VOC
Grader	7.14	0.63	0.87	1.54	0.36

[a] Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}. (BLM, 2003)

Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (1985).

Table F1.2.50: No Action Road Maintenance Exhaust Emissions Estimates for Grader

Exhaust Emissions Estimation for Grader

Activity	Vehicle Type	Capacity (hp)	Total # of Operating Hours [a]	Emissions (lb/hr)					Emissions (ton/project)				
				NO_x	PM_{10} [b]	SO_x	CO	VOC	NO_x	PM_{10} [b]	SO_x	CO	VOC
Road Maintenance	Grader	135	1,731	2.13	0.19	0.26	0.46	0.11	2	0.2	0.2	0.4	0.1

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM, 2003)
[b] Emissions of $PM_{2.5}$ were assumed to be the same as those for PM_{10}.

Table 76: No Action Fugitive Dust Emission Factors for Commuting Maintenance Vehicles

Emission Factors for Commuting Maintenance Vehicles Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	2.6	0.38
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,200
M = surface material moisture content (%)	0.2	BLM, 2003. Default value in EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads
Control efficiency for watering (%) =	50	BLM, 2003. EPA, *Control of Open Fugitive Dust Sources*, Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.2.52: No Action Fugitive Dust Emission Estimates for Commuting Maintenance Vehicles

Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
						Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)
Road Maintenance	Pickup Truck	7,000	6	288	1,731	0.91	0.8	0.13	0.1

[a] No dust control measures would be applied (BLM, 2003).

Table F1.2.53: No Action Exhaust Emission Factors for Commuting Maintenance Vehicles

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).

[b] BLM, 2003. Including tire and brake wear emissions.

Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table F1.2.54: No Action Exhaust Emission Estimates for Commuting Maintenance Vehicles

Exhaust Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	Emissions (ton/project)					
	Type	Class				NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Road Maintenance	Pickup Truck	LDGT2	6	288	1,731	0.00	0.000	0.000	0.000	0.02	0.00

Emissions = $\frac{\text{emission factor g/mile*total distance in miles}}{\text{(453.6 g/lb)(2000lb/ton)}}$

Table F1.2.55: No Action Fugitive Emission Factors for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Emission Factors for Compressor Maintenance Vehicles Road Traffic: Long-term Production

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42*, Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources*, Section 5.3.1 Watering of Unpaved Surfaces

Table F1.2.56: No Action Fugitive Emissions Estimates for Long-Term Production Operations. Compressor MaintenanceVehicles Road Traffic.

Fugitive Dust Emissions Estimation for Compressor Maintenance Vehicles Road Traffic: Long-term Production

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		PM2.5	
									Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [d]	Emissions (ton/proj.)
Maintenance Visits to Central Compressor Stations	Pickup Truck	7,000	Central Compressor Station	0	3	0	10	0	0.63	0.0	0.09	0.0
								Total		**0.0**		**0.0**

[a] No dust control measures would be applied (BLM, 2003, table APP_A21.xls).

Table 77: No Action Exhaust Emission Factors for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic: Long-term Production

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).
[b] BLM, 2003. Including tire and brake wear emissions.
Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table 78: No Action Exhaust Emissions Estimates for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Emissions Estimation for Road Traffic

Activity	Vehicle		Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	Emissions (ton/project)					
	Type	Class							NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Maintenance Visits to Compressor Stations	Pickup Truck	LDGT2	Central Compressor Station	0	2	0	10	0	0.000	0.0000	0.0000	0.0000	0.000	0.000
							Total		0.000	0.0000	0.0000	0.0000	0.00	0.000

Emissions per Station = $\frac{\text{emission factor g/mile*total distance in miles}}{(453.6\ \text{g/lb})(2000\text{lb/ton})}$

Table 79: No Action Natural Gas Well Condensate VOC Emissions

Tanks 4.0 Natural Gas Well Condensate VOC Emissions

City: Price, Utah
Type of Tank: Vertical Fixed Roof
Size: 400 bbl
Shell height: 20 ft Diameter: 12 ft
Ave. Liquid height: 10 ft Turnovers: 12
Color: White
Assume 9 bbl per MMCF gas production

Natural Gas Well Condensate VOC Emissions

	VOC Losses				
Components	**Working Loss (lbs)[a]**	**Breathing Loss (lbs)[a]**	**Total Emissions per tank (lbs)**	**Total Number of Tanks**	**Total Tank Emissions (tpy)**
Gasoline (RVP8)	**1082.95**	**985**	**2068**	**88**	**91.07**

Meteorological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.27 psia)
[a] Calculated from Tanks 4.0

Table F1.2.60: No Action Natural Gas Well Condensate Truck Loadout VOC and HAP Emissions

Natural Gas Well Condensate Truck Loadout VOC Emissions

Emissions were estimated based on Equation (1) of AP-42, Section 5.2

$$L_L = 12.46 \frac{SPM}{T}$$

L_L = Loading Loss pounds per 1000 gallons (lb/10^3 gal) of liquid loaded

S = a saturation factor
P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia)
M = molecular weight of vapors, pounds per pounds-mole (lb/lb-mole)
T = temperature of bulk liquid loaded (F+460)

S = 1.45 (From Table 5.2-1, splash loading into tanker truck)
P = 8.0 psia
M = 68 lbs/lb-mole
T = 512.62, liquid bulk temp is 52.95 (from Tanks 4.0)

L_L = 12.46 (1.45*8*68)/512.62 = **19.17297023**

L_L = 19.17 lbs/1,000 gal

Natural Gas Well Condensate Truck Loadout VOC Emissions

Pollutant	Emission Factor (lbs/1,000 gallons)	Annual Condensate Volume bbl [a]	Condensate (1,000 gallons)	Total Emissions tpy
VOCs	19.17	1,316,190	55,280	530

a Assume 50,000CFY conventional gas production, 9 bbl condensate per MMCF gas production

Table F1.2.61: No Action Project Emissions Summary

Moxa Arch Proposed Action Alternative Annual Emissions Summary 2013

Activity	PM_{10} Tons	$PM_{2.5}$ Tons	NOx Tons	SO2 Tons	CO Tons	VOC Tons	HAPs[b] Tons
Well Pad Construction	60	9	---	---	---	---	---
Heavy Equipment Vehicle Traffic & Well Flaring [a]	130	130	4573	103	1288	2850	285
Commuting Vehicles - Construction	268	42	12	2	35	6	1
Wind Erosion	1447	579	---	---	---	---	---
Sub-total: Construction [c]	**272**	**109**	**655**	**15**	**189**	**408**	**41**
Natural Gas Compression - Operations [a]	0	0	0	0	0	0	0
Well Head Compression - Operations*	2	2	43	0	43	35	6
Dehydrator & Separator Heater - Operations [a]	5	5	65	0	54	4	0
Condensate & Produced Water Tank Heaters - Operations [a]	5	5	65	0	54	4	0
Dehydrator VOC, Condensate Tank Flashing & Flaring - Operations [a]	---	---	---	---	---	1338	134
Station Visits - Operations	0	0	0	0	0	0	0
Well Workover - Operations	30	3	91	2	21	3	0
Well & Pipeline visits for Inspection & Repair - Operations	0	0	0	0	0	0	0
Tank Condensate & Truck Loadout	---	---	---	---	---	0	0
Sub-total: Operations	**42**	**16**	**264**	**2**	**173**	**1,382**	**140**
Road Maintenance	4	1	2	0	0	0	0
Compressor Maintenance	0	0	0	0	0	0	0
Sub-total: Maintenance	**4**	**1**	**2**	**0**	**0**	**0**	**0**
Grand Total: Natural Gas Long-term Development	**319**	**125**	**920**	**18**	**363**	**1,790**	**181**

[a] $PM_{2.5}$ assumed = PM_{10} for this source.

[b] HAPs = Hazardous Air Pollutants; assumed = VOCs * 0.1, and formaldehyde HAP added for gas compression

[c] Construction emissions divided by 20 (for 20 years) to represent annual emission totals

Table F1.3.1: High Core Action Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C) of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42*, Volume I, Section 13.2.3 Heavy Construction	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Total number of wells in the ground 2031	5165	EOG Resources	
Total number of pads in 2031	5165	EOG Resources	
Number wells to estimate construction emissions in 2031	5165	EOG Resources	
Compression per well	200	EOG Resources	
Average HP of the central compressor station	50,000	EOG Resources	
Total number of well head compressors in 2031.	155	EOG Resources	

Well Emission Assumptions:

Emission factors derived from AP-42 or otherwise noted

Gas compressors assumed to be BACT equipped

Assume diesel fuel sulfur content of 0.05% for diesel engines

Well condensate production assumed to be from wells with Best Available Control Technology (BACT)

Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10} for the following categories, heavy equipment traffic, natural gas compression, dehydrators, separators and flashing emissions.

Hazardous Air Pollutants (HAPS) assumed to be 10% of VOCs and formaldehyde added for gas compression emissions

Assume natural gas heating value of 1,020 Btu/scf. (BLM, 2003) unless specifically noted

Assume 30 wells out of 1,000 will need well head dompression.

Assume that natural gas compressors would operate at full capacity.

Short term represents a seven year time period through the year 2013

Long term represents a twenty-five year time period through the year 2031

86 is the total number of precipitation days for Kemmerer WY, Western Regional Climate Center

Table F1.3.2: High Core Action Natural Gas Pad Construction, Fugitive Dust Assumptions

INPUTS & ASSUMPTIONS			
Description	**Value**	**Source**	**Notes**
Control Efficiency (C)of watering	0.5	BLM 2003; Table APP_a21.xls	
TSP Emission Factor	1.2	EPA, *AP-42* , Volume I, Section 13.2.3 Heavy Construction Operations (1/95)	Tons TSP/acre-month
Conversion factor for TSP to PM-10	0.26	BLM 2003; Table APP_a21.xls	Percentage of TSP
Conversion factor for PM-10 to PM2.5	0.15	BLM 2003; Table APP_a21.xls	Percentage of PM-10
Number of wells in the ground 2013	**757**	**EOG Resources**	
Number of wells in the ground 2031	**5165**	**EOG Resources**	
Total number of pads in 2013	**757**	**EOG Resources**	
Total number of pads in 2031	**5165**	**EOG Resources**	
Number of wells to estimate construction emissions in 2013	**757**	**EOG Resources**	
Number of wells to estimate construction emissions in 2031	**5165**	**EOG Resources**	
Number of well head compressors in 2013	**23**	**EOG Resources**	
Number of well head compressors in 2031	**155**	**EOG Resources**	
HP compression per well	**200**	**EOG Resources**	
HP of central compressor stations	**50,000**	**EOG Resources**	

Table 80: High Core Action Natural Gas Pad Construction, Fugitive Dust Emissions Estimation

Emissions Estimation for Construction Activities

Area Disturbed for NG Wells	Emission Estimation Basis	Disturbed Area (acre) [a]	Avg. Number of Days to Complete	Total # of Well Pads or Stations	Total Disturbed Area (acre)	Emissions					
						(lb/well pad or lb/stn)			(ton/project)		
						TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Drilling Roads, Producing Roads, Drilling Well Pad & Producing Well Pad, New Pipeline and Electric Line	per Well Pad	2.75	7	5,165	14,204	770	200	30	1,989	517	78
Central Compressor Station	per station	1.50	2	3	5	120	31	5	0	0	0
Totals					14,208	**Total**			**1,989**	**517**	**78**

[a] From gross surface disturbance projections BLM

Note: number of compressor stations are for new construction

TSP= 1.2 tpy/acre-month x 14,204 acres x 7/30 days x 0.5 dust control efficiency = 1,989 tons

Table F1.3.4: High Core Action Gas Analysis

Gas Component	Mol%	Mol%/100	Molecular Weight	Molecular Weight of each Component
N_2	1.2953	0.012953	28.01	0.363
Methane (C1)	83.3591	0.833591	16.04	13.371
CO_2	0.1265	0.001265	44.01	0.056
Ethane (C2)	8.7362	0.087362	30.07	2.627
Propane (C3)	4.1642	0.041642	44.10	1.836
I-Butane (iC4)	0.6661	0.006661	58.12	0.387
N-Butane (nC4)	0.9106	0.009106	58.12	0.529
I-pentane (iC5)	0.2129	0.002129	72.15	0.154
N-pentane (nC5)	0.1908	0.001908	72.15	0.138
Hexanes (C6)	0.1454	0.001454	84.18	0.122
Heptanes (C7)	0.1317	0.001317	100.20	0.132
Octanes (C8)	0.058	0.00058	114.23	0.066
Nonanes	0.0032	0.000032	114.23	0.004
TOTAL	**100**			**19.785**

MW = Mol%/100*MW

Methane (C1) = 0.833591*16.04 = 13.371

VOC = C_3^+ components = 3.368

VOC Weight Percent = 3.368/19.785*100 = 17.02%

BTU Value 1,189

Pinedale Frontier Formation Condensate Analysis

WELL NAME:	**Frontier Well**
COMPONENT	**MOL%**
H2S	0.0000
O2	0.0000
CO2	0.0000
N2	0.0000
C1	0.4064
C2	1.7056
C3	3.3635
IC4	2.2423
NC4	3.0113
IC5	3.8486
NC5	3.5648
Hexanes	14.1300
Heptanes	44.6335
Benzene	1.8256
Toluene	8.5229
E-Benzene	0.7922
Xylene	6.2070
n-C6	5.7245
2,2,4-Trimethylpentane	0.0219
Total	**100.000**

Table F1.3.5: Proposed Action Emission Factors for Construction Equipment

Emission Factors for Construction Equipment						
Equipment	Emission Factors (g/hp-hr)					Equipment Category in AP-42 [a]
	NO_x	PM_{10}	SO_2	CO	VOCs	
Backhoe	8.81	0.81	0.86	2.71	0.97	Wheeled Loader
Dozer	7.81	0.69	0.85	2.15	0.75	Track-Type Tractor
Blade	7.14	0.63	0.87	1.54	0.36	Motor Grader
Trencher	11.01	0.90	0.93	4.60	1.01	Miscellaneous
Trackhoe	9.30	0.66	0.85	2.26	1.11	Track-Type Loader

[a] BLM, 2003, table APP_A21.

Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (9/85).

Table F1.3.6: High Core Action Well Pad Construction Emissions

Construction Site	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Oper. Hrs per Day	# of Oper. Days per Well Pad or per Station	# of Oper. Hrs per Well Pad or per Station	# of Well Pads or Stations	Emissions (lb/well pad, lb/station, or lb/project)					Emissions (ton/equipment type)					Emissions (ton/construction site)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_2	CO	VOC	NO_x	PM_{10}	SO_2	CO	VOC
Drilling Roads	Blade	100	1	80	10	3	30	5,165	38	3.3	4.6	8	1.9	98	8.6	11.9	21.0	4.9	187.8	16.9	20.7	48.8	14.9
	Backhoe	80	1	75	10	3	30	5,165	35	3.2	3.4	11	3.8	90	8.3	8.8	27.8	9.9					
Producing Roads	Blade	100	1	80	10	3	30	5,165	38	3.3	4.6	8	1.9	98	8.6	11.9	21.0	4.9	187.8	16.9	20.7	48.8	14.9
	Backhoe	80	1	75	10	3	30	5,165	35	3.2	3.4	11	3.8	90	8.3	8.8	27.8	9.9					
Drilling Well Pad	Backhoe	80	1	75	10	2	20	5,165	23	2.1	2.3	7	2.6	60	5.5	5.9	19	6.6	60.2	5.5	5.9	18.5	6.6
Producing Well Pad	Backhoe	80	1	75	10	2	20	5,165	23	2.1	2.3	7	2.6	60	5.5	5.9	19	6.6	60.2	5.5	5.9	18.5	6.6
New Pipeline	Blade	100	1	80	10	1	10	5,165	13	1.1	1.5	3	0.6	33	2.9	4.0	7.0	1.6	150	12.8	14.3	53	13.0
	Trencher	175	1	80	10	1	10	5,165	34	2.8	2.9	14	3.1	88	7	7	37	8					
	Backhoe	80	1	75	10	1	10	5,165	12	1.1	1.1	4	1.3	30	2.8	2.9	9.3	3.3					
Well Head Compressors	Dozer	350	1	80	8	2	16	155	77	6.8	8.4	21	7.4	6	0.53	0.65	1.6	0.6	9.1	0.8	1.0	2.6	0.9
	Backhoe	80	2	80	8	2	16	155	40	3.7	3.9	12	4.4	3	0.28	0.30	0.95	0.34					
Central Compressor Station	Dozer	350	1	80	8	2	16	3	77	6.8	8.4	21	7.4	0	0.01	0.01	0.0	0.0	0.2	0.0	0.0	0.1	0.0
	Backhoe	80	2	80	8	2	16	3	40	3.7	3.9	12	4.4	0	0.01	0.01	0.02	0.01					
																	Subtotal		**656**	**58.5**	**68.4**	**190**	**56.9**

Table F1.3.7: High Core Action Emission Factors for Industrial Engines

Emission Factors for Industrial Engines

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	lb/hp-hr	3.10E-02	2.20E-03	2.05E-03	6.68E-03	2.15E-03
Industrial Engine [b]	Diesel	lb/hp-hr	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

[a] EPA, *AP-42* , Volume I, Section 3.3 Gasoline and Diesel Industrial Engines (10/96).
[b] EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table F1.3.8: High Core Action Emission Estimates for Industrial Engines

Emissions Estimation for Industrial Engines

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions (lb/well)					Emissions (ton/equipment type)					Emissions (ton/project activity)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC
Rig-up, Drilling, and Rig-down	Main Deck	1,000	2	70	15	16	240	5,165	8,064	193	136	1,848	237	20,825	497	351	4,772	612	26,125	705.2	526.0	5,963	837
	Auxiliary Pump	600	1	80	8	15	120	5,165	1,382	33	23	317	41	3,570	85	60	818	105					
	Generator	150	1	75	24	8	192	5,165	670	48	44	144	46	1,729	123	114	373	120					
Well Completion & Testing	Main Deck	600	1	50	11	5	55	5,165	396	9	7	91	12	1,023	24	17	234	30	1,397	51	42	315	56
	Auxiliary Pump	225	1	80	8	2	16	5,165	89	6	6	19	6	231	16	15	50	16					
	Power Swivel	150	1	75	8	2	16	5,165	56	4	4	12	4	144	10	10	31	10					
																		Subtotal	**27,522**	**756**	**568**	**6,278**	**893**

Table F1.3.9: High Core Action Field Generator Emissions

Emission Factors for Field Generators (Tier II)

Emission Source	Fuel Type	Emission Factors					
		Unit	NO_x	PM_{10}	SO_x	CO	VOC
Industrial Engine [a]	Diesel	g/hp-hr	4.90E+00	2.20E-01	9.30E-01	3.70E+00	4.90E+00
Industrial Engine	Diesel	lbs/hp-hr	1.08E-02	4.80E-04	2.05E-03	8.20E-03	1.08E-02

[a] From USA - Nonroad Diesel Engines Tier 2 Emission Standards
Emission factors for a < 600 hp generator, (NOx & VOC = 4.9 g/hp-hr)

Table F1.3.10: High Core Action Emissions for Field Generators

Temporary Emissions Estimation for Field Generators

Construction Site Activity	Equipment Type	Capacity (hp)	# of Units	Av. Load Factor (%)	# of Operating Hours per Day	# of Operating Days per Well	# of Operating Hours per Well	# of Wells	Emissions									
									(lb/well)					(ton/equipment type)				
									NO_x	PM_{10}	SO_2	CO	VOC	NO_x	PM_{10} [a]	SO_x	CO	VOC
Field Generators	Field Generators for Pumps & Lighting	175	1	75	12	8	96	5,165	136	6	26	103	136	351	16	67	267	351
													TOTALS	**351**	**16**	**67**	**267**	**351**

Table F1.3.11: High Core Action Estimate of Emissions from Well Construction Flaring

Emission Factors for Flaring

Unit	NO_x	PM_{10}	SO_2	CO
lb/MMscf	76.0	7.6	0.6	413.3
lb/MMBtu	6.80E-02	6.80E-03	5.37E-04	3.70E-01

Emission factors for NOx & CO Source: EPA, *AP-42* , Volume I, Section 13.5 Industrial Flares

Emission factors for PM10 & SO2 from EPA, AP-42, Volume I, Section 1.4 Natural Gas Combustion

Table F1.3.12: High Core Action Emissions from Well Completion Flaring

Well Completion Flaring	Gas Production Estimate (MMSCF) per day	# of Days of Flaring	Av. Heat Content of Gas btu/scf	# of Wells	Emissions							
					(lb/well)				(tons)			
					NO_x	PM_{10}	SO_2	CO	NO_x	PM_{10} [a]	SO_x	CO
Flaring	1	2	1020	5,165	139	15.2	1.2	755	358	39	3.1	1,949
TOTALS									**358**	**39**	**3.1**	**1,949**

Emissions = EVH where E= emission factor; V= gas volume; H= heat content
NOx= 0.068lbs/MMBtu*1.0 MMSCFD*1020 Btu/scf = 69.5 lbs per well* 2 days = 139 lbs per well
PM10 & SO2 Emissions = EV where E= emission factor; V= gas volume
PM10 = 7.6 lbs/MMSCF*1.0 MMSCFD = 7.6 lbs/well*2days = 15.2 lbs per well

Table F1.3.13: High Core Action VOC Emissions from Well Completion Flaring

VOC Emissions Well Flaring: Long-term Production

Well Completion Flaring	VOC Emission Factor lbs per well	# of Wells	VOC Emissions tons
Flaring	8,863	5,165	22,889

Assume average VOC content 17 %
Average Mole Weight 19.785
Gas production rate of 1.0 MMSCF per well per day
Assume 2 days of flaring

Flare Gas wt= $\frac{\text{2.0 MMSCF*1,000,00scf/MMSCF*19.785 lbs/lbs-mole}}{\text{379.49scf/mole}}$

VOC Emissions= 104,272 lbs/well*0.17VOC wt%*0.5 efficiency destruction = 8,863 lbs/well

HAPs are estimated at 10% of VOC amounts and are shown on total spread sheets
Assume same gas production rate for short term and long term new constructed wells of 1.0 MMSCFD

Table F1.3.14: High Core Action Well Pad Construction Wind Erosion

Emission Factor: 0.3733 llb/hr/100m^2

Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meterological data.

Control Efficiency: 50%

Disturbed Area:

Well Pad Construction:	4.25 acres	17199.155 m^2
Access Road Construction:	3.00 acres	12140.58 m^2
Pipeline Construction:	0.50 acres	2023.43 m^2

Source Parameters
147 1-km area sources
sigma z=2.33 m

PM_{10} Emission Calculations:

	PM_{10} Emission Factor (llb/hr/100m^2)	$PM_{2.5}$ Emission Factor (llb/hr/100m^2)	Area 100 m^2	Control Efficiency (%)	PM_{10} Emissions (lb/hr)	$PM_{2.5}$ Emissions (lb/hr)	PM_{10} Emissions (g/sec)	$PM_{2.5}$ Emissions (g/sec)
Well Pad Construction:	0.3733	0.1493	171.99	50	32.10	12.84	4.04	1.62
Resource Road Construction:	0.3733	0.1493	121.41	50	22.66	9.06	2.86	1.14
Pipeline Construction:	0.3733	0.1493	20.23	50	3.78	1.51	0.48	0.19
Total:					**58.54**	**23.41**	**7.38**	**2.95**

Table F1.3.15: High Core Action Fugitive Dust Emissions from Commuting Vehicles. Emission Factors for Road Traffic.

Emission Factors for Road Traffic

$$E\ (lb/VMT) = \frac{k\ (s/12)^a\ (W/3)^d}{(M/0.2)^c}$$

Parameter	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)

Function/Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
W = mean vehicle weight (tons)	Listed in the table below	
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.3.16: High Core Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	PM_{10}				$PM_{2.5}$			
							Controlled Em. Factor (lb/VMT)	Emissions			Controlled Em. Factor (lb/VMT)	Emissions		
								(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)		(lb/well pad, lb/stn, or lb/proj.)	(ton/veh. type)	(ton/const. site)
Drilling Roads	Semi Trucks	60,000	6	1	6	5,165	1.21	7	19	18.7	0.18	1.1	2.8	2.8
Producing Roads	Semi Trucks	60,000	6	1	6	5,165	1.21	7	19	18.7	0.18	1.1	2.8	2.8
Drilling Well Pad	Haul Trucks	45,000	6	1	6	5,165	1.05	6	16	22.6	0.16	0.9	2.4	3.4
	Pickup Trucks	7,000	6	1	6	5,165	0.41	2.5	6		0.06	0.4	1.0	
Producing Well Pad	Haul Trucks	45,000	6	1	6	5,165	1.05	6	16	22.6	0.16	0.9	2.4	3.4
	Pickup Trucks	7,000	6	1	6	5,165	0.41	2.5	6		0.06	0.4	1.0	
New Pipeline	Haul Trucks	45,000	6	1	6	5,165	1.05	6	16	22.6	0.16	0.9	2.4	3
	Pickup Trucks	7,000	6	1	6	5,165	0.41	2	6		0.06	0.4	1.0	
Electric Line	Haul Trucks	45,000	6	1	6	5,165	1.05	6.3	16	22.6	0.16	0.9	2.4	3.4
	Pickup Trucks	7,000	6	1	6	5,165	0.41	2.5	6		0.06	0.4	1.0	
Well Head Compressors	Semi Trucks	60,000	6	1	6	155	1.21	7	0.6	1.2	0.18	1	0.1	0
	Haul Trucks	45,000	6	1	6	155	1.05	6	0		0.16	1	0.1	
	Pickup Trucks	7,000	6	1	6	155	0.41	2	0		0.06	0	0.0	
Central Compressor Station	Semi Trucks	60,000	6	1	6	3	1.21	7	0.0	0.0	0.18	1	0.0	0
	Haul Trucks	45,000	6	1	6	3	1.05	6	0		0.16	1	0.0	
	Pickup Trucks	7,000	6	1	6	3	0.41	2	0		0.06	0	0.0	
								Subtotal		**129.3**				**19**

Table F1.3.17: High Core Action Exhaust Emission Factors for Long Term Commuting Construction Vehicles

Emission Factors for Road Traffic

Vehicle		Emission Factors (g/mi)					
Type	**Class**	**NO_x**	**PM_{10} [a,b]**	**$PM_{2.5}$ [a,b]**	**SO_x [a]**	**CO**	**VOC**
Light-Duty Gasoline Truck	LDGT2	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck	HDDV	8.13	1.96	1.81	1.63	17.09	4.83

[a] From BLM, 2003, APP_A21, table 1.1.2.2, estimated using EPA PART5 Model (1995)
[b] Including tire and brake wear emissions.
Source: EPA, *AP-42* , Volume II, Appendix H-117, Table 3.1A.2 Light Duty Gasoline Powered Trucks II and Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehicles (High Altitude; Model Year 1991-1997; 50,000 mileage) (6/30/95).

Table F1.3.18: High Core Action Exhaust Emissions Estimates for Commuting Construction Vehicles

Emissions Estimation for Road Traffic

Construction Site Destination	Vehicle		Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station	Miles Traveled per Well Pad or per Station	Total # of Well Pads or Stations	Emissions																	
							(lb/well pad, lb/station, or lb/project)						(ton/vehicle type)						(ton/construction site)					
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Drilling Roads	Semi Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.07	0.06	0.06	0.6	0.2	0.3	0.07	0.06	0.06	0.6	0.2
Producing Roads	Semi Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.07	0.06	0.06	0.6	0.2	0.3	0.07	0.06	0.06	0.6	0.2
Drilling Well Pad	Haul Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.07	0.06	0.06	0.6	0.2	0.3	0.07	0.06	0.06	1.0	0.2
	Pickup Trucks	LDGT2	6	1	6	5,165	0.01	0.001	0.001	0.001	0.15	0.01	0.0	0.003	0.003	0.004	0.4	0.03						
Producing Well Pad	Haul Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.07	0.06	0.06	0.6	0.2	0.3	0.07	0.06	0.06	1.0	0.2
	Pickup Trucks	LDGT2	6	1	6	5,165	0.01	0.001	0.001	0.001	0.15	0.01	0.0	0.003	0.003	0.004	0.4	0.03						
New Pipeline	Haul Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.1	0.1	0.06	0.6	0.2	0.3	0.1	0.1	0.1	1.0	0.2
	Pickup Trucks	LDGT2	6	1	6	5,165	0.01	0.00	0.00	0.00	0.15	0.01	0.0	0.003	0.003	0.004	0.4	0.03						
Electric Line	Haul Trucks	HDDV	6	1	6	5,165	0.11	0.03	0.02	0.02	0.23	0.06	0.3	0.07	0.06	0.06	0.6	0.16	0.3	0.07	0.06	0.06	1.0	0.2
	Pickup Trucks	LDGT2	6	1	6	5,165	0.01	0.001	0.001	0.001	0.15	0.01	0.0	0.003	0.003	0.004	0.4	0.03						
Central Compressor Station	Semi Trucks	HDDV	6	1	6	3	0.11	0.03	0.02	0.02	0.23	0.06	0.0	0.000	0.000	0.000	0.00	0.000	0.0	0.00	0.00	0.00	0.0	0.0
	Haul Trucks	HDDV	6	1	6	3	0.11	0.03	0.02	0.02	0.23	0.06	0.0	0.000	0.000	0.000	0.00	0.00						
	Pickup Trucks	LDGT2	6	1	6	3	0.01	0.00	0.00	0.00	0.15	0.01	0.0	0.000	0.000	0.000	0.0	0.00						
																		Subtotal	**1.8**	**0.4**	**0.4**	**0.3**	**5.1**	**1.1**

Table F1.3.19: High Core Action Exhaust Emissions Estimates for Commuting Vehicles

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Vehicle Class	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station [a]	Miles Traveled per Well or per Station	Total # of Wells or Stations	Emissions (lb/well)						Emissions (ton/vehicle type)						Emissions (ton/project activity)					
							NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC
Rig-up, Drilling, and Rig-down	Semi Rig Transport	HDDV	6	5	30	5,165	0.54	0.13	0.12	0.11	1.13	0.32	1.4	0.33	0.31	0.28	2.9	0.82	7.1	1.6	1.4	1.3	24.8	4.4
	Fuel Haul Truck	HDDV	6	5	30	5,165	0.54	0.13	0.12	0.11	1.13	0.32	1.4	0.33	0.31	0.28	2.9	0.8						
	Mud Haul Truck, Water	HDDV	6	5	30	5,165	0.54	0.13	0.12	0.11	1.13	0.32	1.4	0.3	0.3	0.3	2.9	0.8						
	Rig Crew	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.017	0.013	0.019	2.0	0.13						
	Rig Mechanics	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.134	0.123	0.111	1.2	0.33						
	Co. Supervisor	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.02	0.01	0.02	2.0	0.13						
	Tool Pusher	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.0	0.0	0.0	2.0	0.1						
	Mud Logger	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.0	0.0	0.0	2.0	0.1						
	Mud Engineer	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.0	0.0	0.0	2.0	0.1						
	Logger, Engr Truck	HDDV	6	5	30	5,165	0.54	0.13	0.12	0.11	1.13	0.32	1.4	0.3	0.3	0.3	2.9	0.8						
	Drill Bit Delivery	LDGT2	6	5	30	5,165	0.07	0.01	0.00	0.01	0.77	0.05	0.2	0.02	0.01	0.02	2.0	0.13						
Well Completion & Testing	Semi Casing Haulers	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33	20.4	4.7	4.3	4.0	54.5	10.3
	Semi Completion, Unit Rig	HDDV	6	8	48	5,165	0.86	0.21	0.19	0.17	1.81	0.51	2.2	0.54	0.49	0.45	4.7	1.32						
	Semi Fracing Blender	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Semi Pumping Tank Battery	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Tubing Truck	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Cementer, Pump Truck	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Cementer, Cement Truck	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Completion Equip Truck	HDDV	6	8	48	5,165	0.86	0.21	0.19	0.17	1.81	0.51	2.2	0.54	0.49	0.45	4.7	1.32						
	Haul Service Tools	LDGT2	6	2	12	5,165	0.03	0.00	0.00	0.00	0.31	0.02	0.1	0.01	0.01	0.01	0.8	0.05						
	Haul Perforators Logging Truck	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Anchor Installation	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Anchor Testing	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Fracing Tank	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Fracing Pump	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Fracing Chemical	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Fracing Sand	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Fracing Other	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Welders	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.33						
	Haul Water Truck	HDDV	6	8	48	5,165	0.86	0.21	0.19	0.17	1.81	0.51	2.2	0.54	0.49	0.45	4.7	1.32						
	Pickup Cementer, Engineer	LDGT2	6	2	12	5,165	0.03	0.00	0.00	0.00	0.31	0.02	0.1	0.01	0.01	0.01	0.8	0.05						
	Pickup Chasing Crew	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.1	0.1	0.1	1.2	0.3						
	Pickup Completion Crew	HDDV	6	8	48	5,165	0.86	0.21	0.19	0.17	1.81	0.51	2.2	0.5	0.5	0.4	4.7	1.3						
	Pickup Completion Pusher	LDGT2	6	8	48	5,165	0.11	0.010	0.008	0.012	1.23	0.08	0.28	0.027	0.021	0.031	3.2	0.20						
	Pickup Perforations Engineer	LDGT2	6	8	48	5,165	0.11	0.010	0.008	0.012	1.23	0.08	0.28	0.027	0.021	0.031	3.2	0.20						
	Pickup Fracing Engineer	HDDV	6	2	12	5,165	0.22	0.052	0.048	0.043	0.45	0.13	0.56	0.134	0.123	0.111	1.2	0.33						
	Pickup Co. Supervisor	LDGT2	6	8	48	5,165	0.11	0.010	0.008	0.012	1.23	0.08	0.28	0.027	0.021	0.031	3.2	0.20						
	Pickup Misc Supplies	LDGT2	6	8	48	5,165	0.11	0.010	0.008	0.012	1.23	0.08	0.28	0.027	0.021	0.031	3.2	0.20						
	Pickup Roustabout Crew	HDDV	6	2	12	5,165	0.22	0.05	0.05	0.04	0.45	0.13	0.6	0.13	0.12	0.11	1.2	0.3						
Well Head Compressors	Semi Trucks	HDDV	6	2	150	155	2.69	0.65	0.60	0.54	5.65	1.60	0.2	0.050	0.046	0.042	0.44	0.124						
	Haul Trucks	HDDV	6	2	12	155	0.22	0.05	0.05	0.04	0.45	0.13	0.0	0.004	0.004	0.003	0.04	0.01						
	Pickup Trucks	LDGT2	6	2	12	155	0.03	0.00	0.00	0.00	0.31	0.02	0.0	0.000	0.000	0.000	0.0	0.00						
Central Compressor Station	Semi Trucks	HDDV	6	2	150	3	2.69	0.65	0.60	0.54	5.65	1.60	0.0	0.001	0.001	0.001	0.01	0.002						
	Haul Trucks	HDDV	6	2	12	3	0.22	0.05	0.05	0.04	0.45	0.13	0.0	0.000	0.000	0.000	0.00	0.00						
	Pickup Trucks	LDGT2	6	2	12	3	0.03	0.00	0.00	0.00	0.31	0.02	0.0	0.000	0.000	0.000	0.0	0.00						
																		Subtotal	**27.5**	**6.3**	**5.8**	**5.3**	**79**	**14.7**
																		TOTAL	**29.3**	**6.7**	**6.2**	**5.7**	**84**	**15.8**

Table F1.3.20: High Core Action Fugitive Dust Emissions Estimates for Well Construction Road Traffic

Emissions Estimation for Road Traffic

Construction Site Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well Pad or per Station *	Miles Traveled per Well Pad or per Station	Total # of Wells or Stations	Controlled Em. Factor (lb/VMT)	PM_{10} Emissions (lb/well)	PM_{10} Emissions (ton/veh. type)	PM_{10} Emissions (ton/proj. activity)	Controlled Em. Factor (lb/VMT)	$PM_{2.5}$ Emissions (lb/well)	$PM_{2.5}$ Emissions (ton/veh. type)	$PM_{2.5}$ Emissions (ton/proj. activity)
Rig-up, Drilling, and Rig-down	Semi Rig Transport & Drill Rig	80,000	6	5	30	5,165	1.40	42	108	577	0.21	6.3	16.2	87
	Fuel Haul Truck	50,000	6	5	30	5,165	1.10	33	85.5		0.17	5.0	12.8	
	Mud Haul Truck, Water Hauling	60,000	6	5	30	5,165	1.21	36	94		0.18	5	14.1	
	Rig Crew	7,000	6	5	30	5,165	0.41	12	32.0		0.06	1.9	4.8	
	Rig Mechanics	12,000	6	2	12	5,165	0.54	6	16.8		0.08	1.0	2.5	
	Co. Supervisor	7,000	6	5	30	5,165	0.41	12	32		0.06	1.9	4.8	
	Tool Pusher	7,000	6	5	30	5,165	0.41	12	32.0		0.06	1.9	4.8	
	Mud Logger	7,000	6	5	30	5,165	0.41	12	32.0		0.06	1.9	4.8	
	Mud Engineer	7,000	6	5	30	5,165	0.41	12	32.0		0.06	1.9	4.8	
	Logger, Engr Truck	45,000	6	5	30	5,165	1.05	31.4	81.2		0.16	4.7	12.2	
	Drill Bit Delivery	7,000	6	5	30	5,165	0.41	12	32		0.06	1.9	4.8	
Well Completion & Testing	Semi Casing Haulers	60,000	6	2	12	5,165	1.21	14.5	37	1,365	0.18	2.2	5.6	205
	Semi Completion, Unit Rig	120,000	6	8	48	5,165	1.71	82	212.0		0.26	12.3	31.8	
	Semi Fracing Blender	85,000	6	2	12	5,165	1.44	17	44.6		0.22	2.6	6.7	
	Semi Pumping Tank Battery	80,000	6	2	12	5,165	1.40	17	43.3		0.21	2.5	6.5	
	Tubing Truck	60,000	6	2	12	5,165	1.21	14.5	37.5		0.18	2.2	5.6	
	Haul Cementer, Pump Truck	85,000	6	2	12	5,165	1.44	17	44.6		0.22	2.6	6.7	
	Haul Cementer, Cement Truck	60,000	6	2	12	5,165	1.21	15	37.5		0.18	2.2	5.6	
	Haul Completion, Equip Truck	45,000	6	8	48	5,165	1.05	50.3	129.9		0.16	7.5	19.5	
	Haul Service Tools	7,000	6	2	12	5,165	0.41	5.0	12.8		0.06	0.7	1.9	
	Haul Perforators Logging Truck	45,000	6	2	12	5,165	1.05	12.6	32.5		0.16	1.9	4.9	
	Haul Anchor Installation	40,000	6	2	12	5,165	0.99	11.9	30.6		0.15	1.8	4.6	
	Haul Anchor Testing	12,000	6	2	12	5,165	0.54	6.5	16.8		0.08	1.0	2.5	
	Haul Fracing Tank	40,000	6	2	12	5,165	0.99	11.9	30.6		0.15	1.8	4.6	
	Haul Fracing Pump	85,000	6	2	12	5,165	1.44	17.3	44.6		0.22	2.6	6.7	
	Haul Fracing Chemical	45,000	6	2	12	5,165	1.05	12.6	32.5		0.16	1.9	4.9	
	Haul Fracing Sand	60,000	6	2	12	5,165	1.21	14.5	37.5		0.18	2.2	5.6	
	Haul Fracing Other	85,000	6	2	12	5,165	1.44	17.3	44.6		0.22	2.6	6.7	
	Haul Welders	12,000	6	2	12	5,165	0.54	6.5	16.8		0.08	1.0	2.5	
	Haul Water Truck	60,000	6	8	48	5,165	1.21	58	150		0.18	9	22.5	
	Pickup Cementer, Engineer	7,000	6	2	12	5,165	0.41	5.0	12.8		0.06	0.7	1.9	
	Pickup Chasing Crew	10,000	6	2	12	5,165	0.49	5.9	15.3		0.07	0.9	2.3	
	Pickup Completion Crew	10,000	6	8	48	5,165	0.49	23.7	61.2		0.07	3.6	9.2	
	Pickup Completion Pusher	7,000	6	8	48	5,165	0.41	19.8	51.2		0.06	3.0	7.7	
	Pickup Perforators Engineer	7,000	6	8	48	5,165	0.41	19.8	51.2		0.06	3.0	7.7	
	Pickup Fracing Engineer	10,000	6	2	12	5,165	0.49	5.9	15.3		0.07	0.9	2.3	
	Pickup Co. Supervisor	7,000	6	8	48	5,165	0.41	19.8	51.2		0.06	3.0	7.7	
	Miscellaneous Supplies	7,000	6	8	48	5,165	0.41	19.8	51.2		0.06	3.0	7.7	
	Pickup Roustabout Crew	12,000	6	2	12	5,165	0.54	6	16.8		0.08	1.0	2.5	
Well Head Compressors	Semi Trucks	60,000	6	2	12	155	1.21	15	1.1		0.18	2	0.2	
	Haul Trucks	45,000	6	2	12	155	1.05	13	1		0.16	2	0.1	
	Pickup Trucks	7,000	6	2	12	155	0.41	5	0		0.06	1	0.1	
Central Compressor Station	Semi Trucks	60,000	6	2	12	3	1.21	15	0.0		0.18	2	0.0	
	Haul Trucks	45,000	6	2	12	3	1.05	13	0		0.16	2	0.0	
	Pickup Trucks	7,000	6	2	12	3	0.41	5	0		0.06	1	0.0	
								Subtotal		**1,942**				**291**
								TOTAL		**2,071**				**311**

Table F1.3.21: High Core Action Emission Factors for Central Compressor Stations

Emission Factors for Natural Gas-Fired Compressors

Compressor		Horse-Power Rating	Emission Factors (g/hp-hr) [a]					
			NOx [a,]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO
Central Compressor Station	Rich Burn	50,000	1.00	1.8E-01	2.0E-03	2.00	1.00	0.07

[a] From State of Wyoming AQD BACT
[b] From BLM, 2003. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.

Table F1.3.22: High Core Action Emission Estimates for Central Compressor Stations

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)					
			NOx	PM_{10}	SO_2	CO	VOC	HCHO
Central Compressor Station	7	8,760	3,380	608	7	6,759	3,380	237
		Total	**3,380**	**608**	**7**	**6,759**	**3,380**	**237**

Emissions per Compressor = emission factor g/hp-hr*compressor engine hp rating*(453.6g/lb)

NOX Emissions= (1.0 g/hp-hr*50,000 hp)/453.6g/lb = 110.23 lb per hour*8760 hours*7 stations/2000lb per ton = 3,380 tpy

Table F1.3.23: High Core Action Emission Factors for Well Head Compressors

Emission Factors for Natural Gas-Fired Compressors

Compressor			Make	Model	Capacity (hp)	Emission Factors (g/hp-hr)					
						NOx [a, d]	PM_{10} [b,c]	SO_2 [b]	CO	VOC	HCHO
Well Head Compressors	Lean Burn	50%	Caterpillar	G3516LE	200	1.50	6.6E-02	2.0E-03	0.50	1.00	0.07
	Rich Burn	50%	Waukesha	7044GSI	200	1.00	6.6E-02	2.0E-03	2.00	1.00	0.05

[a] BACT
[b] From BLM Rawlins RMP, 2005. Source: EPA, *AP-42* , Volume I, Section 3.2 Natural Gas-Fired Reciprocating Engines, Table 3.2-2 & 3.2-3 (7/00).
[c] From BLM Rawlins RMP, 2005. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.
[d] Equipped with oxidizing catalyst and from Caterpillar gas engine technical data

Table F1.3.24: High Core Action Emission Estimates for Well Head Compressors

Emissions Estimation for Compressors

Type of Compressors	Total # of Operating Station-Year	Operating Hours per Year	Total Emissions (ton/year)					
			NOx	PM_{10}	SO_2	CO	VOC	HCHO*
Well Head Compressors	155	8,760	374.17	19.77	0.60	374.17	299.34	17.96
		Total	**374.17**	**19.77**	**0.60**	**374.17**	**299.34**	**17.96**

Total conventional well production based on 50,000 CF/day/well
*HCHO= formaldehyde

Table F1.3.25: High Core Action VOC Emission Factors for Dehydration and Condensate Tank Flashing During Production Operations

Production Emissions

VOC Emission Factors Dehydration and Condensate Tank Flashing

Dehydration VOC Emissions
0.3759 lb/hr per MMSCF per day [a]

[a] Generated from GRI-GLYCalc Version 4.0 and South Piney AQ Analysis
Emission factor changed from 0.2164 lb/hr to 0.3759 lb/hr due to adding C9 and C10 components from S. Piney gas analysis

Flashing Emissions	
0.023 lb/hr controlled [a]	0.387 lb/hr uncontrolled [a]

[a] from E&P Tank Version 2.0 as per South Piney AQ Analysis

Table F1.3.26: High Core Action Emission Factors for Dehydration and Condensate Flashing During Production Operations

Estimate for Dehydration VOC Emissions per year

VOC Emission Factor lb/hr	Total Number of Wells	Hours of Operation per year	Total VOC Emissions tpy
0.3759	5165	8760	8504

Assume 1.0 MMSCF gas production per well per day

Estimate for VOC Controlled Condensate Tank Flashing and Flaring Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Controlled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy
36,155	3,616	0.023	8760	364

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 70% of condensate tanks operate with a combustion chamber emission control device

Estimate for VOC Uncontrolled Condensate Tank Flashing Emissions per year

Total Field Condensate bbl/day	Total Number of Condensate Tanks	VOC Uncontrolled Emission Factor lb/hr	Hours of Operation per year	Total VOC Emissions tpy
15,495	1,550	0.387	8760	2626

Assume 10 barrels of condensate and produced water per MMCF
HAP emissions represented on summary tables
Assume 30% of condensate tanks operate without an emission control device
Assume one tank per well

Table F1.3.27: High Core Action Emission Factors for Dehydrator Heaters for Production Operations

Production Emissions

Emission Factors for Dehydrator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

[a] From BLM, 2003. Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}.

[b] From BLM, 2003. Assumed a fuel heating value of 1,020 Btu/scf.

Source: EPA, *AP-42* , Volume I, Section 1.4 Natural Gas Combustion (7/98).

Table F1.3.28: High Core Action Emission Estimates for Dehydrator Heaters for Production Operations

Emission Estimate for Dehydrator Heaters

Operating Hours per Year [a]	Dehydrator Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	5165	277	21	2	233	15

[a] Assumed operating 15 minutes per hour per day

Assume Dehydrator Heater Operation at each well site

HAP emissions represented on summary tables

Table F1.3.29: High Core Action Emission Factors for Three-Phase Separator Heaters
Emission Factors for Three-Phase Separator Heaters

Unit	NO_x	PM_{10} [a]	SO_2	CO	VOC
lb/MMscf	100	7.6	0.6	84	5.5
lb/MMBtu [b]	9.80E-02	7.45E-03	5.88E-04	8.24E-02	5.39E-03

Table F1.3.30: High Core Action Emission Estimates for Three-Phase Separator Heaters

Emission Estimates for Three Phase Separator Heaters

Operating Hours per Year [a]	Separator Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Wells	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	5165	277	21	2	233	15

[a] Assumed operating 15 minutes per hour per day

Assume Dehydrator Heater Operation at each well site

Table F1.3.31: High Core Action Emission Estimates for Condensate Tank Heaters

Emission Estimates for Condensate Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Condensate Tanks	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	5165	277	21	2	233	15

[a] Assumed operating 15 minutes per hour per day

Assume a separator and heater for each well

Table F1.3.32: High Core Action Emission Estimates for Produced Water Tank Heaters

Emission Estimates for Produced Water Tank Heaters

Operating Hours per Year [a]	Tank Heater Size MMBtu/hr	Fuel Usage MMCF/yr	Number of Produced Water Tanks	Total Emissions (ton/year)				
				NOx	PM_{10}	SO_2	CO	VOC
2,190	0.50	1.07	5165	277	21	2	233	15

[a] Assumed operating 15 minutes per hour per day

Assume a heater for each tank

Table F1.3.33: High Core Action for Production Operations Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.3.34: High Core Action Fugitive Dust Emissions Estimate for Production Operations Road Traffic

Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	PM_{10}			$PM_{2.5}$		
								Em. Factor (lb/VMT) a	Emissions (lb/stn-yr)	Emissions (ton/proj.)	Em. Factor (lb/VMT)	Emissions (lb/stn-yr)	Emissions (ton/proj.)
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	7	52	364	10	0.63	6.3	1.1	0.09	0.9	0.17
								Total		**1.1**			**0.2**

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Table F1.3.35: High Core Action Exhaust Emission Factors for Production Operations Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] Including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table F1.3.36: High Core Action Exhaust Emission Estimates for Production Operations Road Traffic

Exhaust Emissions Estimation for Road Traffic

Activity	Compressor Station	Vehicle Type	Av. Vehicle Weight (lb)	Total # of Operating Stations	Total # Inspection Visits per Station per year	Total # of Inspection Visits per year	Total # Miles per Inspection	Emissions											
								(lb/station-yr)						(ton/project)					
								NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Inspection Visits for Compressor Stations	Central Compressor Station	Pickup Truck	7,000	7	52	364	10	0.02	0.00	0.00	0.00	0.26	0.02	0.004	0.000	0.000	0.000	0.047	0.003
													Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.00**

[a] BLM, 2003. Table APP_A21, field and sales compressors are visited using a 200 hp pick up truck (4 wheels) once a week

Emissions per well = emission factor g/mile*total miles per inspection/453.6 g/lb

Table F1.3.37: High Core Action Fugitive Dust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W= mean vehicle weight (tons)	60	Assume workover rig 120,000 lbs
W= mean vehicle weight (tons)	30	Assume haul truck 60,000 lbs
W = mean vehicle weight (tons)	3.5	Assume pickup truck weight of 7,000 lbs
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
CE = control efficiency for watering (%)	50	EPA, *Control of Open Fugitive Dust Sources* ,

Table F1.3.38: High Core Action Fugitive Dust Emission Estimates for Well Workover Road Traffic

Fugitive Dust Emissions Estimation for Road Traffic: Long-term Production												
Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi)	# of Round Trips per Well	Miles Traveled per Well	Total # of Wells Drilled	PM_{10}			$PM_{2.5}$		
							Emission Factor (lb/VMT) [a]	Emissions		Emission Factor (lb/VMT) [b]	Emissions	
								(lb/well)	(ton/proj.)		(lb/well)	(ton/proj.)
Well Workover	Workover Rig	120,000	6	3	18	5,165	2.6	47	122	0.1	2	4.4
	Haul Truck	60,000	6	3	18	5,165	1.8	33	86	0.4	6	16.3
	Pickup Truck	7,000	6	3	18	5,165	0.6	11	29	0.2	3	8.2
							Total		**237**			**28.9**

[a] BLM, 2003. Table APP_A21.
[b] BLM, 2003. No dust control measures would be applied.

Table F1.3.39: High Core Action Exhaust Emission Factors for Well Workover On-Site Industrial Engines

Emission Factors for Industrial Engines					
Fuel Type	Emission Factors (lb/hp-hr)				
	NO_x	PM_{10}	SO_x	CO	VOC
Diesel	2.40E-02	5.73E-04	4.05E-04	5.50E-03	7.05E-04

EPA, *AP-42* , Volume I, Section 3.4 Large Stationary Diesel and all Stationary Dual Fuel Engines (10/96).

Table F1.3.40: High Core Action Exhaust Emission Estimates for Well Workover On-Site Industrial Engines

On-Site Exhaust Emissions Estimation for Industrial Engines: Long-term Production

Activity	Equipment	Capacity (hp)	Ave. Operating Load Factor (%)	Operating Hours per well	Total # of Wells Drilled	Emissions (lb/well)					Emissions (ton/project)				
						NO_x	PM_{10}	SO_x	CO	VOC	NO_x	PM_{10}	SO_x	CO	VOC
Well Workover	Truck-Mounted Unit	600	0.7	30	5,165	302	7	5	69	9	781	18.6	13.2	179.0	22.9

Emissions per well
= emission factor lb/hp-hr*engine hp rating*operating hours*engine load factor %

NOX Emissions= $\frac{302 \text{ lb/well}*5{,}165 \text{ wells}}{2000\text{lb/ton}}$ = 781 tons

Table F1.3.41: High Core Action Exhaust Emission Factors for Well Workover Road Traffic

Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light Duty Gasoline Truck (LDGT2)	1.01	0.10	0.08	0.11	11.64	0.75
Heavy-Duty Diesel Truck (HDDV)	8.13	1.96	1.81	1.63	17.09	4.83

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).
[b] BLM, 2003. Including tire and brake wear emissions.
Source: EPA (1985), AP-42, Volume II, Appendix H-259, Table 7.1.2 Heavy Duty Diesel Powered Vehicles (High Altitude; Model Year 1991-1997; 50,000 mileage).

Table F1.3.42: High Core Action Exhaust Emissions for Well Workover Road Traffic

On-Road Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi)	Round Trip Per Well	Miles Traveled per Well	Total # of Wells Drilled	Emissions											
							(lb/well)						(ton/project)					
	Type	Class					NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Well Workover	Workover Rig	HDDV	6	3	18	5,165	0.3	0.1	0.1	0.1	0.7	0.2	0.8	0.2	0.2	0.2	1.8	0.5
	Haul Truck	HDDV	6	3	18	5,165	0.3	0.1	0.1	0.1	0.7	0.2	0.8	0.2	0.2	0.2	1.8	0.5
	Pickup Truck	LDGT2	6	3	18	5,165	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.0	1.2	0.1
						TOTAL							**1.8**	**0.4**	**0.4**	**0.3**	**4.7**	**1.1**

Workover Rig
Emissions per well = $\frac{\text{emission factor g/mile*distance in miles}}{\text{(453.6 g/lb)}}$

NOX Emissions= $\frac{\text{0.1lb/welll*5,165 wells}}{\text{2000lb/ton}}$ = 1.8 tons

Table F1.3.43: High Core Action Fugitive Dust Emission Factors for Well and Pipeline Road Traffic

Emission Factors for Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F1.3.44: High Core Action Fugitive Dust Emission Estimates for Well and Pipeline Road Traffic

Well & Pipeline Fugitive Dust Emissions Estimation for Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	PM_{10}			$PM_{2.5}$		
								Em. Factor (lb/VMT) [c]	Emissions (lb/well-yr)	Emissions (ton/proj.)	Em. Factor (lb/VMT) [c]	Emissions (lb/well-yr)	Emissions (ton/proj.)
Visits for Inspection and Repair	200-hp Pickup	7,000	75	120	3	1.875	5,165	0.63	1.2	3	0.09	0.2	0.5

[a] BLM, 2003. Table APP_A21.xls
[b] BLM, 2003. Table APP_A21.xls
[c] BLM, 2003. Table APP_A21.xls

Table F1.3.45: High Core Action Exhaust Emission Factors for Well and Pipeline Road Traffic

Exhaust Emission Factors for Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] From BLM, 2003, table 1.1.2.2

[b] From BLM, 2003, table 1.1.2.2; including tire and brake wear emissions.

Source: EPA, *AP-42* , Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II (High Altitude; Model Year 1991-1997; 50,000 mileage) (1985).

Table F1.3.46: HIgh Core Action Exhaust Emissions for Well and Pipeline Road Traffic

Well & Pipeline Exhaust Emissions Estimation for Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	# of Wells Visited per Day [a]	# of Visits per Well per Year [b]	Miles Traveled per Well per Year	Total # of Operating Well-Yr	Emissions											
								(lb/well-yr)						(ton/project)					
	Type	Class						NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC	NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Visits for Inspection and Repair	200-hp Pickup	LDGT2	75	120	3	1.875	5,165	0.00	0.000	0.000	0.000	0.0	0.00	0.01	0.001	0.001	0.001	0.1	0.01

[a] From BLM, 2003, APP_A21, table 1.2.5.2
[b] Wells visited once per month

Table F1.3.47: High Core Action Road Maintenance Emission Estimation Information

Maintenance [a]	Equipment/Vehicle			Road Length Worked On per Day	# of Operating Hours per Day
	Type	Fuel	Capacity (hp)		
Summer	Heavy Equipment [b]	Diesel	135 [c]	6	10
	Commuting Vehicle	Gasoline	225	6 [d]	1 [e]
Winter	Heavy Equipment [b]	Diesel	135 [c]	5	10
	Commuting Vehicle	Gasoline	225	6 [d]	1.5 [e]

[a] BLM, 2003. Road maintenance would be made twice in summer and once in winter every year.
[b] BLM, 2003. Assume a motor grader.
[c] BLM, 2003. Assume 135 hp.
[d] BLM, 2003. Average round trip mileage on unpaved road.
[e] BLM, 2003. Assume one round trip per day.

Estimation of Total and Cumulative Length of Roads

Total Length of Roads Built (mi/pad) [a,b]	0.9
Cumulative Length of Roads Maintained [c] (mi)	4,649

[a] Reflects combination of drilling and producing roads
[b] = drilling roads 0.5 mile per well and access roads are 0.4 mile per well for a total of 0.9 mile per well pad
[c] = 0.9 miles of road built per pad*5165 well pads = 4,649 miles of roads to maintain

Estimation of Total Operation Days and Hours

Season	# of Operation per Year	Cumulative Length of Roads (mi-yr)	Road Length Worked On (mi/day)	# of Operating Hours per Day	Total # of Operating Days	Total # of Operating Hours
Summer	2	4,649	6	10	1,550	15,495
Winter	1	4,649	5	10	930	9,297
				Total	**2,479**	**24,792**

Table F1.3.48: High Core Road Maintenance Fugitive Dust Emission Factors for Grader

Emission Factors for Grader

Pollutant	Emission Factor Equation (lb/VMT)	S [a] (mph)	Emission Factor (lb/VMT)
PM_{10}	$E = (0.6)(0.051)\ S^{2}$	5	0.765
$PM_{2.5}$	$E = (0.031)(0.04)\ S^{2.5}$	5	0.069

[a] Assumed a mean vehicle speed (S) of 5 mph. (BLM, 2003)
Source: EPA, *AP-42* , Volume I, Section 11.9 Western Surface Coal Mining (10/9

Table F1.3.39: High Core Action Road Maintenance Fugitive Dust Emission Estimates for Grader

Fugitive Dust Emissions Estimation for Grader

Activity	Equipment	Total # of Operating Hours [a]	Mean Vehicle Speed (mph)	Total Miles Maintained	PM_{10}		$PM_{2.5}$	
					Em. Factor (lb/VMT)	Emissions (ton/proj.)	Em. Factor (lb/VMT)	Emissions (ton/proj.)
Road Maintenance	Grader	14,875	5	74,376	0.765	28	0.069	2.6

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM,

Table F1.3.40: High Core Action Road Maintenance Exhaust Emission Factors for Grader

Emission Factors for Grader

Equipment		Emission Factors (g/hp-hr)			
	NO_x	PM_{10} [a]	SO_2	CO	VOC
Grader	7.14	0.63	0.87	1.54	0.36

[a] Emission factor for $PM_{2.5}$ was assumed to be the same as that for PM_{10}. (BLM, 2003)

Source: EPA, *AP-42* , Volume II, Section II-7 Heavy-Duty Construction Equipment (1985).

Table F1.3.41: High Core Action Road Maintenance Exhaust Emission Estimates for Grader

Exhaust Emissions Estimation for Grader

Activity	Vehicle Type	Capacity (hp)	Total # of Operating Hours [a]	Emissions									
				(lb/hr)					(ton/project)				
				NO_x	PM_{10} [b]	SO_x	CO	VOC	NO_x	PM_{10} [b]	SO_x	CO	VOC
Road Maintenance	Grader	135	14,875	2.13	0.19	0.26	0.46	0.11	16	1.4	1.9	3.4	0.8

[a] Assumed that a grader would operate for 60% of the time, considering hours for preparation and closing of the shift, lunch break, and other extra activities. (BLM, 2003)
[b] Emissions of $PM_{2.5}$ were assumed to be the same as those for PM_{10}.

Table F1.3.42: High Core Action Fugitive Dust Emission Factors for Commuting Maintenance Vehicles

Emission Factors for Commuting Maintenance Vehicles Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	2.6	0.38
a	0.8	0.8
d	0.4	0.4
c	0.3	0.3

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	BLM, 2003. Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	BLM, 2003. EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces (1988)

Table F.1.3.43: High Core Fugitive Dust Emission Estimates for Commuting Maintenance Vehicles

Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	PM_{10}		$PM_{2.5}$	
						Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)
Road Maintenance	Pickup Truck	7,000	6	2,479	14,875	1.07	7.9	0.16	1.2

[a] No dust control measures would be applied (BLM, 2003).

Table F1.3.44: High Core Action Exhaust Emission Estimates for Commuting Maintenance Vehicles

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).
[b] BLM, 2003. Including tire and brake wear emissions.
Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table F1.3.45: High Core Action Exhaust Emission Estimates for Commuting Maintenance Vehicles

Exhaust Emissions Estimation for Commuting Maintenance Vehicles Road Traffic

Activity	Vehicle		Round Trip Distance (mi/day)	Total # of Operating Days	Total Miles Traveled	Emissions (ton/project)					
	Type	Class				NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Road Maintenance	Pickup Truck	LDGT2	6	2,479	14,875	0.02	0.002	0.001	0.002	0.19	0.01

$$\text{Emissions} = \frac{\text{emission factor g/mile*total distance in miles}}{(453.6\ \text{g/lb})(2000\text{lb/ton})}$$

Table F1.3.46: HighCore Action Fugitive Emission Factors for Long-Term Production Operations. Compressor Maintenance Vehicles Road Traffic.

Emission Factors for Compressor Maintenance Vehicles Road Traffic

$$E\ [lb/VMT] = \frac{k(s/12)^a(W/3)^d}{(M/0.2)^c}$$

Constant	PM_{10}	$PM_{2.5}$
k	1.8	0.27
a	1	1
d	0.5	0.5
c	0.2	0.2

Source: EPA (1995), AP-42, Section 13.2.2 Unpaved Roads (9/98).

Variable Description	Assumed Value	Reference
E = size-specific emission factor (lb/VMT)		
s = surface material silt content (%)	5.1	BLM, 2003. (EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98))
W = mean vehicle weight (tons)	3.5	Assume a light-duty truck of 7,000 lb (BLM,2003)
M = surface material moisture content (%)	0.2	Default value in EPA, *AP-42* , Volume I, Section 13.2.2 Unpaved Roads (9/98)
Control efficiency for watering (%) =	50	EPA, *Control of Open Fugitive Dust Sources* , Section 5.3.1 Watering of Unpaved Surfaces

Table F1.3.47: High Core Action Fugitive Dust Emission Estimates for Long-Term Production Operations. Compressor Maintenance Vehicle Road Traffic.

Fugitive Dust Emissions Estimation for Compressor Maintenance Vehicles Road Traffic

Activity	Vehicle Type	Av. Vehicle Weight (lb)	Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	PM_{10}		PM2.5	
									Em. Factor (lb/VMT) [a]	Emissions (ton/proj.)	Em. Factor (lb/VMT) [d]	Emissions (ton/proj.)
Maintenance Visits to Central Compressor Stations	Pickup Truck	7,000	Central Compressor Station	3	3	9	10	90	0.63	0.0	0.09	0.0
								Total		**0.0**		**0.0**

[a] No dust control measures would be applied (BLM, 2003, table APP_A21.xls).

Table F1.3.48: High Core Action Exhaust Emission Factors for Long term Production Operations. Compressor Maintenance Vehicle Road Traffic.

Exhaust Emission Factors for Commuting Maintenance Vehicles Road Traffic

Vehicle Class	Emission Factors (g/mi)					
	NO_x	PM_{10} [a,b]	$PM_{2.5}$ [a,b]	SO_x [a]	CO	VOC
Light-Duty Gasoline Truck	1.01	0.10	0.08	0.11	11.64	0.75

[a] BLM, 2003. Estimated using the EPA PART5 model (1995).

[b] BLM, 2003. Including tire and brake wear emissions.

Source: EPA (1985), AP-42, Volume II, Appendix H-116, Table 7.1.2 Light Duty Gasoline Powered Trucks II

Table F1.3.49: HIgh Core Action Exhaust Emissions for Long-Term Production operations. Compressor Maintenance Vehicle Road Traffic.

Emissions Estimation for Road Traffic

Activity	Vehicle		Compressor Station	# of Stations	# of Visits per Year	Total # of Round Trips	Round Trip Distance (mi)	Total Miles Traveled	Emissions (ton/project)					
	Type	Class							NO_x	PM_{10}	$PM_{2.5}$	SO_x	CO	VOC
Maintenance Visits to Compressor Stations	Pickup Truck	LDGT2	Central Compressor Station	3	2	6	10	60	0.000	0.0000	0.0000	0.0000	0.001	0.000
							Total		**0.000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.000**

Emissions per Station = $\frac{\text{emission factor g/mile*total distance in miles}}{\text{(453.6 g/lb)(2000lb/ton)}}$

Table F1.3.50: High Core Action Natural Gas Condensate VOC and Loadout VOC Emissions

Tanks 4.0 Natural Gas Well Condensate VOC Emissions

City: Price, Utah
Type of Tank: Vertical Fixed Roof
Size: 400 bbl
Shell height: 20 ft Diameter: 12 ft
Ave. Liquid height: 10 ft Turnovers: 12
Color: White
Assume 9 bbl per MMCF gas production

Natural Gas Well Condensate VOC Emissions

	VOC Losses				
Components	**Working Loss (lbs)[a]**	**Breathing Loss (lbs)[a]**	**Total Emissions per tank (lbs)**	**Total Number of Tanks**	**Total Tank Emissions (tpy)**
Gasoline (RVP8)	**1082.95**	**985**	**2068**	**88**	**91.07**

Meteorological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.27 psia)
[a] Calculated from Tanks 4.0

Natural Gas Well Condensate Truck Loadout VOC Emissions

Emissions were estimated based on Equation (1) of AP-42, Section 5.2

$$L_L = 12.46 \frac{SPM}{T}$$

L_L = Loading Loss pounds per 1000 gallons (lb/10^3 gal) of liquid loaded
S = a saturation factor
P = true vapor pressure of liquid loaded, pounds per square inch absolute (psia)
M = molecular weight of vapors, pounds per pounds-mole (lb/lb-mole)
T = temperature of bulk liquid loaded (F+460)

S = 1.45 (From Table 5.2-1, splash loading into tanker truck)
P = 8.0 psia
M = 68 lbs/lb-mole
T = 512.62, liquid bulk temp is 52.95 (from Tanks 4.0)

L_L = 12.46 (1.45*8*68)/512.62 = **19.17297023**

L_L = 19.17 lbs/1,000 gal

Natural Gas Well Condensate Truck Loadout VOC Emissions

Pollutant	**Emission Factor (lbs/1,000 gallons)**	**Annual Condensate Volume bbl [a]**	**Condensate (1,000 gallons)**	**Total Emissions tpy**
VOCs	**19.17**	**11,311,350**	**475,077**	**4554**

a Assume 50,000CFY conventional gas production, 9 bbl condensate per MMCF gas production

Table F1.3.51: High Core Action Summary

Moxa Arch High Core Alternative Annual Emissions Summary 2031

Activity	PM_{10} Tons	$PM_{2.5}$ Tons	NOx Tons	SO2 Tons	CO Tons	VOC Tons	HAPs[b] Tons
Well Pad Construction	517	78	---	---	---	---	---
Heavy Equipment Vehicle Traffic & Well Flaring [a]	870	870	28887	706	8685	24190	2419
Commuting Vehicles - Construction	2078	317	29	6	84	16	2
Wind Erosion	6410	2564	---	---	---	---	---
Sub-total: Construction [c]	**395**	**153**	**1,157**	**28**	**351**	**968**	**97**
Natural Gas Compression - Operations [a]	608.33	608.33	3379.63	6.76	6759.26	3379.63	574.54
Well Head Compression - Operations*	19.77	19.77	374.17	0.60	374.17	299.34	47.89
Dehydrator & Separator Heater - Operations [a]	42.14	42.14	554.48	3.33	465.76	30.50	3.05
Condensate & Produced Water Tank Heaters - Operations [a]	42.14	42.14	554.48	3.33	465.76	30.50	3.05
Dehydrator VOC, Condensate Tank Flashing & Flaring - Operations [a]	---	---	---	---	---	11494.59	1149.46
Station Visits - Operations	1.15	0.17	0.00	0.00	0.05	0.00	0.00
Well Workover - Operations	255.94	29.25	782.72	13.52	183.66	24.01	2.40
Well & Pipeline visits for Inspection & Repair - Operations	3.06	0.46	0.01	0.00	0.12	0.01	0.00
Tank Condensate & Truck Loadout	---	---	---	---	---	0.00	0.00
Sub-total: Operations	**972.53**	**742.26**	**5645.49**	**27.54**	**8248.79**	**15258.57**	**1780.39**
Road Maintenance	37.76	5.12	15.82	1.94	3.60	0.81	0.08
Compressor Maintenance	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Sub-total: Maintenance	**37.79**	**5.13**	**15.82**	**1.94**	**3.60**	**0.81**	**0.08**
Grand Total: Natural Gas Long-term Development	**1405.31**	**900.49**	**6817.98**	**57.95**	**8603.15**	**16227.60**	**1877.29**

[a] $PM_{2.5}$ assumed = PM_{10} for this source.

3754 3,064

[b] HAPs = Hazardous Air Pollutants; assumed = VOCs * 0.1, and formaldehyde HAP added for gas compression

[c] Construction emissions divided by 20 (for 20 years) to represent annual emission totals