APPENDIX B:

PROJECT EMISSIONS INVENTORIES

APPENDIX B

The following is a list of the tables included within this appendix.

B.1.0 CONSTRUCTION EMISSION TABLES

Emissions listed in the construction emission tables are for all construction scenarios unless otherwise specified.

B.1.1 Well Pad Construction – 1 Well per Pad
B.1.2 Resource Road Construction
B.1.3 Well Pad/Resource Road Traffic
B.1.4 Well Pad/Resource Road Heavy Equipment Tailpipe
B.1.5 Rig Move and Drilling Traffic – Straight Drilling
B.1.6 Rig Move and Drilling Haul Truck Tailpipe –Straight Drilling
B.1.7 Drilling Emissions AP-42 – Straight Drilling
B.1.8 Drilling Emissions – Tier 1 – Straight Drilling
B.1.9 Drilling Emissions – Tier 2 – Straight Drilling
B.1.10 Completion/Testing Traffic
B.1.11 Completion/Testing Heavy Equipment Tailpipe
B.1.12 Completion Flaring
B.1.13 Pipeline Construction
B.1.14 Pipeline Construction Traffic
B.1.15 Pipeline Heavy Equipment Tailpipe
B.1.16 Construction Wind Erosion – 1 Well per Pad

The following tables show construction emissions for the multiple well pad scenarios. Emissions are only shown if the multiple well pad scenario varies from the single well pad scenarios.

B.1.17 Well Pad/Resource Road Construction – 2 Wells per Pad
B.1.18 Well Pad/Resource Road Construction – 5 Wells per Pad

B.1.19 Well Pad/Resource Road Construction – 10 Wells per Pad

B.1.20 Rig Move and Drilling Traffic – Directional Drilling

B.1.21 Rig Move and Drilling Haul Truck Tailpipe – Directional Drilling

B.1.22 Drilling Emission AP-42 – Directional Drilling

B.1.23 Drilling Emissions –Tier 1 – Directional Drilling

B.1.24 Drilling Emissions – Tier 2 – Directional Drilling

B.1.25 Wind Erosion – 2 Wells per Pad

B.1.26 Wind Erosion – 5 Wells per Pad

B.1.27 Wind Erosion – 10 Wells per Pad

B.2.0 PRODUCTION EMISSION TABLES

Emissions listed in the production emission tables are for all production scenarios unless otherwise specified.

B.2.1 Production Traffic – 1 Well per Pad

B.2.2 Production Heavy Equipment Tailpipe – 1 Well per Pad

B.2.3 Indirect Heater

B.2.4 Separator Heater

B.2.5 Dehydrator Reboiler Heater

B.2.6 Dehydrator Flashing

B.2.7 Fugitive HAPs and VOC

B.2.8 Condensate Storage Tank

B.2.9 Jonah Water Disposal Well

B.2.10 Bird Canyon Compressor Station

B.2.11 Falcon Compressor Station

B.2.12 Gobblers Knob Compressor Station

B.2.13 Jonah Compressor Station

B.2.14 Luman Compressor Station

B.2.15 Paradise Compressor Station

B.2.16 Wind Erosion – 1 Well per Pad

The following tables show production emissions for the multiple well pad scenarios. Emissions are only shown if the multiple well pad scenario varies from the single well pad scenarios.

B.2.17 Production Traffic – 2 Wells per Pad

B.2.18 Production Traffic – 5 Wells per Pad

B.2.19 Production Traffic – 10 Wells per Pad

B.2.20 Wind Erosion – 2 Wells per Pad

B.2.21 Wind Erosion – 5 Wells per Pad

B.2.22 Wind Erosion – 10 Wells per Pad

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Table B.1.1
Well Pad Construction - 1 Well per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: **Jonah Infill Drilling Project**
Scenario: **1 well per pad**
Activity: **Well Pad Construction**
Emissions: **Fugitive Particulate Emissions from Well Pad Construction**
Date: **3/24/2004**

Well Pad Area	Construction Activity TSP Emission Factor[1]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[2]	$PM_{2.5}$ Emissions (controlled)[3]
(acre)	(tons/acre-month)	(days/well pad)	(hours/day)	(%)	(lb/well)	(lb/well)
3.8	1.2	4	10	50	218.88	57.76
			Well Pad Construction Emissions (lb/day/well)		54.72	14.44
			Well Pad Construction Emissions (lb/hr/well)		5.47	1.44

[1] AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations"; TSP = total suspended particulates.

[2] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the PM_{10} size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

Table B.1.2
Resource Road Construction

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Resource Road Construction
Emissions: Fugitive Particulate Emissions from Resource Road Construction
Date: 3/24/2004

Resource Road Area[1]	Construction Activity TSP Emission Factor[2]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[3]	$PM_{2.5}$ Emissions (controlled)[4]
(acres)	(tons/acre-month)	(days/pad)	(hours/day)	(%)	(lb/pad)	(lb/pad)
1.3455	1.2	4	10	50	77.50	20.45
	Resource Road Construction Emissions (lb/day/pad resource road segment)				19.38	5.11
	Resource Road Construction Emissions (lb/hr/pad resource road segment)				1.94	0.51

[1] Construction Area = 0.15-mi x 74-ft ROW = 1.3455 acres; TSP = total suspended particulates.

[2] AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the PM_{10} size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

[4] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

Table B.1.3
Well Pad/Resource Road Traffic

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Well Pad/Resource Road
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[1] (%)	Moisture Content[2] (%)	Round Trips (RTs) (RT/pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[3] (VMT/pad)	Emission Control Efficiency (%)	PM_{10} Emission Factor[4] (lb/VMT)	$PM_{2.5}$ Emission Factor[4] (lb/VMT)	PM_{10} Emissions[5] (controlled) (lb/pad)	$PM_{2.5}$ Emissions[5] (controlled) (lb/pad)
Gravel/haul trucks	Primary Access	magnesium chloride	35,000	20	5.1	2.4	8	14	112	85	1.54	0.24	25.80	3.96
	Resource	water	35,000	15	5.1	2.4	8	5	40	50	1.54	0.24	30.71	4.71
Light trucks/pickups	Primary Access	magnesium chloride	7,000	30	5.1	2.4	12	14	168	85	0.56	0.08	14.08	2.10
	Resource	water	7,000	20	5.1	2.4	12	5	60	50	0.46	0.07	13.68	2.04
											Total Unpaved Road Traffic Emissions (lb/pad)		84.27	12.81
											Total Unpaved Road Traffic Emissions (lb/hr/pad)[6]		2.11	0.32

[1] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[2] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[3] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[4] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[5] Calculated as lb/VMT x VMT/pad x control efficiency.

[6] Calculated as lb/well; 4 days/well; 10 hours/day; and represents emissions for 9.5-mile segment of road.

Table B.1.4
Well Pad/Resource Road Heavy Equipment Tailpipe

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Well Pad/Resource
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: 3/24/2004

Heavy Equipment	Engine Horsepower	Number Required	Operating Load Factor[1]	Pollutant Emission Factor[2] (g/hp-hr)					Construction Activity Duration (days/	Construction Activity Duration (hours/day)	Pollutant Emissions (lb/well)					Pollutant Emissions[4] (lb/hr/well)				
	(hp)			CO	NO_x	SO_2	VOC	PM_{10}	equipment type)		CO	NO_x	SO_2	VOC	PM_{10}[5]	CO	NO_x	SO_2	VOC	PM_{10}[5]
Scraper	700	2	0.4	2.45	7.46	0.901	0.55	0.789	4	10	120.99	368.40	44.49	27.16	38.96	3.02	9.21	1.11	0.68	0.97
Motor Grader	250	1	0.4	1.54	7.14	0.874	0.36	0.625	4	10	13.58	62.96	7.71	3.17	5.51	0.34	1.57	0.19	0.08	0.14
D8 Dozer[3]	210	1	0.4	2.15	7.81	0.851	0.75	0.692	2	10	7.96	28.93	3.15	2.78	2.56	0.40	1.45	0.16	0.14	0.13
										Total Heavy Equipment Tailpipe Emissions	142.53	460.28	55.35	33.11	47.04	3.76	12.23	1.46	0.90	1.24

[1] Taken from "Surface Mining" (Pfleider 1972) for average service duty.

[2] AP-42 (EPA 1985), Volume II Mobile Sources.

[3] Emission factor for track-type tractor.

[4] Calculated as lb/well; days/equipment type; 10 hours/day.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.

Table B.1.5
Rig Move and Drilling Traffic - Straight Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Straight Drilling
Activity: Rig Move and Drilling
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per Well	RT Distance (miles)	VMT[4] (VMT/pad)	Emission Control Efficiency (%)	PM_{10} Emission Factor[5] (lb/VMT)	$PM_{2.5}$ Emission Factor[5] (lb/VMT)	PM_{10} Emissions[6] (controlled) (lb/well)	$PM_{2.5}$ Emissions[6] (controlled) (lb/well)
Semis-tractor/ trailer/mud/water/ fuel/cement trucks[1]	Primary Access	magnesium chloride	44,000	20	5.1	2.4	140	14	1,960	85	1.70	0.26	500.47	76.74
	Resource	water	44,000	15	5.1	2.4	140	5	700	50	1.70	0.26	595.79	91.35
Logging/mud trucks	Primary Access	magnesium chloride	48,000	20	5.1	2.4	10	14	140	85	1.77	0.27	37.18	5.70
	Resource	water	48,000	15	5.1	2.4	10	5	50	50	1.77	0.27	44.26	6.79
Roustabouts/welders/ hot-shot/contract labor	Primary Access	magnesium chloride	20,000	30	5.1	2.4	20	14	280	85	1.19	0.18	50.14	7.69
	Resource	water	20,000	20	5.1	2.4	20	5	100	50	1.19	0.18	59.69	9.15
Vendors/marketers/ various	Primary Access	magnesium chloride	7,000	30	5.1	2.4	30	14	420	85	0.56	0.083	35.19	5.26
	Resource	water	7,000	20	5.1	2.4	30	5	150	50	0.46	0.068	34.20	5.11
												Total Unpaved Road Traffic Emissions (lb/well)	1,356.90	207.79
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	2.57	0.39

[1] Semi vehicle weight range is 28,000-60,000 lbs; average weight of 44,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as (lb/well); 22 days/well; 24 hours/day, and represents emissions for 9.5-mile segment of road. Total duration is 22 days for a vertical well, including rig move duration of 3 days per well.

Table B.1.6
Rig Move and Drilling Haul Truck Tailpipe - Straight Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Straight Drilling
Activity: Rig Move and Drilling
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (g/mile)	Total Haul Truck RTs (RTs/well)	RT Distance (miles/RT)	Total Haul Truck Miles Traveled (miles/well)	Haul Activity Duration (days/well)	Haul Activity Duration (hours/day)	Emissions (lb/well)	Emissions[3] (lb/hr/well)
CO	14.74	170	19	3230	22	24	104.96	0.20
NO_x	11.44	170	19	3230	22	24	81.46	0.15
SO_2[2]	0.32	170	19	3230	22	24	2.26	0.0043
VOC	5.69	170	19	3230	22	24	40.52	0.08

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well; 22 days/well; 24 hours/day.

Table B.1.7
Drilling Emissions AP-42 - Straight Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Straight Drilling
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA AP-42
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total Horsepower (hp) All Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hours/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.00668	2,100	0.42	19	24	2,702.63	5.93
NOx	0.031	2,100	0.42	19	24	12,542.17	27.50
SO_2[4]	0.00205	2,100	0.42	19	24	829.40	1.82
VOC	0.0025	2,100	0.42	19	24	1,011.47	2.22
PM_{10}[5]	0.0022	2,100	0.42	19	24	890.09	1.95

Stack Parameters

Height	5 m
Temperature	700 Kelvin
Diameter	0.2 m
Velocity	25 m/s

5 x 5 x 5 m structure used to determine downwash parameters for the drilling rigs.

[1] AP-42 (EPA 2004), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines"; lb/hp-hr = pounds per horsepower-hour.

[2] Drilling engine horsepower based on three engines, two at 800 hp and one at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheet for G3412, gas petroeleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.8
Drilling Emissions - Tier 1 - Straight Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Straight Drilling
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA Tier 1
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total hpAll Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hours/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.008219978	2,100	0.42	19	24	3,325.69	7.29
NOx	0.01512476	2,100	0.42	19	24	6,119.27	13.42
SO_2[4]	0.00034547	2,100	0.42	19	24	139.77	0.31
VOC	0.002137194	2,100	0.42	19	24	864.68	1.90
PM_{10}[5]	0.000887758	2,100	0.42	19	24	359.17	0.79

Stack Parameters

Height	5 m
Temperature	700 Kelvin
Diameter	0.2 m
Velocity	25 m/s

5 x 5 x 5 m structure used to determine downwash parameters for the drilling rigs.

[1] Emission factor for Tier 1 engine taken from Diesel Net, Revision 2003.10, Table 1, "EU Emission Regulations for Nonroad Diesel Engines." Available on-line at http://www.dieselnet.com/standards/eu/offroad.html.

[2] Drilling engine horsepower based on three engines, two at 800 hp and one at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheets for G4312, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.9
Drilling Emissions - Tier 2 - Straight Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Straight Drilling
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA Tier 2
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total Horsepower All Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hours/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.0058	2,100	0.42	19	24	2,327.98	5.11
NOx	0.0066	2,100	0.42	19	24	2,660.55	5.83
SO_2[4]	0.00035	2,100	0.42	19	24	139.77	0.31
VOC	0.0021	2,100	0.42	19	24	864.68	1.90
PM_{10}[5]	0.00033	2,100	0.42	19	24	133.03	0.29

Stack Parameters

Height	5 m
Temperature	700 Kelvin
Diameter	0.2 m
Velocity	25 m/s

5 x 5 x 5 m structure used to determine downwash parameters for the drilling rigs.

[1] Emission factor for Tier 2 engine taken from Diesel Net, Revision 2003.10, Table 1, "EU Emission Regulations for Nonroad Diesel Engines." Avaliable on-line at http://www.dieselnet.com/standards/eu/offroad.html.

[2] Drilling engine horsepower based on three engines, two at 800 hp and one at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheets for G4312, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.10
Completion/Testing Traffic

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Completion/Testing Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per Well	RT Distance (miles)	VMT[4] (VMT/well)	Emission Control Efficiency (%)	PM_{10} Emissions[5] (lb/VMT)	$PM_{2.5}$ Emissions[5] (lb/VMT)	PM_{10} Emissions[6] (controlled) (lb/well)	$PM_{2.5}$ Emissions[6] (controlled) (lb/well)
Semis/transport/ water/sand/frac trucks[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	350	14	4,900	85	1.87	0.29	1,371.95	210.37
	Resource	water	54,000	15	5.1	2.4	350	5	1,750	50	1.87	0.29	1,633.27	250.44
Large Haul Trucks	Primary Access	magnesium chloride	48,000	20	5.1	2.4	50	14	700	85	1.77	0.27	185.88	28.50
	Resource	water	48,000	15	5.1	2.4	50	5	250	50	1.77	0.27	221.28	33.93
Small Haul Trucks	Primary Access	magnesium chloride	20,000	30	5.1	2.4	30	14	420	85	1.19	0.18	75.21	11.53
	Resource	water	20,000	20	5.1	2.4	30	5	150	50	1.19	0.18	89.54	13.73
Light trucks/ pick-ups	Primary Access	magnesium chloride	7,000	30	5.1	2.4	140	14	1,960	85	0.56	0.08	164.21	24.55
	Resource	water	7,000	20	5.1	2.4	140	5	700	50	0.46	0.07	159.58	23.84
												Total Unpaved Road Traffic Emissions (lb/well)	3,900.91	596.87
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	6.56	1.00

[1] Semi vehicle weight range is 28,000-80,000 lbs; average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as lb/well; 35 days/well; 17 hours/day; and represents emissions for 9.5-mile segment of road.

Table B.1.11
Completion/Testing Heavy Equipment Tailpipe

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Completion/Testing
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (g/mile)	Total Haul Truck RTs (RTs/well)	RT Distance (miles/RT)	Total Haul Truck Miles Traveled (miles/well)	Haul Activity Duration (days/well)	Haul Activity Duration (hours/day)	Emissions (lb/well)	Emissions[3] (lb/hr/well)
CO	14.74	430	19	8170	35	17	265.49	0.45
NO_x	11.44	430	19	8170	35	17	206.05	0.35
SO_2[2]	0.32	430	19	8170	35	17	5.72	0.0096
VOC	5.69	430	19	8170	35	17	102.49	0.17

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well; 35 days/well; 17 hours/day.

Table B.1.12
Completion Flaring

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Completion/Testing Flaring
Emissions: Gas Flaring without High Pressure Flowback Separator Units
Date: 3/24/2004

Flaring Specifications:

Total Volume of Gas Emitted	35,000	mcf
Total Volume of Condensate Emitted	250	bbls
Average Heat Content	1,093	BTU/scf
Flaring/Flowback Activity Duration	120	hrs/well
Flaring Duration	80	hrs/well
Pre-ignition Flow-back Duration	40	hrs/well
Pre-ignition Flow-back Time Involving a Gas Stream	10	%
Actual Hours Gas is Vented	4	hrs
Total Hours in which Gas is Vented or Flared[1]	84	hrs
Average Flowrate of Gas[2]	416.67	mcf/hr
Total Volume of Gas Vented[3]	1,666.67	mcf
Total Volume of Flared Gas[4]	33,333.33	mcf
Average Flowrate of Condensate	2.98	bbls/hr
Pre-flare Volume of Condensate	11.90	bbls
Volume of Condensate Flared	238.10	bbls

Stack Parameters

Height	5 m
Temperature	1,273 Kelvin
Diameter	1.0 m
Velocity	20 m/s

Activity	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source[6]	Total Emissions (tons)	Duration (hours)	Hourly Emissions (lb/hr)
Venting - Natural Gas [5]	1,666.67	mcf	VOC	4.70	lb / 1000 scf	Gas Constituent Analysis	3.91	4	1,956.87
			HAP (total)	0.17	lb / 1000 scf	Gas Constituent Analysis	0.14	4	71.37
			n-Hexane	0.08	lb / 1000 scf	Gas Constituent Analysis	0.070	4	35.13
			Benzene	0.026	lb / 1000 scf	Gas Constituent Analysis	0.022	4	10.75
			Toluene	0.041	lb / 1000 scf	Gas Constituent Analysis	0.034	4	17.02
			Ethylbenzene	0.0019	lb / 1000 scf	Gas Constituent Analysis	0.0016	4	0.80
			Xylenes	0.018	lb / 1000 scf	Gas Constituent Analysis	0.015	4	7.67
Flaring - Natural Gas	33,333.33	mcf	NOx	0.068	lb / 10^6 BTU	AP-42 Section 13.5	1.24	80	30.97
			CO	0.37	lb / 10^6 BTU	AP-42 Section 13.5	6.74	80	168.49
			VOC	2.35	lb / 1000 scf	Gas Constituent Analysis	39.14	80	978.43
			HAP (total)	0.09	lb / 1000 scf	Gas Constituent Analysis	1.43	80	35.69
			n-Hexane	0.042	lb / 1000 scf	Gas Constituent Analysis	0.70	80	17.57
			Benzene	0.013	lb / 1000 scf	Gas Constituent Analysis	0.22	80	5.38
			Toluene	0.020	lb / 1000 scf	Gas Constituent Analysis	0.34	80	8.51
			Ethylbenzene	0.001	lb / 1000 scf	Gas Constituent Analysis	0.016	80	0.40
			Xylenes	0.009	lb / 1000 scf	Gas Constituent Analysis	0.15	80	3.83

Table B.1.12 (Continued)

Activity	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source[6]	Total Emissions (tons)	Duration (hours)	Hourly Emissions (lb/hr)
Flaring - Condensate	238.10	bbls	VOC	121.98	lb/bbl	Condensate Constituent Analysis	14.52	80	363.03
			HAP (total)	25.85	lb/bbl	Condensate Constituent Analysis	3.08	80	76.93
			n-hexane	4.59	lb/bbl	Condensate Constituent Analysis	0.55	80	13.67
			Benzene	1.42	lb/bbl	Condensate Constituent Analysis	0.17	80	4.22
			Toluene	6.11	lb/bbl	Condensate Constituent Analysis	0.73	80	18.19
			Ethylbenzene	0.74	lb/bbl	Condensate Constituent Analysis	0.09	80	2.19
			Xylenes	12.99	lb/bbl	Condensate Constituent Analysis	1.55	80	38.66

[1] Calculated as 10% * 40 hrs of pre-ignition flowback + 80 hrs of flaring.

[2] Calculated as 3,500 mcf/84 hrs.

[3] Calculated as 416.67 mcf/hr * 4 hrs.

[4] Calculated as 416.67 mcf/hr * 80 hrs.

[5] An estimated 11.9 bbl of condensate are captured prior to flare ignition. Flashing from this condensate is not analyzed.

[6] For all emission factors that used the constituent analysis, a 50% destruction rate was assumed.

Table B.1.13
Pipeline Construction

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Pipeline Construction
Emissions: Fugitive Particulate Emissions from Pipeline Construction
Date: 3/24/2004

Pipeline Construction Area[1] (acres)	Construction Activity TSP Emission Factor[2] (tons/acre-month)	Construction Activity Duration (days/pad)	Construction Activity Duration (hours/day)	PM_{10} Emissions[3] (lb/pad)	$PM_{2.5}$ Emissions[4] (lb/pad)
0.45	1.2	4	8	52.36	13.82
			Pipeline Construction Emissions (lb/day/pad)	13.09	3.45
			Pipeline Construction Emissions (lb/hr/pad)	1.64	0.43

[1] Pipeline construction area = 0.15-mi x 25-ft ROW = 0.45 acres.

[2] AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

[4] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range,

Table B.1.14
Pipeline Construction Traffic

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Pipeline Construction
Emissions: Fugitive Particulate Emissions from Unpaved Road Traffic
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per pad	RT Distance (miles)	VMT[4] (VMT/pad)	Emission Control Efficiency (%)	PM_{10} Emission Factor[5] (lb/VMT)	$PM_{2.5}$ Emission Factor[5] (lb/VMT)	PM_{10} Emissions[6] (controlled) (lb/pad)	$PM_{2.5}$ Emissions[6] (controlled) (lb/pad)
Semis/transport, boom, equipment, water removal, sand, and gravel trucks[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	8	14	112	85	1.87	0.29	31.36	4.81
	Resource	water	54,000	15	5.1	2.4	8	5	40	50	1.87	0.29	37.33	5.72
Light truck/pick-ups	Primary Access	magnesium chloride	7,000	30	5.1	2.4	12	14	168	85	0.23	0.03	5.80	0.86
	Resource	water	7,000	20	5.1	2.4	12	5	60	50	0.23	0.03	6.90	1.03
											Total Unpaved Road Traffic Emissions (lb/pad)		81.39	12.42
											Total Unpaved Road Traffic Emissions (lb/hr/pad)[7]		2.54	0.39

[1] Semi vehicle weight range is 28,000-80,000 lbs, average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as Emissions (lb/pad); 4 (days/pad); 8 (hours/day); and represents emissions over 9.5-mile segment of road.

Table B.1.15
Pipeline Heavy Equipment Tailpipe

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Pipeline Construction
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: 3/24/2004

Heavy Equipment	Engine Horsepower	Number Required	Operating Load Factor	Pollutant Emission Factor[1]					Construction Activity Duration	Construction Activity Duration	Pollutant Emissions					Pollutant Emissions[3]				
	(hp)			(g/hp-hr)					(days/equip type)	(hours/day)	(lb/well)					(lb/hr/well)				
				CO	NO_x	SO_2	VOC	PM_{10}			CO	NO_x	SO_2	VOC	PM_{10}[7]	CO	NO_x	SO_2	VOC	PM_{10}[6]
Grader	200	1	0.4	1.54	7.14	0.874	0.36	0.625	2	8	4.35	20.15	2.47	1.02	1.76	0.27	1.26	0.15	0.06	0.11
Excavator[2]	300	1	0.4	2.15	7.81	0.851	0.75	0.692	4	8	18.20	66.12	7.20	6.35	5.86	0.57	2.07	0.23	0.20	0.18
Trencher[3]	300	1	0.4	4.6	11.01	0.932	1.01	0.902	1	8	9.74	23.30	1.97	2.14	1.91	1.22	2.91	0.25	0.27	0.24
Tractor[4]	150	1	0.4	7.34	11.91	0.851	1.76	1.27	2	8	15.53	25.21	1.80	3.72	2.69	0.97	1.58	0.11	0.23	0.17
									Total Emissions from Heavy Equipment Tailpipes		47.82	134.77	13.44	13.23	12.22	3.03	7.81	0.74	0.76	0.70

[1] AP-42 (EPA 1985), Volume II Mobile Sources; g/hp-hr = grams per horsepower-hour.

[2] Emission factor for track-type tractor.

[3] Emission factor for miscellaneous.

[4] Emissions factor for wheeled tractor.

[5] Calculated as lb/well; days/equipment type; 8 hours/day.

[6] $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.

Table B.1.16
Construction Wind Erosion - 1 Well Per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 1 well per pad
Activity: Well Pad, Resource Road, Pipeline Construction
Emissions: Wind Erosion
Date: 3/24/2004

Emission Factor :	0.3733	lb/hr/100m^2		Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.
Control Efficiency:	50	%		
Disturbed Area:				
Well Pad Construction:	3.8	acres	15,378.60 m^2	
Access Road Construction:	1.3455	acres	5,445.24 m^2	(based on 74-ft ROW width, 0.15-mile length)
Pipeline Construction	0.45	acres	1,821.15 m^2	(based on 25-ft ROW width, 0.15-mile length)

Source Parameters
148 1-km area sources
sigma z = 2.33 m

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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	153.79	50	28.70	11.48	3.62	1.45
Resource Road Construction	0.3733	0.1493	54.45	50	10.16	4.07	1.28	0.51
Pipeline Construction	0.3733	0.1493	18.21	50	3.40	1.36	0.43	0.17

Table B.1.17
Well Pad/Resource Road Construction - 2 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 2 wells per pad
Activity: Well Pad Construction
Emissions: Fugitive Particulate Emissions from Well Pad Construction
Date: 3/24/2004

Well Pad Area	Construction Activity TSP Emission Factor[1]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[2]	$PM_{2.5}$ Emissions (controlled)[3]
(acre)	(tons/acre-month)	(days/well pad)	(hours/day)	(%)	(lb/well)	(lb/well)
7.0	1.2	4	10	50	403.20	106.40
			Well Pad Construction Emissions (lb/day/well)		100.80	26.60
			Well Pad Construction Emissions (lb/hr/well)		10.08	2.66

[1] AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

[2] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the PM_{10} size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

Table B.1.18
Well Pad/Resource Road Construction - 5 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 5 wells per pad
Activity: Well Pad Construction
Emissions: Fugitive Particulate Emissions from Well Pad Construction
Date: 3/24/2004

Well Pad Area	Construction Activity TSP Emission Factor[1]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[2]	$PM_{2.5}$ Emissions (controlled)[3]
(acre)	(tons/acre-month)	(days/well pad)	(hrs/day)	(%)	(lb/well)	(lb/well)
10.0	1.2	4	10	50	576.00	152.00
			Well Pad Construction Emissions (lb/day/well)		144.00	38.00
			Well Pad Construction Emissions (lb/hr/well)		14.40	3.80

1 AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

2 AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the PM_{10} size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

3 AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

Table B.1.19
Well Pad/Resource Road Construction - 10 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 10 wells per pad
Activity: Well Pad Construction
Emissions: Fugitive Particulate Emissions from Well Pad Construction
Date: 3/24/2004

Well Pad Area	Construction Activity TSP Emission Factor[1]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[2]	$PM_{2.5}$ Emissions (controlled)[3]
(acre)	(tons/acre-month)	(days/well pad)	(hrs/day)	(%)	(lb/well)	(lb/well)
10.0	1.2	4	10	50	576.00	152.00
			Well Pad Construction Emissions (lb/day/well)		144.00	38.00
			Well Pad Construction Emissions (lb/hr/well)		14.40	3.80

[1] AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

[2] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 36% of the TSP is in the PM_{10} size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that 9.5% of the TSP is in the $PM_{2.5}$ size range, monthly emissions converted to daily and hourly emissions based on 30-day month.

Table B.1.20
Rig Move and Drilling Traffic – Directional Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Directional Drilling
Activity: Rig Move and Drilling
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per Well	RT Distance (miles)	VMT[4] (VMT/pad)	Emission Control Efficiency (%)	PM_{10} Emission Factor[5] (lb/VMT)	$PM_{2.5}$ Emission Factor[5] (lb/VMT)	PM_{10} Emissions[6] (controlled) (lb/well)	$PM_{2.5}$ Emissions[6] (controlled) (lb/well)
Semis-tractor/ trailer/mud/water/fuel/	Primary Access	magnesium chloride	44,000	20	5.1	2.4	168	14	2,352	85	1.70	0.26	600.56	92.09
cement trucks[1]	Resource	water	44,000	15	5.1	2.4	168	5	840	50	1.70	0.26	714.95	109.63
Logging/mud trucks	Primary Access	magnesium chloride	48,000	20	5.1	2.4	12	14	168	85	1.77	0.27	44.61	6.84
	Resource	water	48,000	15	5.1	2.4	12	5	60	50	1.77	0.27	53.11	8.14
Roustabouts/welders/ hot-shot/contract labor	Primary Access	magnesium chloride	20,000	30	5.1	2.4	24	14	336	85	1.19	0.18	60.17	9.23
	Resource	water	20,000	20	5.1	2.4	24	5	120	50	1.19	0.18	71.63	10.98
Vendors/marketers/ various	Primary Access	magnesium chloride	7,000	30	5.1	2.4	36	14	504	85	0.56	0.083	42.23	6.31
	Resource	water	7,000	20	5.1	2.4	36	5	180	50	0.46	0.068	41.04	6.13
												Total Unpaved Road Traffic Emissions (lb/well)	1,628.28	249.34
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	2.61	0.40

[1] Semi vehicle weight range is 28,000-60,000 lbs; average weight of 44,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as (lb/well); 26 days/well; 24 hours/day; and represents emissions for 9.5-mile segment of road. Total duration is 26 days for a directional well, including rig move duration of 3 days per well.

Table B.1.21
Rig Move and Drilling Haul Truck Tailpipe - Directional Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: **Jonah Infill Drilling Project**
Scenario: **Directional Drilling**
Activity: **Rig Move and Drilling**
Emissions: **Diesel Combustion Emissions from Heavy Equipment Tailpipes**
Date: **3/24/2004**

Pollutant	Pollutant Emission Factor[1] (g/mile)	Total Haul Truck RTs (RTs/well)	RT Distance (miles/RT)	Total Haul Truck Miles Traveled (miles/well)	Haul Activity Duration (days/well)	Haul Activity Duration (hrs/day)	Emissions (lb/well)	Emissions[3] (lb/hr/well)
CO	14.74	216	19	4,104	26	24	133.36	0.21
NO_x	11.44	216	19	4,104	26	24	103.50	0.17
SO_2[2]	0.32	216	19	4,104	26	24	2.87	0.0046
VOC	5.69	216	19	4,104	26	24	51.48	0.08

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well; 26 days/well; 24 hours/day.

Table B.1.22
Drilling Emission AP-42 - Directional Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Directional Drilling
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA AP-42
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total Horsepower All Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hours/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.00668	2,600	0.42	23	24	4,050.56	7.34
NO_x	0.03100	2,600	0.42	23	24	18,797.53	34.05
SO_2[4]	0.00205	2,600	0.42	23	24	1,243.06	2.25
VOC	0.00250	2,600	0.42	23	24	1,515.93	2.75
PM_{10}[5]	0.00220	2,600	0.42	23	24	1,334.02	2.42

Stack Parameters
Height 5 m
Temperat 675 Kelvin
Diameter 0.2 m
Velocity 30 m/s
5 x 5 x 5 m structure used to determine downwash parameters for drilling rigs

[1] Emission factor for Tier 1 engine taken from Diesel Net, Revision 2003.10, Table 1, "EU Emission Regulations for Nonroad Diesel Engines." Avaliable on-line at http://www.dieselnet.com/standards/eu/offroad.html.

[2] Drilling engine horsepower based on four engines, two at 800 hp and two at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheets for G4312, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.23
Drilling Emissions –Tier 1- Directional Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: **Jonah Infill Drilling Project**
Scenario: **Directional Drilling**
Activity: **Drilling**
Emissions: **Diesel Combustion Emissions from Drilling Engines - EPA Tier 1**
Date: **3/24/2004**

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total Horsepower All Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hours/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.00822	2,600	0.42	23	24	4,984.36	9.03
NO_x	0.01512	2,600	0.42	23	24	9,171.23	16.61
SO_2[4]	0.00035	2,600	0.42	23	24	209.48	0.38
VOC	0.00214	2,600	0.42	23	24	1,295.93	2.35
PM_{10}[5]	0.00089	2,600	0.42	23	24	538.31	0.98

Stack Parameters

Height	5 m
Temperature	675 Kelvin
Diameter	0.2 m
Velocity	30 m/s

5 x 5 x 5 m structure used to determine downwash parameters for drilling rigs

[1] Emission factor for Tier 1 engine taken from Diesel Net, Revision 2003.10, Table 1, "EU Emission Regulations for Nonroad Diesel Engines." Available on-line at http://www.dieselnet.com/standards/eu/offroad.html.

[2] Drilling engine horsepower based on four engines, two at 800 hp and two at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheets for G4312, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.24
Drilling Emissions - Tier 2 - Directional Drilling

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: Directional Drilling
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA Tier 2
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (lb/hp-hr)	Total Horsepower All Engines[2] (hp)	Overall Load Factor[3]	Drilling Activity Duration (days/well)	Drilling Activity Duration (hrs/day)	Emissions (lb/well)	Emissions (lb/hr/well)
CO	0.00575	2,600	0.42	23	24	3,489.06	6.32
NO_x	0.00658	2,600	0.42	23	24	3,987.49	7.22
SO_2[4]	0.00035	2,600	0.42	23	24	209.48	0.38
VOC	0.00214	2,600	0.42	23	24	1,295.93	2.35
PM_{10}[5]	0.00033	2,600	0.42	23	24	199.37	0.36

Stack Parameters

Height	5 m
Temperature	675 Kelvin
Diameter	0.2 m
Velocity	30 m/s

5 x 5 x 5 m structure used to determine downwash parameters for drilling rigs

[1] Emission factor for Tier 2 engine taken from Diesel Net, Revision 2003.10, Table 1, "EU Emission Regulations for Nonroad Diesel Engines." Available on-line at http://www.dieselnet.com/standards/eu/offroad.html.

[2] Drilling engine horsepower based on four engines, two at 800 hp and two at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheets for G4312, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.25
Wind Erosion – 2 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 2 wells per pad
Activity: Well Pad, Resource Road, Pipeline Construction
Emissions: Wind Erosion
Date: 3/24/2004

Emission Factor :	0.3733	lb/hr/100m^2		Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.
Control Efficiency:	50	%		
Disturbed Area:				
Well Pad Construction:	7	acres	28,329.00 m^2	
Access Road Construction:	1.3455	acres	5,445.24 m^2	(based on 74-ft ROW width, 0.15-mile length)
Pipeline Construction	0.45	acres	1,821.15 m^2	(based on 25-ft ROW width, 0.15-mile length)

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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	283.29	50	52.87	21.15	6.66	2.66
Resource Road Construction	0.3733	0.1493	54.45	50	10.16	4.07	1.28	0.51
Pipeline Construction	0.3733	0.1493	18.21	50	3.40	1.36	0.43	0.17

Table B.1.26
Wind Erosion – 5 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 5 wells per pad
Activity: Well Pad, Resource Road, Pipeline Construction
Emissions: Wind Erosion
Date: 3/24/2004

Emission Factor :	0.3733	lb/hr/100m^2		Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.
Control Efficiency:	50	%		
Disturbed Area:				
Well Pad Construction:	10	acres	40,470.00 m^2	
Access Road Construction:	1.3455	acres	5,445.24 m^2	(based on 74-ft ROW width, 0.15-mile length)
Pipeline Construction	0.45	acres	1,821.15 m^2	(based on 25-ft ROW width, 0.15-mile length)

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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	404.70	50	75.53	30.21	9.52	3.81
Resource Road Construction	0.3733	0.1493	54.45	50	10.16	4.07	1.28	0.51
Pipeline Construction	0.3733	0.1493	18.21	50	3.40	1.36	0.43	0.17

Table B.1.27
Wind Erosion – 10 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 10 wells per pad
Activity: Well Pad, Resource Road, Pipeline Construction
Emissions: Wind Erosion
Date: 3/24/2004

Emission Factor :	0.3733	lb/hr/100m^2			Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.
Control Efficiency:	50	%			
Disturbed Area:					
Well Pad Construction:	10	acres	40,470.00	m^2	
Access Road Construction:	1.3455	acres	5,445.24	m^2	(based on 74-ft ROW width, 0.15-mile length)
Pipeline Construction	0.45	acres	1,821.15	m^2	(based on 25-ft ROW width, 0.15-mile length)

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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	404.70	50	75.53	30.21	9.52	3.81
Resource Road Construction	0.3733	0.1493	54.45	50	10.16	4.07	1.28	0.51
Pipeline Construction	0.3733	0.1493	18.21	50	3.40	1.36	0.43	0.17

Table B.2.1
Production Traffic – 1 Well per Pad

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 1 well per pad
Activity: Production Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well[4]	RT Distance	VMT[5]	Emission Control Efficiency	PM_{10} Emission Factor[6]	$PM_{2.5}$ Emission Factor[6]	PM_{10} Emissions[7] (controlled)	$PM_{2.5}$ Emissions[7] (controlled)
			(lb)	(mph)	(%)	(%)	(RTs/yr)	(miles)	(VMT/well/yr)	(%)	(lb/VMT)	(lb/VMT)	(lb/well/yr)	(lb/well/yr)
Workover Rig	Primary Access	magnesium chloride	90,000	20	5.1	2.4	1	14	14	85	2.35	0.36	4.93	0.76
	Resource	water	90,000	15	5.1	2.4	1	5	5	50	2.35	0.36	5.87	0.90
Haul trucks (water/condensate)[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	35	14	490	85	1.87	0.29	137.19	21.04
	Resource	water	54,000	15	5.1	2.4	35	5	175	50	1.87	0.29	163.33	25.04
Light trucks/ pickups/pumpers[8]	Primary Access	magnesium chloride	7,000	30	5.1	2.4	122	14	1,708	85	0.56	0.08	143.10	21.39
	Resource	water	7,000	20	5.1	2.4	122	5	610	50	0.46	0.07	139.07	20.77
												Total Access and Unimproved Road Emissions (lb/well/yr)	593.49	89.90

1 Haul trucks weight range is 28,000-80,000 lbs. Average weight of 54,000 lbs used for calculations.

2 AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

3 AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

4 Includes Supervisory Control and Data Acquisitions system (SCADA). SCADA is being installed at wells to increase production efficiency by providing real-time operating data to field staff including well flow rates and pressures, processing equipment operating conditions, tank levels, and emissions control equipment status. SCADA implementation is expected to reduce well site visits by 30-40%b and reduce potential for spills.

5 Calculated as Round Trips per Vehicle Type x Round Trip Distance

6 AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

7 Calculated as lb/VMT x VMT/well x control efficiency.

8 Emissions based on trip frequency and miles traveled to one well in the field. During production, 20 wells could be visited per day. This assumption will be reflected in full-field modeled emissions.

Table B.2.2
Production Heavy Equipment Tailpipe – 1 Well per Pad

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Production Traffic
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: 3/24/2004

Pollutant	Pollutant Emission Factor[1] (g/mi)	Annual RTs per Well (RTs/well/yr)	Single Well Round Trip Distance (mi/RT)	Single Well Annual VMT (mi/well/yr)	Hourly Emissions Single Well (lb/hr)	Annual Emissions Single Well (tpy)
CO	14.74	35	19	665.00	0.002467	0.01080
NO_x	11.44	35	19	665.00	0.001915	0.00839
SO_2[2]	0.32	35	19	665.00	0.000054	0.00024
VOC	5.69	35	19	665.00	0.000952	0.00417

[1] AP-42 (EPA 1985), Table 2.7.1 "Volume II Mobile Sources." Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.08 lb/gal.

Table B.2.3
Indirect Heater

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 1 well per pad
Activity: Production
Emissions: Emissions from Indirect Heater
Date: 1/26/04

Fuel Combustion Source:

Unit Description	Indirect Heater					
Design Firing Rate (MMBTU/hr)	0.75					

Operating Parameters:

Operating cycle	15	min/hr September to April				
Operating hours	24	hr/day,	7	days/wk,	213	days/yr.
Annual Operating Hours	1,277.5					
Capacity (%)	100					
Annual Load (%):	Winter	43.75	Spring	12.5		
	Summer	0	Fall	43.75		

Actual Fuel Combustion for the Year per Unit:

Volume of Natural Gas Combusted	0.96	MMSCF
Heat Content	1,000.00	Btu/scf

Building Size (approximate):

Width	8.00	ft
Length	15.00	ft
Height	7	ft

Potential Emission Data:

	From Stack Testing (lb/hr)	Actual[2] (lb/hr)	Actual (tpy)	Method of Determination	Emission Factors	Units
Filterable Particulate	--	0.0034	0.002	AP-42	4.5	lb/MMscf
Condensable Particulate	--	0.0056	0.004	AP-42	7.5	lb/MMscf
Total PM	--	0.0090	0.006			
VOC	--	0.0060	0.004	AP-42	8.0	lb/MMscf
CO	0.291	0.073	0.19	Stack Testing[1]		
NO_x	0.034	0.0085	0.022	Stack Testing[1]		
SO_2	--	0.0	0.0	Fuel Analysis	0.0	lb/MMscf

[1] Stack testing data for this heater was provided by EnCana and included five separate tests of NO_x and CO emissions. NOx and CO were the only pollutants for which stack testing emission were provided. The maximum of the stack test emissions was used for calculations.

[2] Actual lb/hr calculated using stack testing lb/hr * 15 min/hr * 60 min/hr.

Table B.2.4
Separator Heater

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 1 well per pad
Activity: Production
Emissions: Low-pressure Separator Heater
Date: 1/26/04

Fuel Combustion Source:

Unit Description	Low-pressure Separator Burner					
Design Firing Rate (MMBTU/hr)	0.085					
Operating Parameters:						
Operating cycle	7.5	min/hr September to April				
Operating hours	24	hr/day,	7	days/wk,	213	days/yr.
Annual Operating hours	638.75					
Capacity (%)	100					
Annual Load (%):	Winter	43.75	Spring	12.5		
	Summer	0	Fall	43.75		
Actual Fuel Combustion for the Year for Unit:						
Volume of Natural Gas Combusted	0.05	MMSCF	1000			
Heat Content	1,000	Btu/scf				
Building Size:						
Width	8.00	ft				
Length	15.00	ft				
Height	7.00	ft				

Potential Emission Data:

	From Stack Testing lb/hr	Actual[2] lb/hr	Actual tpy	Method of Determination	Emission Factors	Units
Filterable Particulate		0.00038	0.00012	AP-42	4.5	lb/MMscf
Condensable Particulate		0.00064	0.00020	AP-42	7.5	lb/MMscf
Total PM		0.0010	0.00033			
SO_2		0.0	0.0	Fuel Analysis	0.0	lb/MMscf
NO_x	0.0100	0.0013	0.0032	Stack Testing[1]		
CO	0.138	0.0173	0.044	Stack Testing[1]		
VOC		0.00068	0.00022	AP-42	8.0	lb/MMscf

[1] Stack testing data for this heater was provided by EnCana and included five separate tests of NO_x and CO emissions. NOx and CO were the only pollutants for which stack testing emission were provided. The maximum of the stack test emissions was used for calculations.

[2] Actual lb/hr calculated using stack testing lb/hr * 7.5 min/hr * 60 min/hr.

Table B.2.5
Dehydrator Reboiler Heater

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 1 well per pad
Activity: Production
Emissions: Dehy Reboiler Heater
Date: 1/26/04

Fuel Combustion Source:

Unit Description	Reboiler Heater					
Design Firing Rate (MMBTU/hr)	0.085					
Operating Parameters:						
Operating cycle	35	min/hr year round				
Operating hours	24	hr/day,	7	days/wk,	365	days/yr.
Annual Operating hours	5,110					
Capacity (%)	100					
Annual Load (%):	Winter	25	Spring	25		
	Summer	25	Fall	25		
Actual Fuel Combustion for the Year for Unit:						
Volume of Natural Gas Combusted	0.43	MMSCF				
Heat Content	1,000	Btu/scf				
Building Size:						
Width	8.00	ft				
Length	15.00	ft				
Height	7.00	ft				

Potential Emission Data:

	From Stack Testing lb/hr	Actual[2] lb/hr	Actual tpy	Method of Determination	Emission Factors	Units
Filterable Particulate	--	0.00038	0.0010	AP-42	4.5	lb/MMscf
Condensable Particulate	--	0.00064	0.0016	AP-42	7.5	lb/MMscf
Total PM	--	0.00102	0.0026			
SO_2	--	0.0	0.0	Fuel Analysis	0.0	lb/MMscf
NO_x	0.0080	0.0047	0.020	Stack Testing[1]		
CO	0.080	0.047	0.20	Stack Testing[1]		
VOC	--	0.00068	0.0017	AP-42	8.0	lb/MMscf

[1] Stack testing data for this heater was provided by EnCana and included five separate tests of NO_x and CO emissions. NOx and CO were the only pollutants for which stack testing emission were provided. The maximum of the stack test emissions was used for calculations.

[2] Actual lb/hr calculated by using stack testing lb/hr * 35 min/hr * 60 min/hr.

Table B.2.6
Dehydrator Flashing

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Production
Emissions: TEG Dehydrator Flashing
Date: 10/30/2003

Pollutant	Uncontrolled (tpy)[1]	Controlled (tpy)[1]
VOC	12.78	1.20
HAP	6.75	0.68
Benzene	1.55	0.15
Toluene	3.18	0.35
Ethylbenzene	0.15	0.01
Xylene	1.70	0.15
n-Hexane	0.16	0.02

[1] Data provided by EnCana. Assumes 75% of the wells have a pump limit and 25% of the wells have BTEX control.

Table B.2.7
Fugitive HAPs and VOC

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Production
Emissions: Fugitive VOC/HAP Emissions
Date: 10/30/2003

Gas Analysis Weight Fraction

VOC	0.18378
Benzene	0.00054
Toluene	0.00085
Ethlybenzene	0.00004
Xylene	0.00038
n-hexane	0.00176

Source	Quantity	Emission Factor[1] (lb/hr/component)	Non-methane Hydrocarbons[2] (lb/hr)	Non-methane Hydrocarbons (tpy)	Benzene[2] (lb/hr)	Benzene (tpy)	Toluene[2] (lb/hr)	Toluene (tpy)	Ethlybenzene[2] (lb/hr)	Ethlybenzene (tpy)	Xylene[2] (lb/hr)	Xylene (tpy)	n-Hexane[2] (lb/hr)	n-Hexane (tpy)
Valves	16	0.00992	0.0292	0.128	0.00009	0.00038	0.00014	0.00059	0.000006	0.000028	0.00006	0.00027	0.00028	0.0012
Flanges	38	0.00086	0.0060	0.026	0.00002	0.00008	0.00003	0.00012	0.000001	0.000006	0.00001	0.00006	0.00006	0.0003
Connections	94	0.00044	0.0076	0.033	0.00002	0.00010	0.00004	0.00015	0.000002	0.000007	0.00002	0.00007	0.00007	0.0003
Pump seals	8	0.00529	0.0078	0.034	0.00002	0.00010	0.00004	0.00016	0.000002	0.000007	0.00002	0.00007	0.00007	0.0003
Open ended lines	6	0.00441	0.0049	0.021	0.00001	0.00006	0.00002	0.00010	0.000001	0.000005	0.00001	0.00004	0.00005	0.0002
		Total Emissions/Well	0.0554	0.243	0.00016	0.00071	0.00026	0.00113	0.000012	0.000053	0.00012	0.00051	0.00053	0.0023

[1] Taken from the WDEQ (2001) "Oil and Gas Production Facilities Chapter 6, Section 2 Permitting Guidance".

[2] Calculated as weight fraction * emissions factor * quantity of source.

Table B.2.8
Condensate Storage Tank

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Production
Emissions: Condensate Storage Tank
Date: 10/30/2003

Storage Tank with Control (assuming 98% control)[1]

VOC and HAP Emissions

VOC	1	tpy/tank
HAP	0.1	tpy/tank
Benzene	0.0024	tpy/tank
Toluene	0.0001	tpy/tank
Ethylbenzene	0.0014	tpy/tank
Xylene	0.0018	tpy/tank
n-Hexane	0.0443	tpy/tank

These wells average 25.3 bbls of condensate per day.

NO_x and CO Emissions from Smokeless Flare Combustion

NO_x Emission Factor[2]	0.068	lb/MMBTU
CO Emission Factor[2]	0.37	lb/MMBTU
Heat Content	1,000	Btu/scf
Condensate Production	25.30	bbl/day
Gas to Oil Ratio[3]	957.37	scf/bbl
Gas Production	24,221.46	SCFD

Combustion Emissions from Storage Tanks

NO_x	0.30	tpy/tank
CO	1.64	tpy/tank

Uncontrolled Storage Tank Emissions[1]

VOC	15.9	tpy/tank
HAP	0.8	tpy/tank
Benzene	0.0367	tpy/tank
Toluene	0.0021	tpy/tank
Ethylbenzene	0.022	tpy/tank
Xylene	0.0279	tpy/tank
n-Hexane	0.6891	tpy/tank

These wells average 7.9 bbls of condensate per day.

[1] Provided by EnCana.

[2] AP-42 (EPA 2004), Table 13.5-1, "Emission Factors for Flare Operations."

[3] Taken from Tank Oil Analysis Global Properties.

Table B.2.9
Jonah Water Disposal Well

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Production
Emissions: Jonah Water Disposal Well
Date: 3/31/2004

Unit Description	Jonah Water Disposal Well					
Engine Design (hp)	400					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		
Stack Parameters						
Height	6.1 m					
Temperature	832 Kelvin					
Diameter	0.2 m					
Velocity	16.7 m/s					

Emissions Data:	lb/hr	tpy
NO_x	0.90	3.9
CO	0.90	3.9
VOC	0.90	3.9
Formaldehyde	0.10	0.2

Table B.2.10
Bird Canyon Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Jonah Field Compression
Emissions: Duke Field Services Bird Canyon C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Bird Canyon Compressor Station					
Engine design (hp)	11,004					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	636.30	MMSCF
Assumes gas consumed at rate of	6601	Btu/hp-hr
Heat Content	1000	Btu/scf

Emission Data:

	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.00008	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.00008	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	17.0	74.4	BACT	0.7	g/hp-hr
CO	7.3	31.9	Permitted Emissions[2]	0.300	g/hp-hr
VOC	12.1	53.1	Permitted Emissions[2]	0.500	g/hp-hr
Formaldehyde	1.9	8.5	Permitted Emissions[2]	0.080	g/hp-hr

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).

[2] Emission rates taken from Bird Canyon Permit for an engine with 0.7g/hp-hr NO_x.

Table B.2.11
Falcon Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Pinedale Anticline Compression
Emissions: Duke Field Services Falcon C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Falcon Compressor Station
Engine design (hp/hr)	7,336

Operating Parameters:

Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	424.20	MMSCF
Assumes gas consumed at rate of	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf

Emission Data:

	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.0000771	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.0000771	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	11.3	49.6	BACT	0.7	g/hp-hr
CO	4.9	21.3	Permitted Emissions[2]	0.300	g/hp-hr
VOC	8.1	35.4	Permitted Emissions[2]	0.500	g/hp-hr
Formaldehyde	1.3	5.7	Permitted Emissions[2]	0.080	g/hp-hr

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).

[2] Emission rates taken from a Pinedale Anticline Permit for an engine with 0.7g/hphr NO_x.

Table B.2.12
Gobblers Knob Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Pinedale Anticline Compression
Emissions: Questar Gobblers Knob C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Gobblers Knob Compressor Station (Comprised of Pinedale, Mesa 1, and Mesa 2)					
Engine design (hp/hr)	10,000					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	578.25	MMSCF
Assumes gas consumed at rate of	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf

Emission Data:

	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.0000771	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.0000771	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	15.4	67.6	BACT	0.7	g/hp-hr
CO	6.6	29.0	Permitted Emissions[2]	0.300	g/hp-hr
VOC	11.0	48.3	Permitted Emissions[2]	0.500	g/hp-hr
Formaldehyde	1.8	7.7	Permitted Emissions[2]	0.080	g/hp-hr

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).

[2] Emission rates taken from a Pinedale Anticline WDEQ permit for an engine with 0.7g/hp-hr NO_x.

Table B.2.13
Jonah Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Jonah Field Compression
Emissions: Mountain Gas Resources Jonah C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Jonah Compressor Station					
Engine design (hp/hr)	3,900					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	225.52	MMSCF
Assumes gas consumed at rate of	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf

Emission Data:

	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.0000771	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.0000771	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	6.0	26.4	BACT	0.7	g/hp-hr
CO	2.6	11.3	Permitted Emissions[2]	0.300	g/hp-hr
VOC	4.3	18.8	Permitted Emissions[2]	0.500	g/hp-hr
Formaldehyde	0.7	3.0	Permitted Emissions[2]	0.080	g/hp-hr

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).

[2] Emission rates taken from a Pinedale Anticline Permit for an engine with 0.7g/hp-hr NO_x.

Table B.2.14
Luman Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Jonah Field Compression
Emissions: Duke Field Services Luman C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Luman Compressor Station					
Engine design (hp/hr)	11,604					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	671.00	MMSCF
Assumes gas consumed at rate of	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf

Emission Data for 11,004 hp:

	lb/hr	TPY	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.0000771	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.0000771	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	17.9	78.4	BACT	0.70	g/hp-hr
CO	7.7	33.6	Permitted Emissions[2]	0.30	g/hp-hr
VOC	12.8	56.0	Permitted Emissions[2]	0.50	g/hp-hr
Formaldehyde	2.0	9.0	Permitted Emissions[2]	0.08	g/hp-hr

Emission Data for 600 hp:

	lb/hr	TPY	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	7.71E-05	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	7.71E-05	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	1.3	5.8	BACT	1.0	g/hp-hr
CO	0.7	2.9	Permitted Emissions[2]	0.50	g/hp-hr
VOC	0.7	2.9	Permitted Emissions[2]	0.50	g/hp-hr
Formaldehyde	0.1	0.4	Permitted Emissions[2]	0.07	g/hp-hr

Total Emissions:	lb/hr	TPY
PM_{10}	0.0	0.0
$PM_{2.5}$	0.0	0.0
SO_2	0.0	0.0
NO_x	19.2	84.2
CO	8.3	36.5
VOC	13.5	58.9
Formaldehyde	2.1	9.4

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).
[2] Emission rates taken from Luman Permit MD-921.

Table B.2.15
Paradise Compressor Station

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: All Scenarios
Activity: Projected Pinedale Anticline Compression
Emissions: Paradise C.S.
Date: 3/24/2004

Fuel Combustion Source:

Unit Description	Paradise Compressor Station
Engine design (hp/hr)	7,336

Operating Parameters:

Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	424.20	MMSCF
Assumes gas consumed at rate of	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf

Emission Data:

	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
PM_{10}	0.0	0.0	AP-42	0.0000771	lb/MMscf
$PM_{2.5}$	0.0	0.00	AP-43	0.0000771	lb/MMscf
SO_2	0.0	0.0	Fuel Analysis	0.00	lb/MMscf
NO_x	11.3	49.6	BACT	0.7	g/hp-hr
CO	4.9	21.3	Permitted Emissions[2]	0.300	g/hp-hr
VOC	8.1	35.4	Permitted Emissions[2]	0.500	g/hp-hr
Formaldehyde	1.3	5.7	Permitted Emissions[2]	0.080	g/hp-hr

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-3 (EPA 2004).

[2] Emission rates taken from a Pinedale Anticline WDEQ permit for an engine with 0.7g/hp-hr NO_x.

Table B.2.16
Wind Erosion – 1 Well per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: **Jonah Infill Drilling Project**
Scenario: **1 well per pad**
Activity: **Production**
Emissions: **Wind Erosion from Well Pads**
Date: **10/30/2003**

Emission Factor : 0.3733 lb/hr/100m^2 Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.

Control Efficiency: 0 %

Disturbed Area:
Well Pad Production: 0.9 acres 3642.30 m^2

PM-10 Emissions Calculations:

	PM_{10} Emission Factor ($lb/hr/100\ m^2$)	$PM_{2.5}$ Emission Factor ($lb/hr/100\ m^2$)	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 - Production:	0.3733	0.1493	36.42	0	13.60	5.438341379	1.71	0.69

Table B.2.17
Production Traffic – 2 Wells per Pad

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 2 wells per pad
Activity: Production Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per Well[4] (RTs/yr)	RTs per Pad[4] (RTs/year)	RT Distance (miles)	VMT[5] (VMT/well/yr)	Emission Control Efficiency (%)	PM_{10} Emission Factor[6] (lb/VMT)	$PM_{2.5}$ Emission Factor[6] (lb/VMT)	PM_{10} Emissions[7] (controlled) (lb/well/yr)	$PM_{2.5}$ Emissions[7] (controlled) (lb/well/yr)
Workover Rig	Primary Access	magnesium chloride	90,000	20	5.1	2.4	1	na	14	14	85	2.35	0.36	4.93	0.76
	Resource	water	90,000	15	5.1	2.4	1	na	5	5	50	2.35	0.36	5.87	0.90
Haul trucks (water/condensate)[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	35	na	14	490	85	1.87	0.29	137.19	21.04
	Resource	water	54,000	15	5.1	2.4	35	na	5	175	50	1.87	0.29	163.33	25.04
											Total Unpaved Road Emissions (lb/well/yr)			311.33	47.74
Light trucks/ pickups/pumpers[8]	Primary Access	magnesium chloride	7,000	30	5.1	2.4	na	122	14	1,708	85	0.56	0.08	143.10	21.39
	Resource	water	7,000	20	5.1	2.4	na	122	5	610	50	0.46	0.07	139.07	20.77
											Total Unpaved Road Emissions (lb/pad/yr)			282.16	42.16
										Total Unpaved Road Emissions - All Traffic (lb/pad/yr)				904.8	137.6

[1] Haul trucks weight range is 28,000-80,000 lbs; average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Includes Supervisory Control and Data Acquisitions system (SCADA). SCADA is being installed at wells to increase production efficiency by providing real-time operating data to field staff including well flow rates and pressures, processing equipment operating conditions, tank levels, and emissions control equipment status. SCADA implementation is expected to reduce well site visits by 30-40% and reduce potential for spills.

[5] Calculated as Round Trips per Vehicle Type x Round Trip Distance

[6] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[7] Calculated as lb/VMT x VMT/well x control efficiency.

[8] Emissions based on trip frequency and miles traveled to one well in the field. During production, 20 wells could be visited per day. This assumption will be reflected in full-field modeled emissions.

Table B.2.18
Production Traffic – 5 Wells per Pad

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 5 wells per pad
Activity: Production Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well[4]	RTs per Pad[4]	RT Distance	VMT[5]	Emission Control Efficiency	PM_{10} Emission Factor[6]	$PM_{2.5}$ Emission Factor[6]	PM_{10} Emissions[7] (controlled)	$PM_{2.5}$ Emissions[7] (controlled)
			(lb)	(mph)	(%)	(%)	(RTs/yr)	(RTs/year)	(miles)	(VMT/well/yr)	(%)	(lb/VMT)	(lb/VMT)	(lb/well/yr)	(lb/well/yr)
Workover Rig	Primary Access	magnesium chloride	90,000	20	5.1	2.4	1	na	14	14	85	2.35	0.36	4.93	0.76
	Resource	water	90,000	15	5.1	2.4	1	na	5	5	50	2.35	0.36	5.87	0.90
Haul trucks (water/condensate)[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	35	na	14	490	85	1.87	0.29	137.19	21.04
	Resource	water	54,000	15	5.1	2.4	35	na	5	175	50	1.87	0.29	163.33	25.04
												Total Unpaved Road Emissions (lb/well/yr)		311.33	47.74
Light trucks/ pickups/pumpers[8]	Primary Access	magnesium chloride	7,000	30	5.1	2.4	na	122	14	1,708	85	0.56	0.08	143.10	21.39
	Resource	water	7,000	20	5.1	2.4	na	122	5	610	50	0.46	0.07	139.07	20.77
												Total Unpaved Road Emissions (lb/pad/yr)		282.16	42.16
												Total Unpaved Road Emissions - All Traffic (lb/pad/yr)		1,838.8	280.8

[1] Haul trucks weight range is 28,000-80,000 lbs; average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Includes Supervisory Control and Data Acquisitions system (SCADA). SCADA is being installed at wells to increase production efficiency by providing real-time operating data to field staff including well flow rates and pressures, processingequipment operating conditions, tank levels, and emissions control equipment status. SCADA implementation is expected to reduce well site visits by 30-40% and reduce potential for spills.

[5] Calculated as Round Trips per Vehicle Type x Round Trip Distance

[6] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[7] Calculated as lb/VMT x VMT/well x control efficiency.

[8] Emissions based on trip frequency and miles traveled to one well in the field. During production, 20 wells could be visited per day. This assumption will be reflected in full-field modeled emissions.

Table B.2.19
Production Traffic – 10 Wells per Pad

TRC Environmental
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 10 wells per pad
Activity: Production Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: 3/24/2004

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[2] (%)	Moisture Content[3] (%)	RTs per Well[4] (RTs/yr)	RTs per Pad[4] (RTs/year)	RT Distance (miles)	VMT[5] (VMT/well/yr)	Emission Control Efficiency (%)	PM_{10} Emission Factor[6] (lb/VMT)	$PM_{2.5}$ Emission Factor[6] (lb/VMT)	PM_{10} Emissions[7] (controlled) (lb/well/yr)	$PM_{2.5}$ Emissions[7] (controlled) (lb/well/yr)
Workover Rig	Primary Access	magnesium chloride	90,000	20	5.1	2.4	1	na	14	14	85	2.35	0.36	4.93	0.76
	Resource	water	90,000	15	5.1	2.4	1	na	5	5	50	2.35	0.36	5.87	0.90
Haul trucks (water/condensate)[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	35	na	14	490	85	1.87	0.29	137.19	21.04
	Resource	water	54,000	15	5.1	2.4	35	na	5	175	50	1.87	0.29	163.33	25.04
											Total Unpaved Road Emissions (lb/well/yr)			311.33	47.74
Light trucks/ pickups/pumpers[8]	Primary Access	magnesium chloride	7,000	30	5.1	2.4	na	122	14	1,708	85	0.56	0.08	143.10	21.39
	Resource	water	7,000	20	5.1	2.4	na	122	5	610	50	0.46	0.07	139.07	20.77
											Total Unpaved Road Emissions (lb/pad/yr)			282.16	42.16
											Total Unpaved Road Emissions - All Traffic (lb/pad/yr)			3,395.4	519.5

[1] Haul trucks weight range is 28,000-80,000 lbs; average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Includes Supervisory Control and Data Acquisitions system (SCADA). SCADA is being installed at wells to increase production efficiency by providing real-time operating data to field staff including well flow rates and pressures, processing equipment operating conditions, tank levels, and emissions control equipment status. SCADA implementation is expected to reduce well site visits by 30-40% and reduce potential for spills.

[5] Calculated as Round Trips per Vehicle Type x Round Trip Distance

[6] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[7] Calculated as lb/VMT x VMT/well x control efficiency.

[8] Emissions based on trip frequency and miles traveled to one well in the field. During production, 20 wells could be visited per day. This assumption will be reflected in full-field modeled emissions.

Table B.2.20
Wind Erosion – 2 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 2 wells per pad
Activity: Production
Emissions: Wind Erosion from Well Pads
Date: 10/30/2003

Emission Factor : 0.3733 lb/hr/100m^2 Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.

Control Efficiency: 0 %

Disturbed Area:

Well Pad Production: 1.2 acres 4,856.40 m^2

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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 - Production	0.3733	0.1493	48.56	0	18.13	7.251121838	2.28	0.91

Table B.2.21
Wind Erosion – 5 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 5 well per pad
Activity: Production
Emissions: Wind Erosion from Well Pads
Date: 10/30/2003

Emission Factor : 0.3733 lb/hr/100m^2 Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.

Control Efficiency: 0 %

Disturbed Area:
Well Pad Production: 2 acres 8,094.00 m^2

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor ($lb/hr/100\ m^2$)	$PM_{2.5}$ Emission Factor ($lb/hr/100\ m^2$)	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 - Production	0.3733	0.1493	80.94	0	30.21	12.08520306	3.81	1.52

Table B.2.22
Wind Erosion – 10 Wells per Pad

TRC Environmental Corporation
605 Skyline Drive
Laramie, WY 82070
Phone: (307) 742-3843
Fax: (307) 745-8317

Project: Jonah Infill Drilling Project
Scenario: 10 well per pad
Activity: Production
Emissions: Wind Erosion from Well Pads
Date: 10/30/2003

Emission Factor : 0.3733 lb/hr/100m^2 Based on AP-42 Chapter 13.2.5 (EPA 2004), Industrial Wind Erosion using Jonah Field, Wyoming meteorological data.

Control Efficiency: 0 %

Disturbed Area:

Well Pad Production: 2 acres 8,094.00 m^2

PM_{10} Emissions Calculations:

	PM_{10} Emission Factor (lb/hr/100 m^2)	$PM_{2.5}$ Emission Factor (lb/hr/100 m^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 - Production	0.3733	0.1493	80.94	0	30.21	12.08520306	3.81	1.52