Table B.1.1
Jonah Infill Drilling Project
Summary of Maximum Field Wide Emissions Scenarios - Preferred Alternative
(Tons Per Year)

	High Emissions Cases			Low Emissions Cases			Mitigation Runs[7]			
	WDR250	WDR150	WDR75	WDR250	WDR150	WDR75	80%	60%	40%	20%
Production Emissions										
Wells[1]										
NO_x	129.2	133.8	137.2	129.2	133.8	137.2	103.4	77.5	51.7	25.8
SO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM_{10}	24.7	25.6	26.3	24.7	25.6	26.3	19.8	14.8	9.9	4.9
$PM_{2.5}$	24.7	25.6	26.3	24.7	25.6	26.3	19.8	14.8	9.9	4.9
Traffic[2]										
NO_x	23.9	24.7	25.4	23.9	24.7	25.4	19.1	14.3	9.6	4.8
SO_2	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.4	0.3	0.1
PM_{10}	652.0	674.9	692.0	652.0	674.9	692.0	521.6	391.2	260.8	130.4
$PM_{2.5}$	99.1	102.6	105.2	99.1	102.6	105.2	79.3	59.5	39.7	19.8
Compression[3]										
NO_x	211.0	211.0	211.0	211.0	211.0	211.0	168.8	126.6	84.4	42.2
SO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM_{10}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction Emissions										
Well Drilling[4]										
NO_x	2,421.6	1,453.0	726.5	786.2	471.7	235.9	1,937.3	1,453.0	968.6	484.3
SO_2	161.9	97.1	48.6	30.0	18.0	9.0	129.5	97.1	64.8	32.4
PM_{10}	464.9	278.9	139.5	28.8	17.3	8.6	371.9	278.9	186.0	93.0
$PM_{2.5}$	464.9	278.9	139.5	28.8	17.3	8.6	371.9	278.9	186.0	93.0
Traffic[5]										
NO_x	13.5	8.1	4.1	13.5	8.1	4.1	10.8	8.1	5.4	2.7
SO_2	0.4	0.2	0.1	0.4	0.2	0.1	0.3	0.2	0.2	0.1
PM_{10}	225.1	135.1	67.5	225.1	135.1	67.5	180.1	135.1	90.0	45.0
$PM_{2.5}$	34.5	20.7	10.3	34.5	20.7	10.3	27.6	20.7	13.8	6.9
Flaring[6]										
NO_x	406.9	271.3	135.6	406.9	271.3	135.6	325.5	244.1	162.8	81.4
SO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM_{10}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$PM_{2.5}$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total										
NO_x	3,206.1	2,101.8	1,239.7	1,570.7	1,120.6	749.1	2,564.9	1,923.7	1,282.5	641.2
SO_2	162.9	98.1	49.4	31.0	18.9	9.8	130.3	97.8	65.2	32.6
PM_{10}	1,366.8	1,114.5	925.3	930.7	852.8	794.5	1,093.4	820.1	546.7	273.4
$PM_{2.5}$	623.3	427.9	281.3	187.2	166.2	150.5	498.6	374.0	249.3	124.7

[1] Includes emissions from indirect heater, separator heater, and dehyrator heater.
[2] Includes emissions from all traffic associated with full field production. Emissions calculations assume 20 wells can be visited per day.
[3] Includes emissions from the following compressor stations: Bird Canyon, Luman, Falcon, Jonah and the Jonah Water Well.
[4] Includes emissions from drilling rigs operating continuously during the year.
Well Development Rates of 250, 150 and 75 assume drill rig counts of 20, 12, and 6, respectively.
High emissions cases assume 50% straight and 50% directional at an 80%/20% Tier 0/Tier 1 ratio.
Low Emissions cases assume 50% straight and 50% directional with 100% Tier 2 compliant rigs.
[5] Includes emissions from all traffic associated with 20, 12, and 6 drilling rigs in operation.
[6] Includes emissions from 3, 2, and 1 "completion/testing" flares operating continously during the year.
[7] Mitigation runs assume 80%, 60%, 40% and 20% of the high-emissions WDR250 case emissions, respectively.

Table B.1.2
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: **6/30/2005**

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions per Well	Emissions per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.00668	2,100	0.42	19	24	2,702.63	5.93	25.96
NOx	0.031	2,100	0.42	19	24	12,542.17	27.50	120.47
SO_2	0.00205	2,100	0.42	19	24	829.40	1.82	7.97
VOC	0.0025	2,100	0.42	19	24	1,011.47	2.22	9.72
PM_{10}[4]	0.0022	2,100	0.42	19	24	890.09	1.95	8.55

[1] AP-42 (EPA, 1996), Section 3.3, Gasoline and Diesel Industrial Engines. Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines."
[2] Drilling engine horsepower based on three engines, two at 800hp and one at 500hp.
[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] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.3
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: **6/30/2005**

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions Per Well	Emissions per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.0187	2,100	0.42	19	24	7,581.69	16.63	72.82
NOx	0.015	2,100	0.42	19	24	6,154.55	13.50	59.12
SO_2[4]	0.00035	2,100	0.42	19	24	139.77	0.31	1.34
VOC	0.0022	2,100	0.42	19	24	891.96	1.96	8.57
PM_{10}[5]	0.00088	2,100	0.42	19	24	356.79	0.78	3.43

[1] Emission factor for Tier 1 engine taken from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 1, "EPA Tier 1-3 Nonroad Diesel Engine Emission Standards, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.
[2] Drilling engine horsepower based on three engines, two at 800hp and one at 500hp.
[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 taken from Caterpillar "Oilfield Mechanical Rig Power" specification sheets.
[5] PM2.5 assumed equivalent to PM10 for drilling engines.

Table B.1.4
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: 6/30/2005

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions per Well	Emissions per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.0057	2,100	0.42	19	24	2,319.11	5.09	22.28
NOx	0.0090	2,100	0.42	19	24	3,657.05	8.02	35.13
SO_2[4]	0.00035	2,100	0.42	19	24	139.77	0.31	1.34
VOC	0.0004	2,100	0.42	19	24	148.87	0.33	1.43
PM_{10}[5]	0.00033	2,100	0.42	19	24	133.79	0.29	1.29

[1] Emission factor for Tier 2 engine taken from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 1, "EPA Tier 1-3 Nonroad Diesel Engine Emission Standards, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html. NO_x and HC Emission Factors estimated based on Tables 3 and 5 of "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling--Compression-Ignition," NR-009c, EPA, April 2004.

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

[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 taken from Caterpillar "Oilfield Mechanical Rig Power" specification sheets.

[5] PM2.5 assumed equivalent to PM10 for drilling engines.

Table B.1.5
Drilling Emissions 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: **6/30/2005**

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions Per Well	Emissions Per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.00668	2,600	0.42	23	24	4,050.56	7.34	32.14
NOx	0.031	2,600	0.42	23	24	18,797.53	34.05	149.15
SO_2	0.00205	2,600	0.42	23	24	1,243.06	2.25	9.86
VOC	0.0025	2,600	0.42	23	24	1,515.93	2.75	12.03
PM_{10}[4]	0.0022	2,600	0.42	23	24	1,334.02	2.42	10.59

[1] AP-42 (EPA, 1996), Section 3.3, Gasoline and Diesel Industrial Engines. Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines."
[2] Drilling engine horsepower based on three engines, two at 800hp and one at 500hp.
[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] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

Table B.1.6
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: **6/30/2005**

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions per Well	Emissions per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.0187	2,600	0.42	23	24	11,363.04	20.59	90.16
NOx	0.015	2,600	0.42	23	24	9,224.12	16.71	73.19
SO_2[4]	0.00035	2,600	0.42	23	24	209.48	0.38	1.66
VOC	0.0022	2,600	0.42	23	24	1,336.83	2.42	10.61
PM_{10}[5]	0.00088	2,600	0.42	23	24	534.73	0.97	4.24

[1] Emission factor for Tier 1 engine taken from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 1, "EPA Tier 1-3 Nonroad Diesel Engine Emission Standards, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.
[2] Drilling engine horsepower based on four engines, two at 800hp and two at 500hp.
[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 taken from Caterpillar "Oilfield Mechanical Rig Power" specification sheets.
[5] PM2.5 assumed equivalent to PM10 for drilling engines.

Table B.1.7
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: **6/30/2005**

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions per Well	Emissions per Rig	Yearly Emissions Per Rig Based on Continuous Operation
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr)	(tpy)
CO	0.0057	2,600	0.42	23	24	3,475.75	6.30	27.58
NOx	0.0090	2,600	0.42	23	24	5,481.00	9.93	43.49
SO_2[4]	0.00035	2,600	0.42	23	24	209.48	0.38	1.66
VOC	0.0004	2,600	0.42	23	24	223.12	0.40	1.77
PM_{10}[5]	0.00033	2,600	0.42	23	24	200.52	0.36	1.59

[1] Emission factor for Tier 2 engine taken from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 1, "EPA Tier 1-3 Nonroad Diesel Engine Emission Standards, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.
NO_x and HC Emission Factors estimated based on Tables 3 and 5 of "Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling--Compression-Ignition," NR-009c, EPA, April 2004.
[2] Drilling engine horsepower based on four engines, two at 800hp and two at 500hp.
[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 taken from Caterpillar "Oilfield Mechanical Rig Power" specification sheets.
[5] PM2.5 assumed equivalent to PM10 for drilling engines.