APPENDIX B

Nearby Field Office Emissions Inventories

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Colorado River Valley Field Office (CRVFO)

5/18/2010

Alternative Description				
Development Scenario	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**
Wells Developed Over 20 Years -- Field Wide	12,072	10,965	10,965	15,664
Wells Developed Over 20 Years Outside Roan Plateau	8,381	7,274	7,274	11,973
	4,845	4,196	4,196	6,903
Wells on Fee (Private) Lands	3,536	3,078	3,078	5,070
Wells on Federal Lands	1,415	674	674	1,109
Number of Well Pads	8	8	8	8
Typical Wells Per Pad	274	238	238	392
Maximum Wells Constructed in Single Year	0.800	0.800	0.800	0.800
Wells Developed Over 20 Years (Within the Roan Plateau)	3,691	3,691	3,691	3,691
	2,121	2,121	2,121	2,121
Wells on Fee (Private) Lands	1,570	1,570	1,570	1,570
Wells on Federal Lands	669	669	669	669
Number of Well Pads	8	8	8	8
Typical Wells Per Pad	121	121	121	121
Maximum Wells Constructed in Single Year	0.800	0.800	0.800	0.800
Maximum Additional Drill Rigs (Field wide)	8	7	7	10
Percent of Drill Rigs for the Roan Plateau (%)	31	34	34	24
Maximum Gas Production (MMscfd) -- Field Wide	1,207	1,097	1,097	1,566
Gas Production Per Well (MMscfd/well) -- Field Wide	0.100	0.100	0.100	0.100
Field Compression	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**
Assumed Field Compressor Station Throughput (MMscfd)	180	180	180	180
Number of Field Compressor Stations -- Field Wide	7	6	6	9
Number of Field Compressor Stations Outside Roan	5	4	4	7

Emission Controls

Emission Source	Controlled Pollutant	Alt. A -- Control Efficiency[1] (%)	Alt. B -- Control Efficiency[1] (%)	Alt. C -- Control Efficiency[1] (%)	Alt. D -- Control Efficiency[1] (%)
Local Roads	PM_{10}, $PM_{2.5}$	50	94	94	94
Resource Roads	PM_{10}, $PM_{2.5}$	50	94	94	94
Construction Activities	PM_{10}, $PM_{2.5}$	50	50	50	50
Compressor Engines[2]	All (due to electrification)	0	100	100	50
Well Completion	VOC, HAP	47.5	98.95	98.95	98.95
Glycol Dehydrators[3]	VOC, HAP	0	90	90	90
Condensate and Produced Water Tanks[3]	VOC, HAP	0	95	95	95

Emission Source	Controlled Pollutant	Alternative A Methods	Alternative B Methods	Alternative C Methods	Alternative D Methods
Local Roads	PM_{10}, $PM_{2.5}$	Watering.	Watering, chemical suppression, graveling or paving.	Watering, chemical suppression, graveling or paving.	Watering, chemical suppression, graveling or paving.
Resource Roads	PM_{10}, $PM_{2.5}$	Watering.	Watering, chemical suppression, graveling or paving.	Watering, chemical suppression, graveling or paving.	Watering, chemical suppression, graveling or paving.
Construction Activities	PM_{10}, $PM_{2.5}$	Watering.	Watering or chemical suppression.	Watering or chemical suppression.	Watering or chemical suppression.
Drill Rig Engines	SO_2	Ultra-low sulfur diesel fuel (15 ppm).	Ultra-low sulfur diesel fuel (15 ppm).	Ultra-low sulfur diesel fuel (15 ppm).	Ultra-low sulfur diesel fuel (15 ppm).
Drill Rig Engines	NO_x, PM_{10}, $PM_{2.5}$, VOC	Drill rig engines would meet Colorado and EPA requirements.	Within one year of the ROD, all new and existing drill rig engines would meet Tier 4 Nonroad Diesel Engine Standards	Within one year of the ROD, all new and existing drill rig engines would meet Tier 4 Nonroad Diesel Engine Standards	Within one year of the ROD, all new and existing drill rig engines would meet Tier 2 Nonroad Diesel Engine Standards, and by year 2015, all new and existing drill rig engines would meet EPA Tier 4 emissions standards.
Frac Pump Engines	NO_x, PM_{10}, $PM_{2.5}$, VOC	Frac pump engines would meet Colorado and EPA requirements.	Within one year of the ROD, all new and existing frac pump engines would meet Tier 4 Nonroad Diesel Engine Standards	Within one year of the ROD, all new and existing frac pump engines would meet Tier 4 Nonroad Diesel Engine Standards	Within one year of the ROD, all new and existing frac pump engines would meet Tier 2 Nonroad Diesel Engine Standards, and by year 2015, all new and existing frac pump engines would meet EPA Tier 4 emissions standards.
Well Completion	VOC, HAP	Flaring and venting would be allowed in accordance with Notice to Lessees (NTL-4A).	Green completion for 98% of wells.	Green completion for 98% of wells.	Green completion for 98% of wells.
Compressor Engines[2]	CO, NO_x, VOC	Meet EPA and Colorado standards.	New and existing compressor engines required to meet CDPHE AQCC Regulation No.7 emissions standards for new and relocated engines, compliance with EPA standards also required.	New and existing compressor engines required to meet CDPHE AQCC Regulation No.7 emissions standards for new and relocated engines, compliance with EPA standards also required.	New and relocated compressor engines required to meet CDPHE AQCC Regulation No.7 emissions standards for new and relocated engines, compliance with EPA standards also required.
Compressor Engines[2]	All	No electrification at compressor stations.	100% of compressor engines at compressor stations will be electrified (no emissions).	100% of compressor engines at compressor stations will be electrified (no emissions).	50% of compressor engines at compressor stations will be electrified (no emissions).
Glycol Dehydrators[3]	VOC, HAP	Meet EPA and Colorado standards.	90% control.	90% control.	90% control.
Condensate and Produced Water Tanks[3]	VOC, HAP	No control, unless required by EPA or Colorado regulations.	95% control.	95% control.	95% control.

[1] Control efficiency is based on "add-on" controls compared to uncontrolled emissions. Control efficiencies are not included for equipment subject to emission limits imposed on engine manufacturers.

[2] Compressor engines will meet engine manufacturer emission control standards in accordance federal and state regulations. These controls are reflected in the emission factors used to calculate emissions; consequently, zero emission control is shown for most compressor engines. However, in-field compressor engine emissions may be avoided by use of electrically-powered compressors. Alternative D management actions require electrification of at least 50 percent of all compression at compressor stations. This requirement is accounted for by including 50 percent "control" of all emissions associated with compressor engines at compressor stations.

[3] Equipment located at major sources of air pollution could be subject to more stringent control, as determined by CDPHE on a case-by-case basis.

Year 2028 CRVFO BLM and Non-BLM Activity Summary

CRVFO Alternative: All
Phase: Construction and Production
Activity: All
Date: 5/18/2010

Actitivty Description on BLM and non-BLM Land

Alternative A 2028 Activity	Outside Roan Total	Fraction on BLM Land Outside Roan	On BLM Land Outside Roan	On Fee (Private) Land Outside Roan	Roan Total	Fraction on BLM Land for the Roan	On BLM Land for the Roan	On Fee (Private) Land for the Roan	Forest Service Total
Wells Constructed During 2028 [1]	274	0.3179	87	187	121	0.4254	51	69	0
Drill Rigs Operating During 2028 [1]	5	0.3179	2	4	2	0.4254	1	1	0
Wells Operating During 2028 [1]	8,381	0.3179	2,664	4,845	3,691	0.4254	1,570	2,121	872
Operating Compressor Stations [1]	5	0.3179	2	3	2	0.4254	1	1	0
Alternative B 2028 Activity	**Outside Roan Total**	**Fraction on BLM Land Outside Roan**	**On BLM Land Outside Roan**	**On Fee (Private) Land Outside Roan**	**Roan Total**	**Fraction on BLM Land for the Roan**	**On BLM Land for the Roan**	**On Fee (Private) Land for the Roan**	**Forest Service Total**
Wells Constructed During 2028 [1]	238	0.3033	72	166	121	0.4254	51	69	0
Drill Rigs Operating During 2028 [1]	5	0.3033	1	3	2	0.4254	1	1	0
Wells Operating During 2028 [1]	7,274	0.3033	2,206	4,196	3,691	0.4254	1,570	2,121	872
Operating Compressor Stations [1]	4	0.3033	1	3	2	0.4254	1	1	0
Alternative C 2028 Activity	**Outside Roan Total**	**Fraction on BLM Land Outside Roan**	**On BLM Land Outside Roan**	**On Fee (Private) Land Outside Roan**	**Roan Total**	**Fraction on BLM Land for the Roan**	**On BLM Land for the Roan**	**On Fee (Private) Land for the Roan**	**Forest Service Total**
Wells Constructed During 2028 [1]	238	0.3033	72	166	121	0.4254	51	69	0
Drill Rigs Operating During 2028 [1]	5	0.3033	1	3	2	0.4254	1	1	0
Wells Operating During 2028 [1]	7,274	0.3033	2,206	4,196	3,691	0.4254	1,570	2,121	872
Operating Compressor Stations [1]	4	0.3033	1	3	2	0.4254	1	1	0
Alternative D 2028 Activity	**Outside Roan Total**	**Fraction on BLM Land Outside Roan**	**On BLM Land Outside Roan**	**On Fee (Private) Land Outside Roan**	**Roan Total**	**Fraction on BLM Land for the Roan**	**On BLM Land for the Roan**	**On Fee (Private) Land for the Roan**	**Forest Service Total**
Wells Constructed During 2028 [1]	392	0.3506	137	255	121	0.4254	51	69	0
Drill Rigs Operating During 2028 [1]	8	0.3506	3	5	2	0.4254	1	1	0
Wells Operating During 2028 [1]	11,973	0.3506	4,198	6,903	3,691	0.4254	1,570	2,121	872
Operating Compressor Stations [1]	7	0.3506	2	5	2	0.4254	1	1	0

[1] Approximate locations of wells, drill rigs, and compressor stations on BLM and non-BLM lands were provided by the BLM.

Year 2028 CRVFO BLM and Non-BLM Emission Summary (tons)

CRVFO Alternative: All
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

		Emissions (ton/yr)														
Alternative	**Source Location**	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOCs**	**Benzene**	**Toluene**	**Ethyl-benzene**	**Xylene**	**Hexane**	**Form.**	**CO_2**	**CH_4**	**N_2O**
A	BLM (outside Roan)	423	805	1	1,950	200	3,382	73	52	0	28	210	55	200,171	15,404	2
	Fee/Private (outside Roan)	775	1,488	2	3,621	372	6,177	134	95	1	51	383	101	369,750	28,247	4
	BLM (Roan)	249	474	0	1,149	118	1,993	43	31	0	17	124	33	117,969	9,078	1
	Fee/Private (Roan)	336	641	1	1,553	159	2,692	58	42	0	22	168	44	159,370	12,264	2
	Forest Service	132	238	0	564	58	1,080	24	17	0	9	69	18	59,821	4,810	1
	Total	**1,915**	**3,646**	**4**	**8,837**	**906**	**15,325**	**332**	**236**	**1**	**128**	**954**	**251**	**907,080**	**69,802**	**11**
B	BLM (outside Roan)	60	103	1	66	10	1,268	21	22	0	17	122	0	66,891	10,804	1
	Fee/Private (outside Roan)	672	1,292	2	139	22	5,353	116	83	0	45	331	87	320,984	24,494	4
	BLM (Roan)	43	73	0	47	7	903	15	16	0	12	87	0	47,606	7,689	1
	Fee/Private (Roan)	336	641	1	64	10	2,692	58	42	0	22	168	44	159,370	12,264	2
	Forest Service	19	16	0	13	3	499	8	9	0	7	48	0	21,598	4,266	0
	Total	**1,130**	**2,125**	**3**	**328**	**53**	**10,716**	**219**	**171**	**1**	**102**	**757**	**131**	**616,450**	**59,518**	**8**
C	BLM (outside Roan)	60	103	1	66	10	1,268	21	22	0	17	122	0	66,891	10,804	1
	Fee/Private (outside Roan)	672	1,292	2	139	22	5,353	116	83	0	45	331	87	320,984	24,494	4
	BLM (Roan)	43	73	0	47	7	903	15	16	0	12	87	0	47,606	7,689	1
	Fee/Private (Roan)	336	641	1	64	10	2,692	58	42	0	22	168	44	159,370	12,264	2
	Forest Service	19	16	0	13	3	499	8	9	0	7	48	0	21,598	4,266	0
	Total	**1,130**	**2,125**	**3**	**328**	**53**	**10,716**	**219**	**171**	**1**	**102**	**757**	**131**	**616,450**	**59,518**	**8**
D	BLM (outside Roan)	383	726	1	177	25	2,599	41	43	0	32	234	44	218,522	21,592	3
	Fee/Private (outside Roan)	1,101	2,110	2	306	44	8,789	190	136	1	73	545	143	524,386	40,146	6
	BLM (Roan)	143	271	0	66	9	972	15	16	0	12	87	16	81,725	8,075	1
	Fee/Private (Roan)	336	641	1	90	13	2,692	58	42	0	22	168	44	159,370	12,264	2
	Forest Service	74	126	0	24	4	538	8	9	0	7	49	9	40,548	4,480	1
	Total	**2,037**	**3,874**	**5**	**663**	**95**	**15,590**	**313**	**245**	**2**	**146**	**1,083**	**256**	**1,024,551**	**86,557**	**13**

Scaling Factors for CRVFO Alternatives

NOTE: These scaling factors are used throughout the emission calculation worksheets in order to streamline alternative-specific calculations.

CRVFO Alternative: All
Phase: Construction and Production
Activity: All
Date: 5/18/2010

	Parameter Value (Units shown at left)				Scaling Factor for Alternative Calculations (Units are number of wells, number of sources, or percentage)			
Source Category	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**
Land Disturbance From Well Pad, Resource Road to Well Pad, an equal portion of the divided Local Road for each well pad, an equal portion of the divided area for other associated infrastructure, and pipeline disturbance per pad (acres)	**10.05**	**10.05**	**10.05**	**10.05**	1	1	1	1
Ratio of Months with Frozen or Muddy Roads	**0.5**	**0.5**	**0.5**	**0.5**	0.5	0.5	0.5	0.5
Vehicle Road Dust Local Road -- Control Percent (%)	**50**	**94**	**94**	**94**	0.5	0.06	0.06	0.06
Vehicle Road Dust Resource Road -- Control Percent (%)	**50**	**94**	**94**	**94**	0.5	0.06	0.06	0.06
Average Well Count Per Pad outside Roan Plateau	**8**	**8**	**8**	**8**	8	8	8	8
Average Well Count Per Pad for the Roan Plateau	**8**	**8**	**8**	**8**	8	8	8	8
Condensate Tank -- Control Percent (%)	**0**	**95**	**95**	**95**	1	0.05	0.05	0.05
Produced Water Tank -- Control Percent (%)	**0**	**95**	**95**	**95**	1	0.05	0.05	0.05
Glycol Dehydrator -- Control Percent (%)	**0**	**90**	**90**	**90**	1	0.1	0.1	0.1
Percent of producing wells that are recompleted each year (%)	**1**	**1**	**1**	**1**	83.81	72.74	72.74	119.73
Number of pneumatic pumps for all gas plants	**0**	**0**	**0**	**0**	0.0	0.0	0.0	0.0
Number of pneumatic pumps for all compressor stations	**0**	**0**	**0**	**0**	0.0	0.0	0.0	0.0
Number of pneumatic pumps for all consolidated field facilities	**0**	**0**	**0**	**0**	0.0	0.0	0.0	0.0
Number of pneumatic pumps per well	**---**	**---**	**---**	**---**	1.00	1.00	1.00	1.00
Well Completion percentage of wells with green completion	**0**	**98**	**98**	**98**	1.00	0.02	0.02	0.02
Well Pad Wind Erosion Emissions During Production -- Control Percent (%)	**50**	**50**	**50**	**50**	0.4785	0.4785	0.4785	0.4785
For Production Operations -- percentage of produced water that is trucked	**60**	**10**	**10**	**20**	0.6	0.1	0.1	0.2
For Production Operations -- percentage of facilities consolidated	**60**	**90**	**90**	**80**	0.4	0.1	0.1	0.2
Electrification of Compressor Engines at Compressor Stations (%)	**0**	**100**	**100**	**50**	1.0	0.0	0.0	0.5

Land Disturbance From Well Pad, Resource Road, and Local Road Construction

CRVFO Alternative: All
Phase: Construction
Activity: Well Pad Construction
Emissions: Fugitive Particulate Emissions from Well Pad and Resource Road Construction
Date: 5/18/2010

Well Pad, Resource Road, Local Road Area [1]	Construction Activity TSP Emission Factor[2]	Construction Activity Duration	Construction Activity Duration	Manual Emission Control Efficiency	Rainfall Emission Control Efficiency[3]	PM_{10} Emissions (controlled)	$PM_{2.5}$ Emissions (controlled)[4]	Wells per Well Pad	PM_{10} Emissions (controlled)	$PM_{2.5}$ Emissions (controlled)
(acre)	(tons/acre-month)	(days/well pad)	(hours/day)	(%)	(%)	(lb/well pad)	(lb/well pad)		(lb/well)	(lb/well)
10.1	1.2	5	10	50	100	197.63	19.76	8	24.70	2.47
			Well Pad Construction Emissions (lb/well/day)			4.94	0.49		0.62	0.06

[1] Total disturbance area per well pad is estimated to be 6 acres for the well pad, 0.25 acre for a portion of compressor station and central treating facility (CTF), 2.8 acres for resource road and portion of local road area, and 1 acres for a portion of pipeline disturbance.

[2] AP-42 (EPA 2006), Section 13.2.3, "Heavy Construction Operations".

[3] Frequency is 4.3% of annual hours have measurable precipitation -- Western Regional Climate Center (http://www.wrcc.dri.edu/htmlfiles/hrsofppt.html).

[4] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on "Analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).

Vehicle Road Dust From Well Pad/Resource Road Construction

CRVFO Alternative: All
Phase: Construction
Activity: Well Pad/Resource Road
Emissions: Fugitive Particulate From Well Pad and Resource Road Construction Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/pad)	(miles)	(VMT/pad)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/pad)	(lb/pad)
Low boy hauler	Local	water/chemical	85,000	25	37	6	4	24	0.5	0	6.81	0.68	163.48	16.35
	Resource	water	85,000	25	37	6	1	6	0.5	0	6.81	0.68	40.87	4.09
Gravel haul trucks	Local	water/chemical	54,000	25	37	45	4	180	0.5	0	5.55	0.56	999.68	99.97
	Resource	water	54,000	25	37	45	1	45	0.5	0	5.55	0.56	249.92	24.99
Fuel tanker	Local	water/chemical	54,000	25	37	1	4	4	0.5	0	5.55	0.56	22.22	2.22
	Resource	water	54,000	25	37	1	1	1	0.5	0	5.55	0.56	5.55	0.56
Water tanker (100 bbl)	Local	water/chemical	54,000	25	37	10	4	40	0.5	0	5.55	0.56	222.15	22.22
	Resource	water	54,000	25	37	10	1	10	0.5	0	5.55	0.56	55.54	5.55
Light trucks/pickups	Local	water/chemical	8,000	35	37	22	4	88	0.5	0	2.35	0.24	206.96	20.70
	Resource	water	8,000	35	37	22	1	22	0.5	0	2.35	0.24	51.74	5.17
												Total Unpaved Road Traffic Emissions (lb/pad)	2,018.11	201.81
												Wells per Pad	8	8
												Total Unpaved Road Traffic Emissions (lb/well)	252.26	25.23

[1] Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Pad/Resource Road Heavy Construction Equipment Exhaust

CRVFO Alternative: All
Phase: Construction
Activity: Well Pad/Resource Road
Emissions: Diesel Combustion Emissions from Heavy Equipment Exhaust
Date: 5/18/2010

Heavy Equipment	Engine Horsepower	Operating Load Factor[1]	Pollutant Emission Factor												Construction Activity Duration	Pollutant Emissions											
	(hp)		(g/hp-hr)												(hr)	(lb/well pad)											
			CO	NO_x	SO_2	VOC	PM_{10}[4]	CO_2[5]	CH_4[6]	N_2O[9]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]		CO	NO_x	SO_2[8]	VOC	PM_{10}[4]	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Backhoe[2]	100	0.4	2.45	7.46	0.027	0.55	0.789	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	9	1.94	5.92	0.02	0.44	0.63	414.37	0.02	0.00	0.00	0.00	0.00	0.00
Motor Grader[2]	165	0.4	2.45	7.46	0.027	0.55	0.789	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	12	4.28	13.03	0.05	0.96	1.38	911.60	0.04	0.01	0.01	0.01	0.00	0.00
D8 Dozer[3]	300	0.4	2.15	7.81	0.027	0.75	0.692	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	50	28.44	103.31	0.36	9.92	9.15	6906.08	0.33	0.07	0.05	0.04	0.02	0.01
															Total Heavy Equipment Exhaust Emissions (lb/well pad)	34.66	122.25	0.43	11.32	11.16	8232.05	0.40	0.09	0.06	0.05	0.02	0.01
															Wells per Pad	8	8	8	8	8	8	8	8	8	8	8	8
															Total Heavy Equipment Exhaust Emissions (lb/well)	4.33	15.28	0.05	1.41	1.39	1029.01	0.05	0.01	0.01	0.01	0.00	0.00

[1] Taken from "Surface Mining" (Pfleider 1972) for average service duty.
[2] AP-42 (EPA 1985), Volume II Mobile Sources. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).
[3] Emission factor for track-type tractor.
[4] $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.
[5] 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"; lb/hp-hr = pounds per horsepower-hour.
[6] Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).
[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; converted to g/hp-hr.
[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.
[9] Based on N_2O emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

Well Pad/Resource Road Construction Vehicle Exhaust

CRVFO Alternative: All
Phase: Construction
Activity: Well Pad/Resource Road Construction
Emissions: Construction Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well pad)											
	CO^1	NO_x^1	SO_2^2	VOC^1	PM_{10}^1	CO_2^5	CH_4^6	N_2O^9	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2^8	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Low boy hauler	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	6	5	30	0.70	0.94	0.00	0.12	0.03	112.43	0.01	0.00	0.00	0.00	0.00	0.00
Gravel hauler	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	45	5	225	5.28	7.02	0.01	0.90	0.26	843.25	0.04	0.02	0.01	0.00	0.00	0.00
Fuel tanker	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	1	5	5	0.12	0.16	0.00	0.02	0.01	18.74	0.00	0.00	0.00	0.00	0.00	0.00
Water tanker (100 bbl)	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	10	5	50	1.17	1.56	0.00	0.20	0.06	187.39	0.01	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck	2.429	1.395	0.006	1.262	0.2256	230	0.018	4.59E-02	0.0487	0.02524	0.00371	0.0026	14	5	70	0.37	0.22	---	0.19	0.03	35.49	0.00	0.01	0.01	0.00	0.00	0.00
Light duty gasoline truck	39.45	2.011	0.007	2.209	0.03	330	0.119	4.92E-02	0.0334	0.0594	0.00371	0.0026	8	5	40	3.48	0.18	---	0.19	0.00	29.10	0.01	0.00	0.00	0.01	0.00	0.00
Total Heavy Equipment Exhaust Emissions (lb/well pad)																11.13	10.07	0.01	1.64	0.40	1226.41	0.07	0.04	0.02	0.01	0.00	0.00
Wells per Pad																8	8	8	8	8	8	8	8	8	8	8	8
Total Heavy Equipment Exhaust Emissions (lb/well)																1.39	1.26	0.00	0.20	0.05	153.30	0.01	0.00	0.00	0.00	0.00	0.00

[1] Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.
[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).
[5] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.
[6] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).
[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.
[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.
[9] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust From Drill Rig Transport

CRVFO Alternative: All
Phase: Construction
Activity: Drill Rig Transport
Emissions: Fugitive Particulate from Drill Rig Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well pad)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well pad)	(lb/well pad)
Rig Hauler	Local	water/chemical	100,000	25	37	35	4	140	0.5	0	7.33	0.73	1025.98	102.60
	Resource	water	100,000	25	37	35	1	35	0.5	0	7.33	0.73	256.50	25.65
Water tanker (130 bbl)	Local	water/chemical	85,000	25	37	0	4	0	0.5	0	6.81	0.68	0.00	0.00
	Resource	water	85,000	25	37	0	1	0	0.5	0	6.81	0.68	0.00	0.00
												Total Unpaved Road Traffic Emissions (lb/well pad)	1,282.48	128.25

1 Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).

2 Calculated as Round Trips per Vehicle Type x Round Trip Distance.

3 Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.

4 AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.

5 Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).

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

Drill Rig and Drilling Water Transport Exhaust Emissions

CRVFO Alternative: All
Phase: Construction
Activity: Drill Rig and Water Transport
Emissions: Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor												Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Pollutant Emissions											
	(g/mi)												(RT/well pad)	(miles)	(mi)	(lb/well pad)											
	CO^1	NO_x^1	SO_2^2	VOC^1	PM_{10}^1	CO_2^3	CH_4^4	N_2O^7	Form.[5]	Benzene[5]	Toluene[5]	Xylene[5]				CO	NO_x	SO_2^6	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Rig haulers	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	35	5	175	4.11	5.46	0.01	0.70	0.20	655.86	0.03	0.01	0.00	0.00	0.00	0.00
Water truck (130 bbl)	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	0	5	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Total Heavy Equipment Exhaust Emissions (lb/well pad)										4.11	5.46	0.01	0.70	0.20	655.86	0.03	0.01	0.00	0.00	0.00	0.00

[1] Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.
[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).
[3] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.
[4] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).
[5] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.
[6] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.
[7] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust During Drilling

CRVFO Alternative: All
Phase: Construction
Activity: Drilling
Emissions: Fugitive Particulate From Drilling Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Fuel tanker	Local	water/chemical	54,000	25	37	8	4	32	0.5	0	5.55	0.56	177.72	17.77
	Resource	water	54,000	25	37	8	1	8	0.5	0	5.55	0.56	44.43	4.44
Logging truck	Local	water/chemical	35,000	25	37	1	4	4	0.5	0	4.57	0.46	18.28	1.83
	Resource	water	35,000	25	37	1	1	1	0.5	0	4.57	0.46	4.57	0.46
Cement truck	Local	water/chemical	54,000	25	37	2	4	8	0.5	0	5.55	0.56	44.43	4.44
	Resource	water	54,000	25	37	2	1	2	0.5	0	5.55	0.56	11.11	1.11
Cement supply truck	Local	water/chemical	66,000	25	37	2	4	8	0.5	0	6.08	0.61	48.63	4.86
	Resource	water	66,000	25	37	2	1	2	0.5	0	6.08	0.61	12.16	1.22
Water tanker (130 bbl)	Local	water/chemical	85,000	25	37	200	4	800	0.5	0	6.81	0.68	5449.29	544.93
(road dust control)	Resource	water	85,000	25	37	200	1	200	0.5	0	6.81	0.68	1362.32	136.23
Light duty vehicles (bits)	Local	water/chemical	8,000	35	37	4	4	16	0.5	0	2.35	0.24	37.63	3.76
	Resource	water	8,000	35	37	4	1	4	0.5	0	2.35	0.24	9.41	0.94
Light duty vehicles	Local	water/chemical	3000	35	37	100	4	400	0.5	0	1.51	0.15	605.03	60.50
(commuting)	Resource	water	3000	35	37	100	1	100	0.5	0	1.51	0.15	151.26	15.13
									Total Unpaved Road Traffic Emissions (lb/well)				7,976.26	797.63

[1] Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/well x control efficiency.

Drilling Operation Vehicle Exhaust

CRVFO Alternative: All
Phase: Construction
Activity: Drilling
Emissions: Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/well)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well)											
	CO^1	NO_x^1	SO_2^2	VOC^1	PM_{10}^1	CO_2^5	CH_4^6	N_2O^9	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2^8	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Fuel tanker	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	8	5	40	0.94	1.25	0.00	0.16	0.05	149.91	0.01	0.00	0.00	0.00	0.00	0.00
Logging truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	1	5	5	0.12	0.16	0.00	0.02	0.01	18.74	0.00	0.00	0.00	0.00	0.00	0.00
Cement truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	2	5	10	0.23	0.31	0.00	0.04	0.01	37.48	0.00	0.00	0.00	0.00	0.00	0.00
Cement supply truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	2	5	10	0.23	0.31	0.00	0.04	0.01	37.48	0.00	0.00	0.00	0.00	0.00	0.00
Water truck (130 bbl)	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.039	0.0107	0.0085	0.00371	0.0026	200	5	1000	23.46	31.22	0.03	4.02	1.17	3747.80	0.18	0.09	0.02	0.02	0.01	0.01
Light duty diesel truck (bits)	2.429	1.395	0.00597	1.262	0.2256	230	0.018	0.046	0.0487	0.02524	0.00371	0.0026	3	5	15	0.08	0.05	---	0.04	0.01	7.61	0.00	0.00	0.00	0.00	0.00	0.00
Light duty gasoline truck (bits)	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.049	0.0334	0.0594	0.00371	0.0026	1	5	5	0.43	0.02	---	0.02	0.00	3.64	0.00	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck (commuting)	2.429	1.395	0.00597	1.262	0.2256	230	0.018	0.046	0.0487	0.02524	0.00371	0.0026	60	5	300	1.61	0.92	---	0.83	0.15	152.12	0.01	0.03	0.03	0.02	0.00	0.00
Light duty gasoline truck (commuting)	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.049	0.0334	0.0594	0.00371	0.0026	40	5	200	17.39	0.89	---	0.97	0.01	145.50	0.05	0.02	0.01	0.03	0.00	0.00
															Total Heavy Equipment Exhaust Emissions (lb/well)	44.50	35.12	0.04	6.16	1.41	4300.26	0.26	0.15	0.07	0.06	0.01	0.01

1 Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

5 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

6 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

9 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Drilling Emissions - Tier 4b - Directional Drilling

CRVFO Alternative: All
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA Tier 4b (2015)
Date: 5/18/2010

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Factor for Drilling Activity Duration	Emissions	Emissions
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	2,952	0.40	7	24	1,137.07	6.77
NO_x	0.5000	2,952	0.40	7	24	218.67	1.30
SO_2[4]	0.0278	2,952	0.40	7	24	12.16	0.07
VOC	0.1400	2,952	0.40	7	24	61.23	0.36
PM_{10}[5]	0.0220	2,952	0.40	7	24	9.62	0.06
	(lb/hp-hr)						
CO_2[6]	1.15000	2,952	0.40	7	24	228,130.56	1,357.92
CH_4[7]	5.53E-05	2,952	0.40	7	24	10.97	0.07
N_2O[8]	1.24E-05	2,952	0.40	7	24	2.46	0.01
Formaldehyde[9]	5.52E-07	2,952	0.40	7	24	0.11	0.00
Benzene[10]	6.53E-06	2,952	0.40	7	24	1.30	0.01
Toluene[10]	2.86E-06	2,952	0.40	7	24	0.57	0.00
Xylene[10]	2.00E-06	2,952	0.40	7	24	0.40	0.00

1 Emission factors for Tier 4 (2015) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for generator sets greater than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 4, "Tier 4 Emission Standards—Engines Above 560 kW (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

2 Drilling engine total horsepower is based on three 1,000 hp engines, fueled with ultra low sulfur diesel fuel (15 ppm).

3 The overall load factor is 0.4.

4 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjusting for low-sulfur fuel (15 ppm).

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

6 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"; lb/hp-hr = pounds per horsepower-hour.

7 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

8 Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

9 AP-42 (EPA 1996), Section 3.4, "Large Stationary Diesel and All Stationary Dual-Fuel Engines. Table 3.4-3, "Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

10 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

Frac Pump Emissions - Tier 4b

CRVFO Alternative: All
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Frac Pump Engines - EPA Tier 4b (2015)
Date: 5/18/2010

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Fracing Activity Duration	Factor for Fracing Activity Duration	Emissions	Emissions
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	10,000	0.75	0.5	24	515.87	42.99
NO_x	0.5000	10,000	0.75	0.5	24	99.21	8.27
SO_2[4]	0.0278	10,000	0.75	0.5	24	5.52	0.46
VOC	0.1400	10,000	0.75	0.5	24	27.78	2.31
PM_{10}[5]	0.02200	10,000	0.75	0.5	24	4.37	0.36
	(lb/hp-hr)						
CO_2[6]	1.15000	10,000	0.75	0.5	24	103,500.00	8,625.00
CH_4[7]	5.53E-05	10,000	0.75	0.5	24	4.98	0.41
N_2O[8]	1.24E-05	10,000	0.75	0.5	24	1.12	0.09
Formaldehyde[9]	5.52E-07	10,000	0.75	0.5	24	0.05	0.00
Benzene[10]	6.53E-06	10,000	0.75	0.5	24	0.59	0.05
Toluene[10]	2.86E-06	10,000	0.75	0.5	24	0.26	0.02
Xylene[10]	2.00E-06	10,000	0.75	0.5	24	0.18	0.02

1 Emission factors for Tier 4 (2015) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for generator sets greater than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 4, "Tier 4 Emission Standards—Engines Above 560 kW (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

2 Drilling engine total horsepower is based on eight 1,500 hp engines, fueled with ultra low sulfur diesel fuel (15 ppm).

3 The overall load factor is 0.85.

4 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjusting for ultra-low sulfur fuel (15 ppm).

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

6 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"; lb/hp-hr = pounds per horsepower-hour.

7 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

8 Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

9 AP-42 (EPA 1996), Section 3.4, "Large Stationary Diesel and All Stationary Dual-Fuel Engines. Table 3.4-3, "Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

10 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average BSFC of 7,000 Btu/hp-hr.

Vehicle Road Dust During Completion Watering

CRVFO Alternative: All
Phase: Construction
Activity: Completion and Testing
Emissions: Fugitive Particulate From Completion and Testing Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well pad)	(miles)	(VMT/well pad)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well pad)	(lb/well pad)
Water tanker (130 bbl)	Local	water/chemical	85,000	25	37	208	4	832	0.5	0	6.81	0.68	5667.26	566.73
	Resource	water	85,000	25	37	208	1	208	0.5	0	6.81	0.68	1416.82	141.68
									Total Unpaved Road Traffic Emissions (lb/well pad)				7,084.08	708.41

[1] Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Completion Watering Vehicle Exhaust

CRVFO Alternative: All
Phase: Construction
Activity: Well Completion and Testing
Emissions: Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor												Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Pollutant Emissions											
	(g/mi)												(RT/well pad)	(miles)	(mi)	(lb/well pad)											
	CO^1	NO_x^1	SO_2^2	VOC^1	PM_{10}^1	CO_2^5	CH_4^6	N_2O^{11}	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2^8	VOC	PM_{10}^4	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Water tanker (130 bbl)	10.641	14.16	0.01504	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	208	5	1040	24.40	32.47	0.03	4.18	1.21	3897.71	0.19	0.09	0.02	0.02	0.01	0.01
	Total Heavy Equipment Exhaust Emissions (lb/well pad)															24.40	32.47	0.03	4.18	1.21	3897.71	0.19	0.09	0.02	0.02	0.01	0.01

[1] Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

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

[5] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

[6] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

[9] Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[10] Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[11] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust During Completion

CRVFO Alternative: All
Phase: Construction
Activity: Completion and Testing
Emissions: Fugitive Particulate From Completion and Testing Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well pad)	(miles)	(VMT/well pad)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well pad)	(lb/well pad)
Casing hauler	Local	water/chemical	100,000	25	37	3	4	12	0.5	0	7.33	0.73	87.94	8.79
	Resource	water	100,000	25	37	3	1	3	0.5	0	7.33	0.73	21.99	2.20
Completion rig	Local	water/chemical	85,000	25	37	1	4	4	0.5	0	6.81	0.68	27.25	2.72
	Resource	water	85,000	25	37	1	1	1	0.5	0	6.81	0.68	6.81	0.68
Logging truck	Local	water/chemical	35,000	25	37	2	4	8	0.5	0	4.57	0.46	36.55	3.66
	Resource	water	35,000	25	37	2	1	2	0.5	0	4.57	0.46	9.14	0.91
Cement truck	Local	water/chemical	54,000	25	37	2	4	8	0.5	0	5.55	0.56	44.43	4.44
	Resource	water	54,000	25	37	2	1	2	0.5	0	5.55	0.56	11.11	1.11
Sand truck	Local	water/chemical	85,000	25	37	20	4	80	0.5	0	6.81	0.68	544.93	54.49
	Resource	water	85,000	25	37	20	1	20	0.5	0	6.81	0.68	136.23	13.62
Frac pumper	Local	water/chemical	85,000	25	37	10	4	40	0.5	0	6.81	0.68	272.46	27.25
	Resource	water	85,000	25	37	10	1	10	0.5	0	6.81	0.68	68.12	6.81
Fracmaster delivery	Local	water/chemical	85,000	25	37	2	4	8	0.5	0	6.81	0.68	54.49	5.45
	Resource	water	85,000	25	37	2	1	2	0.5	0	6.81	0.68	13.62	1.36
Water tanker (100 bbl)	Local	water/chemical	54,000	25	37	100	4	400	0.5	0	5.55	0.56	2221.51	222.15
	Resource	water	54,000	25	37	100	1	100	0.5	0	5.55	0.56	555.38	55.54
Light duty gasoline truck	Local	water/chemical	3,000	35	37	30	4	120	0.5	0	1.51	0.15	181.51	18.15
	Resource	water	3,000	35	37	30	1	30	0.5	0	1.51	0.15	45.38	4.54
									Total Unpaved Road Traffic Emissions (lb/well pad)				4,338.85	433.89

[1] Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Completion Vehicle Exhaust

CRVFO Alternative: All
Phase: Construction
Activity: Well Completion and Testing
Emissions: Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/well pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well pad)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[11]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Casing hauler	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	3	5	15	0.35	0.47	0.00	0.06	0.02	56.22	0.00	0.00	0.00	0.00	0.00	0.00
Completion rig	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1	5	5	0.12	0.16	0.00	0.02	0.01	18.74	0.00	0.00	0.00	0.00	0.00	0.00
Logging truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	5	10	0.23	0.31	0.00	0.04	0.01	37.48	0.00	0.00	0.00	0.00	0.00	0.00
Cement truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	5	10	0.23	0.31	0.00	0.04	0.01	37.48	0.00	0.00	0.00	0.00	0.00	0.00
Sand truck	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	20	5	100	2.35	3.12	0.00	0.40	0.12	374.78	0.02	0.01	0.00	0.00	0.00	0.00
Frac pumper	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	10	5	50	1.17	1.56	0.00	0.20	0.06	187.39	0.01	0.00	0.00	0.00	0.00	0.00
Fracmaster delivery	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	5	10	0.23	0.31	0.00	0.04	0.01	37.48	0.00	0.00	0.00	0.00	0.00	0.00
Water truck (100 bbl)	10.641	14.16	0.0150	1.824	0.5286	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	100	5	500	11.73	15.61	0.02	2.01	0.58	1873.90	0.09	0.04	0.01	0.01	0.00	0.00
Light duty diesel truck[9]	2.429	1.395	0.00597	1.262	0.2256	230	0.019	0.0459	0.0487	0.02524	0.00371	0.0026	18	5	90	0.48	0.28	0.00	0.25	0.04	45.63	0.00	0.01	0.01	0.01	0.00	0.00
Light duty gasoline truck[10]	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.0492	0.0334	0.0594	0.00371	0.0026	12	5	60	5.22	0.27	0.00	0.29	0.00	43.65	0.02	0.01	0.00	0.01	0.00	0.00
													Total Heavy Equipment Exhaust Emissions (lb/well pad)			22.12	22.39	0.03	3.36	0.86	2712.74	0.14	0.08	0.03	0.03	0.01	0.00

[1] Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

[5] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

[6] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

[9] Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[10] Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[11] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Completion Venting and Flaring

CRVFO Alternative: Alternative A
Phase: Construction
Activity: Completion/Testing Flaring
Emissions: Gas Flaring without High Pressure Flowback Separator Units
Date: 5/18/2010

Specifications:

Total Volume of Gas Emitted[1]	1.00	MMscf
Total Volume of Gas Vented[1]	0.50	MMscf
Total Volume of Flared Gas[1]	0.50	MMscf
Average Heat Content	1,050	BTU/scf
Total Hours in which Gas is Vented or Flared[1]	24	hrs

For Alternative A, 50% of well completions will use venting and 50% will use flaring. For simplicity, single-well emissions are shown with both venting and flaring.

Alternatives B, C, and D will use green completion techniques for 98% of all wells. Green completion has negligible emissions. Other 2% wells emissions reflect same venting / flaring ratio as Alternative A.

	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (lb/well)	Total Emissions (ton/well)	Duration (hours)	Hourly Emissions (lb/hr/well)
Venting - Natural Gas[2]	0.50	MMscf	VOC	3,346.05	lb/MMscf	Extended Natural Gas Analysis[1]	1673.0	0.84	24	69.71
			CO_2	2,528.70	lb/MMscf	Extended Natural Gas Analysis[1]	1264.4	0.63	24	52.68
			CH_4	32,450.74	lb/MMscf	Extended Natural Gas Analysis[1]	16225.4	8.11	24	676.06
			N_2O	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.0	0.00	24	0.00
			HAP (total)	447.00	lb/MMscf	Extended Natural Gas Analysis[1]	223.5	0.11	24	9.31
			Benzene	47.96	lb/MMscf	Extended Natural Gas Analysis[1]	24.0	0.01	24	1.00
			Toluene	39.80	lb/MMscf	Extended Natural Gas Analysis[1]	19.9	0.01	24	0.83
			Ethylbenzene	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.0	0.00	24	0.00
			Xylenes	26.55	lb/MMscf	Extended Natural Gas Analysis[1]	13.3	0.01	24	0.55
			Hexane	332.68	lb/MMscf	Extended Natural Gas Analysis[1]	166.3	0.08	24	6.93
Flaring - Natural Gas	0.50	MMscf	NOx	100.00	lb/MMscf	AP-42 Section 1.4	50.0	0.03	24	2.08
			CO	84.00	lb/MMscf	AP-42 Section 1.4	42.0	0.02	24	1.75
			PM10	7.60	lb/MMscf	AP-42 Section 1.4	3.8	0.00	24	0.16
			VOC	5.50	lb/MMscf	AP-42 Section 1.4	2.8	0.00	24	0.11
			CO_2	120,000.00	lb/MMscf	AP-42 Section 1.4	60000.0	30.00	24	2500.00
			CH_4	2.30	lb/MMscf	AP-42 Section 1.4	1.2	0.00	24	0.05
			N_2O	2.20	lb/MMscf	AP-42 Section 1.4	1.1	0.00	24	0.05
			HAP (total)	22.35	lb/MMscf	Assume 95% Reduction[3]	11.2	0.01	24	0.47
			Benzene	2.40	lb/MMscf	Assume 95% Reduction[3]	1.2	0.00	24	0.05
			Toluene	1.99	lb/MMscf	Assume 95% Reduction[3]	1.0	0.00	24	0.04
			Ethylbenzene	0.00	lb/MMscf	Assume 95% Reduction[3]	0.0	0.00	24	0.00
			Xylenes	1.33	lb/MMscf	Assume 95% Reduction[3]	0.7	0.00	24	0.03
			Hexane	16.63	lb/MMscf	Assume 95% Reduction[3]	8.3	0.00	24	0.35
Evaporation from condensate/water to waste pit (for wells not using green completion)	8	bbl	VOC	10.00	lb VOC/bbl	Tests conducted by Williams E&P for CDPHE	80.0	0.04000	24	3.33

[1] Based on data collected from oil and gas operators in the Piceance Basin (July 2009).
[2] Based on extended gas analysis for typical Piceance Basin gas (see gas analysis worksheet).
[3] For VOC and HAP emission factors that used the constituent analysis, a 95% destruction rate was assumed.

Workover Rig Emissions - Tier 4b

CRVFO Alternative: All
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Workover Rig Engines - EPA Tier 4b (2015)
Date: 5/18/2010

Percentage of Producing Wells **1.00%** Only 1% of producing wells are expected to be worked over in any single year.

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions Allocated Across All Producing Wells	Emissions Allocated Across All Producing Wells
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	475	0.40	2	24	0.5228	0.0109
NO_x	0.3000	475	0.40	2	24	0.0603	0.0013
SO_2[4]	0.0278	475	0.40	2	24	0.0056	0.0001
VOC	0.1400	475	0.40	2	24	0.0281	0.0006
PM_{10}[5]	0.01500	475	0.40	2	24	0.0030	0.0001
	(lb/hp-hr)						
CO_2[6]	1.15000	475	0.40	2	24	104.8800	2.1850
CH_4[7]	5.53E-05	475	0.40	2	24	0.0050	0.0001
N_2O[8]	1.24E-05	475	0.40	2	24	0.0011	0.0000
Formaldehyde[9]	8.26E-06	475	0.40	2	24	0.0008	0.0000
Benzene[9]	6.53E-06	475	0.40	2	24	0.0006	0.0000
Toluene[9]	2.86E-06	475	0.40	2	24	0.0003	0.0000
Xylene[9]	2.00E-06	475	0.40	2	24	0.0002	0.0000

[1] Emission factors for Tier 4 (2014) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for engines less than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 3, "Tier 4 Emission Standards—Engines Up To 560 kW, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

[2] Drilling engine total horsepower is based on one 475 hp engine, fueled with ultra low sulfur diesel fuel (15 ppm).

[3] The overall load factor is 0.4.

[4] 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjusting for ultra-low sulfur fuel.

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

[6] 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"; lb/hp-hr = pounds per horsepower-hour.

[7] Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

[8] Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

[9] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

Recompletion Venting and Flaring

CRVFO Alternative: All
Phase: Production
Activity: Recompletion, Flaring
Emissions: Recompletion without High Pressure Flowback Separator Units
Date: 5/18/2010

Specifications:

Total Volume of Gas Emitted per recompleted well[1]	0.10	MMscf
Total Volume of Gas Vented	0.05	MMscf
Total Volume of Flared Gas	0.05	MMscf
Average Heat Content	1,050	BTU/scf

During recompletion, 50% of well recompletions will use venting and 50% will use flaring. For simplicity, single-well emissions are shown with both venting and flaring.

Percentage of Operating Wells Recompleted in Year	**1.00%**	
Total Hours in which Gas is Vented or Flared[1]	24	hrs

Only 1% of operating wells are expected to be recompleted in any single year.

	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (lb/well/yr)[4]	Total Emissions (ton/well)[4]	Duration (hours)	Hourly Emissions (lb/hr/well)[4]
Venting - Natural Gas [2]	0.05	MMscf	VOC	3,346.05	lb/MMscf	Extended Natural Gas Analysis[1]	1.673	0.001	24	1.673
			CO_2	2,528.70	lb/MMscf	Extended Natural Gas Analysis[1]	1.264	0.001	24	1.264
			CH_4	32,450.74	lb/MMscf	Extended Natural Gas Analysis[1]	16.225	0.008	24	16.225
			N_2O	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.000	0.000	24	0.000
			HAP (total)	447.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.223	0.000	24	0.223
			Benzene	47.96	lb/MMscf	Extended Natural Gas Analysis[1]	0.024	0.000	24	0.024
			Toluene	39.80	lb/MMscf	Extended Natural Gas Analysis[1]	0.020	0.000	24	0.020
			Ethylbenzei	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.000	0.000	24	0.000
			Xylenes	26.55	lb/MMscf	Extended Natural Gas Analysis[1]	0.013	0.000	24	0.013
			Hexane	332.68	lb/MMscf	Extended Natural Gas Analysis[1]	0.166	0.000	24	0.166
Flaring - Natural Gas	0.05	MMscf	NOx	100.00	lb/MMscf	AP-42 Section 1.4	0.050	0.000	24	0.002
			CO	84.00	lb/MMscf	AP-42 Section 1.4	0.042	0.000	24	0.002
			PM10	7.60	lb/MMscf	AP-42 Section 1.4	0.004	0.000	24	0.000
			VOC	5.50	lb/MMscf	AP-42 Section 1.4	0.003	0.000	24	0.000
			CO_2	120,000.00	lb/MMscf	AP-42 Section 1.4	60.000	0.030	24	2.500
			CH_4	2.30	lb/MMscf	AP-42 Section 1.4	0.001	0.000	24	0.000
			N_2O	2.20	lb/MMscf	AP-42 Section 1.4	0.001	0.000	44	0.000
			HAP (total)	22.35	lb/MMscf	Assume 95% Reduction[3]	0.011	0.000	24	0.000
			Benzene	2.40	lb/MMscf	Assume 95% Reduction[3]	0.001	0.000	24	0.000
			Toluene	1.99	lb/MMscf	Assume 95% Reduction[3]	0.001	0.000	24	0.000
			Ethylbenzei	0.00	lb/MMscf	Assume 95% Reduction[3]	0.000	0.000	24	0.000
			Xylenes	1.33	lb/MMscf	Assume 95% Reduction[3]	0.001	0.000	24	0.000
			Hexane	16.63	lb/MMscf	Assume 95% Reduction[3]	0.008	0.000	24	0.000
Evaporation from condensate/water to waste pit	3	bbl	VOC	0.07	lb VOC/bbl	Tests conducted by Williams E&P for CDPHE	0.002	0.00000	24	0.0001

[1] Based on data collected from oil and gas operators in the Piceance Basin (July 2009).
[2] Based on extended gas analysis for typical Piceance Basin gas (see gas analysis worksheet).
[3] For VOC and HAP emission factors that used the constituent analysis, a 95% destruction rate was assumed.
[4] Per-well totals provide emissions for each operating well based on allocation of emissions from the 1 percent of wells that are recompleted.

Truck Loading Fugitves

CRVFO Alternative: All
Phase: Production
Activity: Truck Loading Fugitives
Emissions: Truck Loading Fugitives Emissions
Date: 5/18/2010

	Input Values for Calculations									
	# of barrels of condensate produced per natural gas volume (bbl/MMscf)[1]	Average gas production per well (MMscfd/ well)	Days per year (days/yr)	Gallons/barrel (gal/bbl)	Percentage of well pad condensate transported by truck out of field (%)	S : Saturation factor shown in AP-42 -- submerged loading: dedicated normal service	V : True vapor pressure of liquid loaded (psia)	M : Molecular weight of the vapor (lb/lb-mole) [1]	T : Temperature of the bulk liquid (Rankine)	Control efficency (%, vapor balancing)
General Information	**3**	**0.1000**	**365**	**42**	**100**	**0.6**	**6**	**33.48**	**518.67**	**98**

Condensate Tank Vapor Composition (wt%) [2]									
VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
51.725	6.755	22.645	0.000	9.161	0.856	1.375	0.015	0.411	6.505

	Pollutant Emissions lb/well/yr										
Equipment	Total Mass [5]	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Truck Loading Condensate	0.27	0.14	0.02	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.02

	Pollutant Emissions (lb/well/hr)										
Equipment	Total Mass	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Truck Loading Condensate	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	**0.00003**	**0.00002**	**0.00000**	**0.00001**	**0.00000**	**0.00000**	**0.00000**	**0.00000**	**0.00000**	**0.00000**	**0.00000**

[1] Based on data collected from oil and gas operators in the Piceance Basin (August, 2009) -- Extended Natural Gas and Light Liquid (LL) Analysis.
[2] Based on E&P Tanks run using a separator operating at 85F and 23 psig.
[5] Determined using EPA -- AP-42. Section 5.2, equation 1, (L = 12.46 * S * V * M / T), where L = lb emissions/1,000 gal loaded.

Well Blowdowns

CRVFO Alternative: All
Phase: Production
Activity: Well blowdowns
Emissions: Gas Flaring without High Pressure Flowback Separator Units
Date: 5/18/2010

Specifications:

Average Number of blowdowns per well per year	3.0	
Average volume of gas emitted per well blowdown[1]	0.00075	MMscf
Total Volume of Gas Vented (100 percent)	0.00225	MMscf
Total Volume of Flared Gas (0 percent)	0.00	MMscf
Actual Hours Gas is Vented	4	hrs

	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (lb/well/yr)	Total Emissions (ton/well)	Duration (hours)	Hourly Emissions (lb/hr/well)
Venting - Natural Gas[2]	0.00225	MMscf	VOC	3,346.05	lb/MMscf	Extended Natural Gas Analysis[1]	7.53	0.00	4	1.88
			CO_2	2,528.70	lb/MMscf	Extended Natural Gas Analysis[1]	5.69	0.00	4	1.42
			CH_4	32,450.74	lb/MMscf	Extended Natural Gas Analysis[1]	73.01	0.04	4	18.25
			N_2O	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.00	0.00	4	0.00
			HAP (total)	447.00	lb/MMscf	Extended Natural Gas Analysis[1]	1.01	0.00	4	0.25
			Benzene	47.96	lb/MMscf	Extended Natural Gas Analysis[1]	0.11	0.00	4	0.03
			Toluene	39.80	lb/MMscf	Extended Natural Gas Analysis[1]	0.09	0.00	4	0.02
			Ethylbenzene	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.00	0.00	4	0.00
			Xylenes	26.55	lb/MMscf	Extended Natural Gas Analysis[1]	0.06	0.00	4	0.01
			Hexane	332.68	lb/MMscf	Extended Natural Gas Analysis[1]	0.75	0.00	4	0.19
Flaring - Natural Gas	0.00000	MMscf	NOx	100.00	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			CO	84.00	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			PM10	7.60	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			VOC	5.50	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			CO_2	120,000.00	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			CH_4	2.30	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			N_2O[6]	2.20	lb/MMscf	AP-42 Section 1.4	0.00	0.00	4	0.00
			HAP (total)	8.94	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00
			Benzene	0.96	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00
			Toluene	0.80	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00
			Ethylbenzene	0.00	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00
			Xylenes	0.53	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00
			Hexane	6.65	lb/MMscf	Assume 98% Reduction[3]	0.00	0.00	4	0.00

[1] Based on data collected from oil and gas operators in the GSFO (August, 2009).
[2] Based on extended gas analysis for typical GSFO gas (see gas analysis worksheet).

Equipment Leaks

CRVFO Alternative: All
Phase: Production
Activity: Area Source Fugitives
Emissions: Area Source Fugitives Emissions
Date: 5/18/2010

	Input Values for Calculations							
	Valves		Pump Seals	Compressor Seals	Relief Valves	Connectors	Open-Ended Lines	Connections
Equipment Type	# of valves in gas service per well	# of valves in LL service per well	# of pump seals in LL service per well	# of compressor seals in gas service per well	# of relief valves in gas service per well	# of connectors per well	# of open-ended lines per well	# of sampling connections per well
Count at compressor stations [1]	81	15	2	6	8	115	10	6
Count at consolidated facilities [1]	0	6	0	0	0	50	0	2
Count at well pads [1]	80	3	2	0	15	160	0	10
Counts per well for all compressor stations	**0.0589**	**0.0109**	**0.0015**	**0.0044**	**0.0058**	**0.0836**	**0.0073**	**0.0044**
Counts per well at consolidated facilities	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**
Counts per well at well pads	**10.0000**	**0.3750**	**0.2500**	**0.0000**	**1.8750**	**20.0000**	**0.0000**	**1.2500**

			Pollutant Emission Factor[1] (lb/hr/source)									
Equipment Type	Oil and Gas Emission Factor (kg TOC/hr/ source) [2]	Oil and Gas Emission Factor (lb TOC/hr/ source)	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Gas Service Valves	0.00450	0.0099	7.82E-04	5.91E-04	7.58E-03	0.00E+00	1.04E-04	1.12E-05	9.30E-06	0.00E+00	6.20E-06	7.77E-05
Light Liquid Valves	0.00250	0.0055	4.49E-03	9.26E-06	3.19E-05	0.00E+00	1.48E-03	7.82E-05	4.32E-04	1.37E-05	4.36E-04	5.16E-04
Light Liquid Pump Seals	0.01300	0.0287	2.34E-02	4.81E-05	1.66E-04	0.00E+00	7.68E-03	4.06E-04	2.25E-03	7.14E-05	2.27E-03	2.68E-03
Gas Service Compressor Seals	0.00880	0.0194	1.53E-03	1.16E-03	1.48E-02	0.00E+00	2.04E-04	2.19E-05	1.82E-05	0.00E+00	1.21E-05	1.52E-04
Gas Service Relief Valves	0.00880	0.0194	1.53E-03	1.16E-03	1.48E-02	0.00E+00	2.04E-04	2.19E-05	1.82E-05	0.00E+00	1.21E-05	1.52E-04
Connectors	0.00020	0.0004	3.47E-05	2.63E-05	3.37E-04	0.00E+00	4.64E-06	4.98E-07	4.13E-07	0.00E+00	2.76E-07	3.45E-06
Open-Ended Lines	0.00200	0.0044	3.47E-04	2.63E-04	3.37E-03	0.00E+00	4.64E-05	4.98E-06	4.13E-06	0.00E+00	2.76E-06	3.45E-05
Sampling Connections	0.00880	0.0194	1.53E-03	1.16E-03	1.48E-02	0.00E+00	2.04E-04	2.19E-05	1.82E-05	0.00E+00	1.21E-05	1.52E-04

	Pollutant Emissions (lb/well/hr)									
Equipment Type	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Gas Service Valves	7.82E-03	5.91E-03	7.58E-02	0.00E+00	1.04E-03	1.12E-04	9.30E-05	0.00E+00	6.20E-05	7.77E-04
Light Liquid Valves	1.68E-03	3.47E-06	1.20E-05	0.00E+00	5.54E-04	2.93E-05	1.62E-04	5.15E-06	1.64E-04	1.94E-04
Light Liquid Pump Seals	5.84E-03	1.20E-05	4.15E-05	0.00E+00	1.92E-03	1.02E-04	5.62E-04	1.78E-05	5.67E-04	6.71E-04
Gas Service Compressor Seals	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gas Service Relief Valves	2.87E-03	2.17E-03	2.78E-02	0.00E+00	3.83E-04	4.11E-05	3.41E-05	0.00E+00	2.27E-05	2.85E-04
Gas Service Connectors	6.95E-04	5.25E-04	6.74E-03	0.00E+00	9.28E-05	9.96E-06	8.27E-06	0.00E+00	5.51E-06	6.91E-05
Gas Service Open-Ended Lines	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Gas Service Sampling Connections	1.91E-03	1.44E-03	1.85E-02	0.00E+00	2.55E-04	2.74E-05	2.27E-05	0.00E+00	1.52E-05	1.90E-04
Consolidated Facilties and Well Pads Total	**2.08E-02**	**1.01E-02**	**1.29E-01**	**0.00E+00**	**4.25E-03**	**3.21E-04**	**8.82E-04**	**2.30E-05**	**8.36E-04**	**2.19E-03**
Compressor Stations Total	**1.57E-04**	**5.59E-05**	**7.15E-04**	**0.00E+00**	**3.71E-05**	**2.50E-06**	**8.85E-06**	**2.53E-07**	**8.64E-06**	**1.69E-05**
All Sources Totals (lbs/well/yr)	**1.84E+02**	**8.86E+01**	**1.14E+03**	**0.00E+00**	**3.75E+01**	**2.84E+00**	**7.80E+00**	**2.04E-01**	**7.40E+00**	**1.93E+01**

[1] Based on data collected from oil and gas operators in the GSFO (August, 2009) -- Extended Natural Gas and Light Liquid (LL) Analysis.
[2] "EPA Protocol for Equipment Leak Emission Estimates" -- Table 2-4. Oil and Gas Production Operations Average Emission Factors.

Pneumatic Pumps

CRVFO Alternative: All
Phase: Production
Activity: Production Phase Pneumatic Pumps
Emissions: Pneumative Pumps Emissions
Date: 5/18/2010

Pneumatic Pumps Input Values for Calculations	
Pneumatic Pumps	Gas Quantity (MMscf/yr) [1]
Amount of gas vented per pump per year at gas plants	**0**
Amount of gas vented per pump per year at compressor stations	**0**
Amount of gas vented per pump per year at consolidated facilities	**0**
Amount of gas vented per pump per year per well	**0.000017**

	Pollutant Emission Factor[1] (lb/MMscf)									
Pneumatic Pumps	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Pneumatic pumps at gas plants	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68
Pneumatic pumps at compressor stations	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68
Pneumatic pumps at consolidated facilities	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68
Pneumatic pumps at well pads	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68

	Pollutant Emissions (lb/well/yr)									
Pneumatic Pumps	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Pneumatic pumps at gas plants	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pneumatic pumps at compressor stations	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pneumatic pumps at consolidated facilities	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pneumatic pumps at well pads	5.69E-02	4.30E-02	5.52E-01	0.00E+00	7.60E-03	8.15E-04	6.77E-04	0.00E+00	4.51E-04	5.66E-03
Total	**0.06**	**0.04**	**0.55**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**

[1] Based on data collected from oil and gas operators in the GSFO (August, 2009) -- Extended Natural Gas Analysis.

Pneumatic Devices (Includes liquid level controllers, pressure regulators, and valve controllers.)

CRVFO Alternative: All
Phase: Production
Activity: Production Well Pneumatic Devices
Emissions: Pneumative Device Emissions
Date: 5/18/2010

Pneumatic Devices Input Values for Calculations

	Liquid Level controllers				Pressure Regulators				Valve Controllers			
Pneumatic Devices	Low bleed (# of devices per well)	Low bleed rate (MMscf/hr/device)	No bleed (# of devices per well)	Control Percent for Low Bleed	Low bleed (# of devices per well)	Low bleed rate (MMscf/hr/device)	No bleed (# of devices per well)	Control Percent for Low Bleed	Low bleed (# of devices per well)	Low bleed rate (MMscf/hr/device)	No bleed (# of devices per well)	Control Percent for Low Bleed
Pneumatic devices at well pad (per well)[1]	2	0.000006	0	0	1	0.000006	0	0	2	0.000006	0	0
Pneumatic devices at consolidated field facilities[1]	0	0	0	0	0	0	0	0	0	0	0	0
Pneumatic devices at compressor stations[1]	0	0	0	0	0	0	0	0	0	0	0	0

	Pollutant Emission Factor[2] (lb/MMscf)									
Pneumatic Devices	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Pneumatic devices at well pad	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68
Pneumatic devices at consolidated field facilities	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68
Pneumatic devices at compressor stations	3,346.05	2,528.70	32,450.74	0.00	447.00	47.96	39.80	0.00	26.55	332.68

	Pollutant Emissions (lb/well/hr)									
Pneumatic Devices	VOC	CO_2	CH_4	N_2O	HAP (total)	Benzene	Toluene	Ethylbenzene	Xylenes	Hexane
Pneumatic devices at well pad	0.10	0.08	0.97	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Pneumatic devices at consolidated field facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pneumatic devices at compressor stations	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.10**	**0.08**	**0.97**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**

[1] Survey data (August, 2009) from oil and gas operators provide the number of devices. Instrument air will be used for devices at consolidated facilities and compressor stations.
[2] Based on data collected from oil and gas operators in the GSFO (August, 2009) -- Extended Natural Gas Analysis.

Condensate Analysis

CRVFO Alternative: All
Phase: Production
Activity: Analysis
Date: 5/18/2010

Component	Molecular Weight (lb/lb-mol)	Weight Percent (wt%)	Carbon Content for TOC (lb C/lb)	Contribution to TOC Carbon Content (lb C/lb TOC)
Methane	16.040	0.579	0.749	0.434
Ethane	30.070	0.458	0.799	0.366
Nitrogen	28.020	0.007	---	---
Carbon Dioxide	43.990	0.168	---	---
Nitrous Oxide	44.020	0.000	---	---
Hydrogen Sulfide	34.060	0.000	---	---
Non-reactive, non-HAP	---	1.212	---	
Propane	44.100	0.771	0.817	0.630
Iso-butane	58.120	0.688	0.827	0.569
n-butane	58.120	0.906	0.827	0.749
i-pentane	72.150	1.515	0.832	1.261
n-pentane	72.150	1.502	0.499	0.750
Hexanes	100.210	9.368	0.719	6.736
Heptanes	100.200	19.328	0.839	16.217
Octanes	114.230	17.614	0.841	14.815
Nonanes	128.258	13.309	0.843	11.216
Decanes+	142.29	16.491	0.844	13.919
Reactive VOC	---	81.492		66.862
Benzene	78.110	1.418	0.923	1.308
Ethylbenzene	106.160	0.249	0.905	0.225
n-Hexane	---	*9.368*	---	---
Toluene	92.130	7.837	0.913	7.151
Xylenes	106.160	7.912	0.905	7.161
HAPs	---	26.784		15.846
Totals	**---**	**100.120**		**83.507** [3]

[1] Extended condensate analysis of typical Piceance Basin condensate.
[2] n-Hexane is a VOC and a HAP. To be conservative, all non-speciated hexanes are assumed to be HAPs.
[3] The carbon contribution to hydrocarbons in the liquid mixture is used to calculate CO2 emissions from the model gas plant thermal oxidizer and flare.

Wind Erosion at Producing Well Pads

CRVFO Alternative: All
Phase: Production
Activity: Wind Erosion
Emissions: Fugitive Particulate Emissions from Wind Blown Dust at Well Pads
Date: 5/18/2010

Well Pad and Resource Road Area [1]	Silt Content[2]	Days with Wind Speed Greater Than 5.4 m/s [3]	Total Suspended Particulate[4]	Time Before Interim Reclamation Complete [5]	Total Suspended Particulate	Emission Control Efficiency[6]	PM_{10} Emissions (uncontrolled)[7]	$PM_{2.5}$ Emissions (uncontrolled)[8]	Wells per Well Pad	PM_{10} Emissions (uncontrolled)[3]	$PM_{2.5}$ Emissions (uncontrolled)[4]
(acre)	(%)	(%)	(lb/acre/month)	(months)	(lb/well pad)	(%)	(lb/well pad)	(lb/well pad)		(lb/well)	(lb/well)
6.6	37	27.4	118.972	24.0	18,702.35	0	4,675.59	467.56	8	584.45	58.44

[1] Total disturbance area per well pad is estimated to be 2.5 acres for the well pad, 0.25 acre for a portion of compressor station and central treating facility (CTF), 2.8 acres for resource road and portion of local road area, and 1 acres for a portion of pipeline disturbance.

[2] Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).

[3] "Control of Fugitive Dust Sources" EPA-450/3-98-008 (EPA 1998). TSP (lb/acre/month) = 1.7 × (s/1.5) × ([365-p]/235) × (f/15), where:
p = number of days with > 0.001 in precipitation (not used)
f = percent of time wind speed exceeds 5.4 (m/s) [equivalent to 12 mph] = 27.4% based on WRCC Ernie Gulch RAWS stations August 1, 1984 through March 1, 2008.

[4] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document.

[5] Interim reclamation is expected to be complete within two years. Emissions for two years are calculated and attributed to each constructed well pad for one year, since emissions from pads constructed during the previous year would be occurring simultaneously.

[6] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.

[7] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that PM10 accounts for 25% of TSP. Daily and hourly emissions based on 30.4-day month.

[8] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on "Analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).

Natural Gas Extended Gas Analysis

CRVFO Alternative: All
Phase: Both
Activity: Gas Analysis
Date: 5/18/2010

Gas Component	Volumetric Concentration[1] (vol%)	Molecular Weight (lb/lb-mol)	Gas Weight (lb/lb-mol)	Weight Percent (wt%)	Weight[2] (lb/MMscf)	Carbon Content for TOC (lb C/lb)	Contribution to TOC Carbon Content (lb C/lb TOC)
Methane	88.972	16.040	14.271	76.427	32,450.7	0.749	57.225
Ethane	5.792	30.070	1.742	9.327	3,960.3	0.799	7.451
Nitrogen	0.094	28.020	0.026	0.141	59.9	---	---
Carbon Dioxide	2.528	43.990	1.112	5.955	2,528.7	---	---
Nitrous Oxide	0.000	44.020	0.000	0.000	0.0	---	---
Hydrogen Sulfide	0.000	34.060	0.000	0.000	0.0	---	---
Non-reactive, non-HAP	97.386	---	17.151	91.850	38,999.6	---	64.675
Propane	1.365	44.100	0.602	3.224	1,368.8	0.817	2.634
Iso-butane	0.370	58.120	0.215	1.152	489.0	0.827	0.952
n-butane	0.261	58.120	0.152	0.812	344.9	0.827	0.671
i-pentane	0.155	72.150	0.112	0.599	254.3	0.832	0.498
n-pentane	0.102	72.150	0.074	0.394	167.3	0.499	0.197
Hexanes	0.146	100.210	0.146	0.784	332.7	0.719	0.563
Heptanes	0.093	100.200	0.093	0.499	211.9	0.839	0.419
Octanes	0.044	114.230	0.050	0.269	114.3	0.841	0.226
Nonanes	0.016	128.258	0.021	0.110	46.7	0.843	0.093
Decanes+	0.005	142.29	0.007	0.038	16.2	0.844	0.032
Reactive VOC	2.557	---	1.472	7.880	3,346.0		6.286
Benzene	0.027	78.110	0.021	0.113	48.0	0.923	0.104
Ethylbenzene	0.000	106.160	0.000	0.000	0.0	0.905	0.000
n-Hexane [3]	*0.146*	*100.210*	*0.146*	*0.784*	*332.7*	---	---
Toluene	0.019	92.130	0.018	0.094	39.8	0.913	0.086
Xylenes	0.011	106.160	0.012	0.063	26.6	0.905	0.057
HAPs	0.203	---	0.197	1.053	447.0		0.246
Totals	**100.000**	**---**	**18.673**	**100.000**	**42,460.0**	**---**	71.207 [4]

[1] Extended gas analysis of typical GSFO natural gas, provided by oil and gas operators (August, 2009).
[2] Gas density is 0.04246 lb/scf (19.26 g/scf).
[3] n-Hexane is a VOC and a HAP. To be conservative, all non-speciated hexanes are assumed to be HAPs.
[4] The carbon contribution to hydrocarbons in the gas mixture is used to calculate CO_2 emissions from the model gas plant thermal oxidizer and flare.

Vehicle Road Dust Associated With Producing Well Pads

CRVFO Alternative: All
Phase: Production
Activity: Production Traffic
Emissions: Fugitive Particulate From Production Traffic on Unpaved Roads
Date: 5/18/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[1] (%)	Round Trips (RTs) (RT/pad)	RT Distance[8] (miles)	Vehicle Miles Traveled (VMT) (VMT/pad)	Ratio of Months with Frozen or Muddy Roads (unitless)	Emission Control Efficiency[3] (%)	PM_{10} Emission Factor[4] (lb/VMT)	$PM_{2.5}$ Emission Factor[5] (lb/VMT)	PM_{10} Emissions[6] (uncontrolled) (lb/well pad)	$PM_{2.5}$ Emissions[5] (uncontrolled) (lb/well pad)
Alternative A (60% Facilities Consolidated)[7]														
Water truck (130 bbl)	Local	water/chemical	85,000	25	37	1123	4	4492	0.5	0	6.81	0.68	30597.78	3059.78
(process water)	Resource	water	85,000	25	37	1123	0.4	449.2	0.5	0	6.81	0.68	3059.78	305.98
Condensate tanker (200 bbl)	Local	water/chemical	75,000	25	37	7.3	4	29.2	0.5	0	6.44	0.64	188.01	18.80
	Resource	water	75,000	25	37	7.3	0.4	2.92	0.5	0	6.44	0.64	18.80	1.88
Light duty vehicles	Local	water/chemical	3,000	35	37	365	0.264	96.36	0.5	0	1.51	0.15	145.75	14.58
	Resource	water	3,000	35	37	52	1	52	0.5	0	1.51	0.15	78.65	7.87
									Total Unpaved Road Traffic Emissions (lb/well pad)				34,088.77	3,408.88
Alternative B and C (90% Facilities Consolidated)[7]														
Water truck (130 bbl)	Local	water/chemical	85,000	25	37	1123	4	4492	0.5	0	6.81	0.68	30597.78	3059.78
(process water)	Resource	water	85,000	25	37	1123	0.1	112.3	0.5	0	6.81	0.68	764.94	76.49
Condensate tanker (200 bbl)	Local	water/chemical	75,000	25	37	7.3	4	29.2	0.5	0	6.44	0.64	188.01	18.80
	Resource	water	75,000	25	37	7.3	0.1	0.73	0.5	0	6.44	0.64	4.70	0.47
Light duty vehicles	Local	water/chemical	3,000	35	37	365	0.264	96.36	0.5	0	1.51	0.15	145.75	14.58
	Resource	water	3,000	35	37	52	1	52	0.5	0	1.51	0.15	78.65	7.87
									Total Unpaved Road Traffic Emissions (lb/well pad)				31,779.83	3,177.98
Alternative D (80% Facilities Consolidated)[7]														
Water truck (130 bbl)	Local	water/chemical	85,000	25	37	1123	4	4492	0.5	0	6.81	0.68	30597.78	3059.78
(process water)	Resource	water	85,000	25	37	1123	0.2	224.6	0.5	0	6.81	0.68	1529.89	152.99
Condensate tanker (200 bbl)	Local	water/chemical	75,000	25	37	7.3	4	29.2	0.5	0	6.44	0.64	188.01	18.80
	Resource	water	75,000	25	37	7.3	0.2	1.46	0.5	0	6.44	0.64	9.40	0.94
Light duty vehicles	Local	water/chemical	3,000	35	37	365	0.264	96.36	0.5	0	1.51	0.15	145.75	14.58
	Resource	water	3,000	35	37	52	1	52	0.5	0	1.51	0.15	78.65	7.87
									Total Unpaved Road Traffic Emissions (lb/well pad)				32,549.48	3,254.95

1 Silt content was determined by soil testing of samples collected by GSFO personnel (April 2008).
2 Calculated as Round Trips per Vehicle Type x Round Trip Distance.
3 Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
4 AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
5 Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
6 Calculated as lb/VMT x VMT/pad x control efficiency.
7 Field wide operations consolidation percentages determined and provided by WRFO personnel (September 2009).
8 Original resource road distances scaled to reflect consolidation.

Vehicle Exhaust Associated With Producing Well Pads

CRVFO Alternative: All
Phase: Production
Activity: Production Vehicle Traffic Exhaust
Emissions: Vehicle Exhaust Emissions
Date: 5/18/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/pad)	RT Distance[13] (miles)	Vehicle Miles Traveled (VMT) (mi)	Pollutant Emissions (lb/well pad)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[11]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Alternative A (60% Facilities Consolidated)[12]																											
Water truck (130 bbl, process)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1123	4.4	4941.2	115.92	154.25	0.16	19.87	5.76	18518.61	0.88	0.42	0.12	0.09	0.04	0.03
Condensate tanker (200 bbl)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	7.3	4.4	32.12	0.75	1.00	0.00	0.13	0.04	120.38	0.01	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck[9]	2.429	1.395	0.00597	1.262	0.226	230	0.019	0.0459	0.0487	0.02524	0.00371	0.0026	219	0.774	169.506	0.91	0.52	---	0.47	0.08	85.95	0.01	0.02	0.02	0.01	0.00	0.00
Light duty gasoline truck[10]	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.0492	0.0334	0.0594	0.00371	0.0026	146	0.774	113.004	9.83	0.50	---	0.55	0.01	82.21	0.03	0.01	0.01	0.01	0.00	0.00
Total Heavy Equipment Exhaust Emissions (lb/well pad)																127.40	156.27	0.16	21.02	5.89	18807.15	0.92	0.45	0.14	0.12	0.04	0.03
Alternative B and C (90% Facilities Consolidated)[12]																											
Water truck (130 bbl, process)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1123	4.1	4604.3	108.01	143.73	0.15	18.51	5.37	17255.97	0.82	0.39	0.11	0.09	0.04	0.03
Condensate tanker (200 bbl)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	7.3	4.1	29.93	0.70	0.93	0.00	0.12	0.03	112.17	0.01	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck[9]	2.429	1.395	0.00597	1.262	0.226	230	0.019	0.0459	0.0487	0.02524	0.00371	0.0026	219	0.774	169.506	0.91	0.52	---	0.47	0.08	85.95	0.01	0.02	0.02	0.01	0.00	0.00
Light duty gasoline truck[10]	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.0492	0.0334	0.0594	0.00371	0.0026	146	0.774	113.004	9.83	0.50	---	0.55	0.01	82.21	0.03	0.01	0.01	0.01	0.00	0.00
Total Heavy Equipment Exhaust Emissions (lb/well pad)																119.45	145.69	0.15	19.66	5.49	17536.31	0.86	0.43	0.14	0.11	0.04	0.03
Alternative D (80% Facilities Consolidated)[12]																											
Water truck (130 bbl, process)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1123	4.2	4716.6	110.65	147.24	0.16	18.97	5.50	17676.85	0.84	0.40	0.11	0.09	0.04	0.03
Condensate tanker (200 bbl)	10.64	14.16	0.01504	1.824	0.529	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	7.3	4.2	30.66	0.72	0.96	0.00	0.12	0.04	114.91	0.01	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck[9]	2.429	1.395	0.00597	1.262	0.226	230	0.019	0.0459	0.0487	0.02524	0.00371	0.0026	219	0.774	169.506	0.91	0.52	---	0.47	0.08	85.95	0.01	0.02	0.02	0.01	0.00	0.00
Light duty gasoline truck[10]	39.45	2.011	0.00702	2.209	0.03	330	0.119	0.0492	0.0334	0.0594	0.00371	0.0026	146	0.774	113.004	9.83	0.50	---	0.55	0.01	82.21	0.03	0.01	0.01	0.01	0.00	0.00
Total Heavy Equipment Exhaust Emissions (lb/well pad)																122.10	149.22	0.16	20.11	5.62	17959.92	0.88	0.44	0.14	0.11	0.04	0.03

1 Emission factors reflect the Rio Blanco County, Colorado, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

5 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

6 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

9 Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

10 Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

11 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

12 Field wide operations consolidation percentages determined and provided by GSFO personnel (September 2009).

13 Sum of original local and resource road distances scaled to reflect consolidation.

Well Pad Heaters

CRVFO Alternative: All
Phase: Production
Activity: Well Pad Heating
Emissions: Combustion Emissions from Natural Gas Fired Heater
Date: 5/18/2010

Fuel Combustion Source:

Heater Fuel Input[1]	1.5	MMBtu/hr

Operating Parameters:

Operated	24	hr/day,	7	days/week
Operating hours	2,190	hr/yr		
Capacity (%)	100	(while operating)		
Seasonal Usage (%)	Winter	12.5	Spring	6.25
	Summer	0	Fall	6.25

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	3.13	MMscf/yr
Heat Content	1050	Btu/scf

Pollutant	Emission Factor[2] (lb/MMscf)	Emissions (lb/well pad per year)	Wells per Pad	Emissions per Well (lb/well)
CO	84.0	262.80	8	32.85
NOx	100.0	312.86	8	39.11
PM_{10}	7.6	23.78	8	2.97
$PM_{2.5}$	7.6	23.78	8	2.97
SO_2	---	---	8	---
VOC	5.5	17.21	8	2.15
CO_2	120,000.0	375428.57	8	46928.57
CH_4	2.3	7.20	8	0.90
N_2O[2]	2.2	6.88	8	0.86
Formaldehyde	0.0750	0.23	8	0.03
Benzene	0.0021	0.01	8	0.00
Ethylbenzene	---	---	8	---
Toluene	0.0034	0.01	8	0.00
Xylene	---	---	8	---

[1] Assumes four 0.25-MMBtu natural gas fired heaters per well pad.

[2] EPA AP-42, Volume I, Fifth Edition - August 2000, Tables 1.4-1, 1.4-2, and 1.4-3, Uncontrolled Emission Factors for Natural Gas Combustion.

Compressor Station Dehydration[1]

CRVFO Alternative:[2] **A (uncontrolled vent emissions)**
B, C, and D (controlled vent emissions)
Phase: **Production**
Activity: **Compressor Station Glycol Dehydrator**
Emissions: **Emissions From Ethylene Glycol Dehydrator**
Date: **5/18/2010**

Ethylene Glycol Dehydrator

Throughput at Example Facility	70.00	MMscfd
Percentage of Gas Needing Dehydration Before Gas Plant	100.00%	
Average Gas Production Per Well	0.100	MMscfd
Number of Wells Served	700.00	

Operating Parameters:

Operating Hours	8760	hr/yr
Vent Control Efficiency (%)	90	(Alternatives B, C, and D)
Wet Gas Temperature	85	° F
Wet Gas Pressure	900	psig
Wet Gas Water Content	Saturated	
Dry Gas Water Content	5	lb water/MMscf
Glycol Type	DEG	
Glycol Circulation Rate	15.0	gal/minute

Flash Tank and Condenser Parameters:

Flash Tank Temperature	140	° F
Flash Tank Pressure	70	psig
Condenser Temperature	90	° F
Condenser Pressure	10	psig

Reboiler Fuel Combustion:

Reboiler Fuel Input	1.00	MMBtu/hr
Volume of Natural Gas Combusted	8.34	MMscf/yr
Heat Content	1050	Btu/scf

Glycol Dehydrator Vent and Flash Gas Emissions	Uncontrolled Emissions[3] (ton/yr)	Uncontrolled Emissions[2] (lb/yr)	Controlled Emissions[2] (lb/yr)	Uncontrolled Emissions[2] (lb/well/yr)	Controlled Emissions[2] (lb/well/yr)
VOC	64.1267	128,253.40	12,825.34	183.22	18.32
Benzene	11.6838	23,367.60	2,336.76	33.38	3.34
Toluene	6.9168	13,833.60	1,383.36	19.76	1.98
Ethylbenzene	0.0000	0.00	0.00	0.00	0.00
Xylene	2.1314	4,262.80	426.28	6.09	0.61
Hexane	5.9587	11,917.40	1,191.74	17.02	1.70
CO_2	8.0485	16,097.02	1,609.70	23.00	2.30
CH_4	103.2862	206,572.40	20,657.24	295.10	29.51
N_2O	0.0000	0.00	0.00	0.00	0.00

Reboiler Emissions	Emission Factor[9] (lb/MMscf)	Uncontrolled Emissions (lb/yr)	Uncontrolled Emissions per Well (lb/well/yr)
CO	84.0	700.80	1.001
NOx	100.0	834.29	1.192
PM_{10}	7.6	63.41	0.091
$PM_{2.5}$	7.6	63.41	0.091
SO_2	---	---	---
VOC	5.5	45.89	0.066
CO_2	120,000.0	1,001,142.86	1,430.204
CH_4	2.3	19.19	0.027
N_2O	2.2	18.35	0.026
Formaldehyde	0.0750	0.63	0.001
Benzene	0.0021	0.02	0.000
Ethylbenzene	---	---	---
Toluene	0.0034	0.03	0.000
Xylene	---	---	---

[1] In-field glycol dehydration may occur at compressor stations, consolidated facilities, or well pads. To avoid double-counting, field glycol dehydration is assumed to occur at compressor stations. Gas dehydration at gas plants is included in the model gas plant calculations.

[2] Alternative A emissions include uncontrolled vent, flash gas, and reboiler emissions. Alternative B, C, and D emissions include controlled vent and flash gas emissions, with uncontrolled reboiler emissions.

[3] Emissions obtained from GRI GlyCalc 4.0 based on parameters provided by oil and gas operator. Emissions include combined regenerator vent and flash gas emissions.

Tanks [1]

ALternatives: A, B, C, and D
Activity: Tanks at Consolidated Facilities and Well Pads
Emissions: Emissions from Condensate and Produced Water Tanks
Date: 5/18/2010

Tanks per Well Pad	Capacity	
(2) Condensate Tanks	300	bbl each
(2) Produced Water Tanks	300	bbl each

Operating Parameters per Well[3]:

Operating hours	8760	hr/yr

Condensate Parameters per Well

Annual Condensate Throughput	100.00	bbl/well
Condensate Control Efficiency (%)	95	%

Produced Water Parameters per Well

Produced Water Production	400	bbl/day/pad
Number of Wells per Pad	8	
Daily Produced Water Production per Well	50	bbl/day/well
Annual Produced Water Throughput	18,250	bbl/well
Produced Water Control Efficiency (%)	95	%

Alternative A Consolidated Facilities -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	600.00	600.00
Benzene	0.048	2.88	2.88
Hexane	0.140	8.40	8.40

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	25.73	25.73
Benzene	2.110E-07	0.002	0.002
Hexane	1.010E-03	11.060	11.060

Alternative A Well Pads -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	400.00	400.00
Benzene	0.048	1.92	1.92
Hexane	0.140	5.60	5.60

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	17.16	17.16
Benzene	2.110E-07	0.002	0.002
Hexane	1.010E-03	7.373	7.373

Alternatives B and C Consolidated Facilities -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	900.00	45.00
Benzene	0.048	4.32	0.22
Hexane	0.140	12.60	0.63

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	38.60	1.93
Benzene	2.110E-07	0.003	0.000
Hexane	1.010E-03	16.589	0.829

Alternatives B and C Well Pads -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	100.00	5.00
Benzene	0.048	0.48	0.02
Hexane	0.140	1.40	0.07

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	4.29	0.21
Benzene	2.110E-07	0.000	0.000
Hexane	1.010E-03	1.843	0.092

Alternatives D Consolidated Facilities -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	800.00	40.00
Benzene	0.048	3.84	0.19
Hexane	0.140	11.20	0.56

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	34.31	1.72
Benzene	2.110E-07	0.003	0.000
Hexane	1.010E-03	14.746	0.737

Alternatives D Well Pads -- Emissions per Well[4]

	Condensate		
	Emission Factor [2]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	10.000	200.00	10.00
Benzene	0.048	0.96	0.05
Hexane	0.140	2.80	0.14

	Produced Water		
	Emission Factor [3]	Uncontrolled Emissions	Controlled Emissions
Pollutant	(lb/bbl)	(lb/well/yr)	(lb/well/yr)
VOC	2.350E-03	8.58	0.43
Benzene	2.110E-07	0.001	0.000
Hexane	1.010E-03	3.687	0.184

[1] Alternative A emissions are based on uncontrolled condensate and produced water tank emissions. Alternative B, C, and D emissions are based on controlled emissions from both types of tanks.
[2] Emission factors for condensate tanks are based on "Oil & Gas Condensate Tank Batteries Regulatory Definitions and Permitting Guidance," PS Memo 05-01, Section 4.1 for Garfield, Mesa, Rio Blanco, and Moffat counties.
[3] The VOC emission factor for produced water tanks was supplied by WRFO oil and gas operators, based on preliminary results from a study overseen by the Colorado Department of Public Health and the Environment.
[4] 80% of operations (liquid storage) occur at consolidated facilities and 20% at well pads.

Field Compressor Stations

Phase: Production
Activity: Field Gas Compression
Emissions: Natural Gas Fired Compressor Engine Emissions
Date: 5/18/2010

Operating Parameters:

Throughput Capacity at Compres	180	MMscfd		
Number of Wells Served	3,600	Assuming that HALF all of producing wells need compression		
Operating hours	8,760			
Capacity (%)	100			
Annual Load (%)	Winter	25	Spring	25
	Summer	25	Fall	25
Engine design (hp)	23,400			

Potential Fuel Combustion for the Year for Unit:

Example Plant Volume of Natural Gas Combusted	1347.62	MMscf
Assumes gas consumed at rate of	6903	Btu/hp-hr
Heat Content	1050	Btu/scf
Example Plant Heat Input	1,415,005	MMBtu/yr

Emission Data:

				Compressor Station Total			Emissions Per Well	
Pollutant	2007 Emission Factor[2]	2010 Emission Factor[2]	Reference	2007 Emissions	2010 Emissions	Number of Wells Served[3]	2007 Emissions	2010 Emissions
	(g/hp-hr)	(g/hp-hr)		(lb)	(lb)		(lb/well)	(lb/well)
CO	4.0	2.0	CDPHE Reg 7 Standard	1,807,619	903,810	3600	502.12	251.06
NOx	2.0	1.0	CDPHE Reg 7 Standard	903,810	451,905	3600	251.06	125.53
PM_{10}	---	---	---	---	---	3600	---	---
$PM_{2.5}$	---	---	---	---	---	3600	---	---
SO_2	---	---	---	---	---	3600	---	---
VOC	1.0	0.7	CDPHE Reg 7 Standard	451,905	316,333	3600	125.53	87.87
	(lb/MMBtu)	(lb/MMBtu)						
CO_2	110.000	110.000	AP-42[2]	155,650,501	155,650,501	3600	43,236.25	43,236.25
CH_4	1.250	1.250	AP-42[2]	1,768,756	1,768,756	3600	491.32	491.32
N_2O[4]	0.001	0.001	IPCC[4]	1,306	1,306	3600	0.36	0.36
Formaldehyde	0.052800	0.052800	AP-42[2]	74,712	74,712	3600	20.75	20.75
Benzene	0.000440	0.000440	AP-42[2]	623	623	3600	0.17	0.17
Ethylbenzene	0.000040	0.000040	AP-42[2]	56	56	3600	0.02	0.02
Toluene	0.000408	0.000408	AP-42[2]	577	577	3600	0.16	0.16
Xylene	0.000184	0.000184	AP-42[2]	260	260	3600	0.07	0.07
n-Hexane	0.001110	0.001110	AP-42[2]	1,571	1,571	3600	0.44	0.44

[1] Based on the Williams Webster Hill Compressor Station. Five natural gas-fired 3,500-hp lean-burn compressor engines (17,500 hp total) are designed to transport 180 MMscf/day to a central gas treatment facility. ["Construction Permit Application Webster Hill Compressor Station"]

[2] EPA AP-42, Volume I, Fifth Edition - August 2000, Table 3.2-2, Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, converted to lb/MMBtu.

[3] Based on individual well production estimates, this compressor station is estimated to have enough capacity to serve 605 wells.

[4] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 2 Energy, Table 2.2, Default Emission Factors for Stationary Combustion in the Energy Industries, default factors for N_2O (IPCC) 2000.

Year 2028 Emission Summary (lb/well)

CRVFO Alternative: Alternative A
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	24.700	2.470	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	126.132	12.613	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	15.282	4.333	0.053	1.395	1.395	1.415	0.006	0.003	---	0.002	---	0.007	1029.007	0.049	0.011
	Delivery/Commuter Vehicle Exhaust	1.259	1.391	0.001	0.050	0.050	0.205	0.002	0.000	---	0.000	---	0.002	153.301	0.009	0.005
	Subtotal	**16.54**	**5.72**	**0.05**	**152.28**	**16.53**	**1.62**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**1,182**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	80.155	8.015	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.683	0.513	0.001	0.025	0.025	0.088	0.000	0.000	---	0.000	---	0.001	81.983	0.004	0.002
	Drilling Traffic Road Dust	---	---	---	3988.130	398.813	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	35.124	44.500	0.035	1.411	1.411	6.157	0.064	0.013	---	0.009	---	0.074	4300.265	0.256	0.145
	Drill Rig Engines - Tier 4b (2015)	218.667	1137.067	12.158	9.621	9.621	61.227	1.295	0.567	---	0.397	---	0.110	228130.560	10.970	2.463
	Frac Pump Engines - Tier4b	99.206	515.873	5.516	4.365	4.365	27.778	0.588	0.257		0.180		0.050	103500.000	4.977	1.117
	Subtotal (with Tier 4B drill rigs)	**353.68**	**1,697.95**	**17.71**	**4,083.71**	**422.25**	**95.25**	**1.95**	**0.84**	**0.00**	**0.59**	**0.00**	**0.23**	**336,012.81**	**16.21**	**3.73**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	442.755	44.276	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	4.058	3.050	0.004	0.151	0.151	0.523	0.002	0.001	---	0.001	---	0.003	487.213	0.023	0.011
	Completion Traffic Road Dust	---	---	---	271.178	27.118	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	2.799	2.765	0.003	0.108	0.108	0.420	0.003	0.001	--	0.001	---	0.004	339.093	0.018	0.009
	Completion Venting and Flaring	50.000	42.000	---	3.800	3.800	1755.774	25.177	20.897	---	13.941	---	---	61264.352	16226.519	1.100
	Subtotal	**56.86**	**47.81**	**0.01**	**717.99**	**75.45**	**1,756.72**	**25.18**	**20.90**	**0.00**	**13.94**	**0.00**	**0.01**	**62,090.66**	**16,226.56**	**1.12**
	CONSTRUCTION SUBTOTAL[1]	**427.08**	**1,751.49**	**17.77**	**4,953.98**	**514.23**	**1,853.59**	**27.14**	**21.74**	**0.00**	**14.53**	**0.00**	**0.25**	**399,286**	**16,243**	**5**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	279.659	27.966	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	1289.109	128.911	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	11.822	10.130	0.012	0.448	0.448	1.634	0.010	0.003	---	0.002	---	---	1424.963	0.071	0.036
	Pad Heaters	39.107	32.850	---	2.972	2.972	2.151	0.001	0.001	---	---	---	0.029	46928.571	0.899	0.860
	Produced Water and Condensate Tanks (all at well pads)	---	---	---	---	---	1042.888	4.804	---	---	---	32.433	---	---	---	---
	Truck Loading	---	---	---	---	---	0.138	0.002	0.004	0.000	0.001	0.017	---	0.018	0.060	0.000
	Pneumatic Devices	---	---	---	---	---	879.342	12.603	10.460	0.000	6.978	87.429	---	664.543	8528.054	0.000
	Pneumatic Pumps	---	---	---	---	---	0.057	0.001	0.001	0.000	0.000	0.006	---	0.043	0.552	0.000
	Well Blowdowns	---	---	---	---	---	7.529	0.108	0.090	0.000	0.060	0.749	---	5.690	73.014	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.110	0.565	---	0.007	0.007	1.706	0.026	0.021	0.000	0.014	0.175	0.001	166.144	16.232	0.002
	Equipment Leaks	---	---	---	---	---	182.328	2.815	7.723	0.201	7.322	19.152	---	88.122	1129.588	0.000
	Subtotal	**51.04**	**43.54**	**0.01**	**1,572.19**	**160.30**	**2,117.77**	**20.37**	**18.30**	**0.20**	**14.38**	**139.96**	**0.03**	**49,278.09**	**9,748.47**	**0.90**
	Centralized Compression and Processing															
	Field Compression (2010 Emissions)	251.058	502.116	---	---	---	175.741	0.346	0.321	0.031	0.145	0.873	41.507	86472.500	982.642	0.725
	Compressor Station Equipment Leaks	---	---	---	---	---	1.372	0.022	0.078	0.002	0.076	0.148	---	0.489	6.265	0.000
	Compressor Station Dehydrators	1.192	1.001	---	0.091	0.091	183.285	33.382	19.762	---	6.090	17.025	0.001	1453.200	295.131	0.026
	Subtotal (with 2010 engines)	**252.25**	**503.12**	**0.00**	**0.09**	**0.09**	**360.40**	**33.75**	**20.16**	**0.03**	**6.31**	**18.05**	**41.51**	**87,926.19**	**1,284.04**	**0.75**
	PRODUCTION SUBTOTAL	**303.29**	**546.66**	**0.01**	**1,572.29**	**160.39**	**2,478.17**	**54.12**	**38.46**	**0.23**	**20.69**	**158.00**	**41.54**	**137,204**	**11,033**	**2**
	CONSTRUCTION AND PRODUCTION TOTAL	**730.37**	**2,298.15**	**17.78**	**6,526.26**	**674.63**	**4,331.75**	**81.26**	**60.20**	**0.23**	**35.22**	**158.00**	**41.79**	**536,490**	**27,275**	**7**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (ton/well)

CRVFO Alternative: Alternative A
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category (ton/well)															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	0.0124	0.0012	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	0.0631	0.0063	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	0.0076	0.0022	0.0000	0.0007	0.0007	0.0007	0.0000	0.0000	---	0.0000	---	0.0000	0.5145	0.0000	0.0000
	Delivery/Commuter Vehicle Exhaust	0.0006	0.0007	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	---	0.0000	---	0.0000	0.0767	0.0000	0.0000
	Subtotal	**0.0083**	**0.0029**	**0.0000**	**0.0761**	**0.0083**	**0.0008**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.5912**	**0.0000**	**0.0000**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	0.0401	0.0040	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	---	0.0000	0.0410	0.0000	0.0000
	Drilling Traffic Road Dust	---	---	---	1.9941	0.1994	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	0.0176	0.0222	0.0000	0.0007	0.0007	0.0031	0.0000	0.0000	---	0.0000	---	0.0000	2.1501	0.0001	0.0001
	Drill Rig Engines - Tier 2	0.8309	0.5685	0.0061	0.0328	0.0328	0.2187	0.0006	0.0003	---	0.0002	---	0.0001	114.0653	0.0055	0.0012
	Drill Rig Engines - Tier 4a (2011)	*0.1093*	*0.5685*	*0.0061*	*0.0164*	*0.0164*	*0.0656*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Drill Rig Engines - Tier 4b (2015)	*0.1093*	*0.5685*	*0.0061*	*0.0048*	*0.0048*	*0.0306*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Frac Pump Engines - Tier4b	0.0496	0.2579	0.0028	0.0022	0.0022	0.0139	0.0003	0.0001	---	0.0001	---	0.0000	51.7500	0.0025	0.0006
	Subtotal	**0.1768**	**0.8490**	**0.0089**	**2.0419**	**0.2111**	**0.0476**	**0.0010**	**0.0004**	**0.0000**	**0.0003**	**0.0000**	**0.0001**	**168.0064**	**0.0081**	**0.0019**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	0.2214	0.0221	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.0020	0.0015	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	---	0.0000	---	0.0000	0.2436	0.0000	0.0000
	Completion Traffic Road Dust	---	---	---	0.1356	0.0136	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.0014	0.0014	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	---	0.0000	---	0.0000	0.1695	0.0000	0.0000
	Completion Venting and Flaring	0.0250	0.0210	---	0.0019	0.0019	0.8779	0.0126	0.0104	---	0.0070	---	---	30.6322	8.1133	0.0006
	Subtotal	**0.0284**	**0.0239**	**0.0000**	**0.3590**	**0.0377**	**0.8784**	**0.0126**	**0.0104**	**0.0000**	**0.0070**	**0.0000**	**0.0000**	**31.0453**	**8.1133**	**0.0006**
	CONSTRUCTION TOTAL[1]	**0.2135**	**0.8757**	**0.0089**	**2.4770**	**0.2571**	**0.9268**	**0.0136**	**0.0109**	**0.0000**	**0.0073**	**0.0000**	**0.0001**	**199.6429**	**8.1214**	**0.0024**
PRODUCTION	**Well Pad Emissions**															
	Wind Erosion	---	---	---	0.1398	0.0140	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	0.6446	0.0645	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	0.0059	0.0051	0.0000	0.0002	0.0002	0.0008	0.0000	0.0000	---	0.0000	---	---	0.7125	0.0000	0.0000
	Pad Heaters	0.0196	0.0164	---	0.0015	0.0015	0.0011	0.0000	0.0000	---	---	---	0.0000	23.4643	0.0004	0.0004
	Condensate Tanks	---	---	---	---	---	0.5214	0.0024	---	---	---	0.0162	---	---	---	---
	Tank Loading	---	---	---	---	---	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0000	0.0000
	Pneumatic Devices	---	---	---	---	---	0.4397	0.0063	0.0052	0.0000	0.0035	0.0437	---	0.3323	4.2640	0.0000
	Pneumatic Pumps	---	---	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0003	0.0000
	Well Blowdowns	---	---	---	---	---	0.0038	0.0001	0.0000	0.0000	0.0000	0.0004	---	0.0028	0.0365	0.0000
	Well Workover & Recompletion (Venting, Flaring)	0.0001	0.0003	---	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0831	0.0081	0.0000
	Equipment Leaks	---	---	---	---	---	0.0912	0.0014	0.0039	0.0001	0.0037	0.0096	---	0.0441	0.5648	0.0000
	Subtotal	**0.0255**	**0.0218**	**0.0000**	**0.7861**	**0.0802**	**1.0589**	**0.0102**	**0.0092**	**0.0001**	**0.0072**	**0.0700**	**0.0000**	**24.6390**	**4.8742**	**0.0004**
	Centralized Compression and Processing															
	Field Compression (2007 Emissions)	0.2511	0.5021	---	---	---	0.1255	0.0002	0.0002	0.0000	0.0001	0.0004	0.0208	43.2363	0.4913	0.0004
	Field Compression (2010 Emissions)	0.1255	0.2511	---	---	---	0.0879	0.0002	0.0002	0.0000	0.0001	0.0004	0.0208	43.2363	0.4913	0.0004
	Compressor Station Equipment Leaks	---	---	---	---	---	0.0007	0.0000	0.0000	0.0000	0.0000	0.0001	---	0.0002	0.0031	0.0000
	Compressor Station Dehydrators	0.0006	0.0005	---	0.0000	0.0000	0.0916	0.0167	0.0099	---	0.0030	0.0085	0.0000	0.7266	0.1476	0.0000
	Subtotal (with 2010 engines)	**0.1261**	**0.2516**	**0.0000**	**0.0000**	**0.0000**	**0.1802**	**0.0169**	**0.0101**	**0.0000**	**0.0032**	**0.0090**	**0.0208**	**43.9631**	**0.6420**	**0.0004**
	PRODUCTION SUBTOTAL	**0.1516**	**0.2733**	**0.0000**	**0.7861**	**0.0802**	**1.2391**	**0.0271**	**0.0192**	**0.0001**	**0.0103**	**0.0790**	**0.0208**	**68.6021**	**5.5163**	**0.0008**
	CONSTRUCTION AND PRODUCTION TOTAL	**0.3652**	**1.1491**	**0.0089**	**3.2631**	**0.3373**	**2.1659**	**0.0406**	**0.0301**	**0.0001**	**0.0176**	**0.0790**	**0.0209**	**268.2450**	**13.6377**	**0.0033**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (lb/well)

CRVFO Alternative: Alternative B
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

Emissions by Source Category

	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	24.700	2.470	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	15.136	1.514	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	15.282	4.333	0.053	1.395	1.395	1.415	0.006	0.003	---	0.002	---	0.007	1029.007	0.049	0.011
	Delivery/Commuter Vehicle Exhaust	1.259	1.391	0.001	0.050	0.050	0.205	0.002	0.000	---	0.000	---	0.002	153.301	0.009	0.005
	Subtotal	**16.54**	**5.72**	**0.05**	**41.28**	**5.43**	**1.62**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**1,182**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	9.619	0.962	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.683	0.513	0.001	0.025	0.025	0.088	0.000	0.000	---	0.000	---	0.001	81.983	0.004	0.002
	Drilling Traffic Road Dust	---	---	---	478.576	47.858	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	35.124	44.500	0.035	1.411	1.411	6.157	0.064	0.013	---	0.009	---	0.074	4300.265	0.256	0.145
	Drill Rig Engines - Tier 4b (2015)	218.667	1137.067	12.158	9.621	9.621	61.227	1.295	0.567	---	0.397	---	0.110	228130.560	10.970	2.463
	Frac Pump Engines - Tier4b	99.206	515.873	5.516	4.365	4.365	27.778	0.588	0.257		0.180		0.050	103500.000	4.977	1.117
	Subtotal (with Tier 4B drill rigs)	**353.68**	**1,697.95**	**17.71**	**503.62**	**64.24**	**95.25**	**1.95**	**0.84**	**0.00**	**0.59**	**0.00**	**0.23**	**336,012.81**	**16.21**	**3.73**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	53.131	5.313	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	4.058	3.050	0.004	0.151	0.151	0.523	0.002	0.001	---	0.001	---	0.003	487.213	0.023	0.011
	Completion Traffic Road Dust	---	---	---	32.541	3.254	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	2.799	2.765	0.003	0.108	0.108	0.420	0.003	0.001	--	0.001	---	0.004	339.093	0.018	0.009
	Completion Venting and Flaring	1.000	0.840	---	0.076	0.076	35.115	0.504	0.418	---	0.279	---	---	1225.287	324.530	0.022
	Subtotal	**7.86**	**6.65**	**0.01**	**86.01**	**8.90**	**36.06**	**0.51**	**0.42**	**0.00**	**0.28**	**0.00**	**0.01**	**2,051.59**	**324.57**	**0.04**
	CONSTRUCTION SUBTOTAL[1]	**378.08**	**1,710.33**	**17.77**	**630.91**	**78.57**	**132.93**	**2.46**	**1.26**	**0.00**	**0.87**	**0.00**	**0.25**	**339,247**	**341**	**4**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	279.659	27.966	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	26.650	2.665	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	2.041	2.780	0.002	0.083	0.083	0.374	0.004	0.001	---	0.001	---	---	250.741	0.016	0.009
	Pad Heaters	39.107	32.850	---	2.972	2.972	2.151	0.001	0.001	---	---	---	0.029	46928.571	0.899	0.860
	Produced Water and Condensate Tanks	---	---	---	---	---	52.144	0.240	---	---	---	1.622	---	---	---	---
	Truck Loading	---	---	---	---	---	0.138	0.002	0.004	0.000	0.001	0.017	---	0.018	0.060	0.000
	Pneumatic Devices	---	---	---	---	---	879.342	12.603	10.460	0.000	6.978	87.429	---	664.543	8528.054	0.000
	Pneumatic Pumps	---	---	---	---	---	0.057	0.001	0.001	0.000	0.000	0.006	---	0.043	0.552	0.000
	Well Blowdowns	---	---	---	---	---	7.529	0.108	0.090	0.000	0.060	0.749	---	5.690	73.014	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.110	0.565	---	0.007	0.007	1.706	0.026	0.021	0.000	0.014	0.175	0.001	166.144	16.232	0.002
	Equipment Leaks	---	---	---	---	---	182.328	2.815	7.723	0.201	7.322	19.152	---	88.122	1129.588	0.000
	Subtotal	**41.259**	**36.195**	**0.002**	**309.371**	**33.693**	**1125.768**	**15.800**	**18.300**	**0.201**	**14.377**	**109.149**	**0.030**	**48103.873**	**9748.414**	**0.872**
	Centralized Compression and Processing															
	Field Compression (2010 Emissions)	0.000	0.000	---	---	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Compressor Station Equipment Leaks	---	---	---	---	---	1.372	0.022	0.078	0.002	0.076	0.148	---	0.489	6.265	0.000
	Compressor Station Dehydrators	1.192	1.001	---	0.091	0.091	18.387	3.338	1.976	---	0.609	1.702	0.001	1432.504	29.538	0.026
	Subtotal (with 2010 engines)	**1.19**	**1.00**	**0.00**	**0.09**	**0.09**	**19.76**	**3.36**	**2.05**	**0.00**	**0.68**	**1.85**	**0.00**	**1,432.99**	**35.80**	**0.03**
	PRODUCTION SUBTOTAL	**42.45**	**37.20**	**0.00**	**309.46**	**33.78**	**1,145.53**	**19.16**	**20.35**	**0.20**	**15.06**	**111.00**	**0.03**	**49,537**	**9,784**	**1**
	CONSTRUCTION AND PRODUCTION TOTAL	**420.53**	**1,747.53**	**17.77**	**940.37**	**112.36**	**1,278.45**	**21.62**	**21.61**	**0.20**	**15.93**	**111.00**	**0.28**	**388,784**	**10,125**	**5**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (ton/well)

CRVFO Alternative: Alternative B
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category (ton/well)															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	0.0124	0.0012	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	0.0076	0.0008	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	0.0076	0.0022	0.0000	0.0007	0.0007	0.0007	0.0000	0.0000	---	0.0000	---	0.0000	0.5145	0.0000	0.0000
	Delivery/Commuter Vehicle Exhaust	0.0006	0.0007	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	---	0.0000	---	0.0000	0.0767	0.0000	0.0000
	Subtotal	**0.0083**	**0.0029**	**0.0000**	**0.0206**	**0.0027**	**0.0008**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.5912**	**0.0000**	**0.0000**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	0.0048	0.0005	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	---	0.0000	0.0410	0.0000	0.0000
	Drilling Traffic Road Dust	---	---	---	0.2393	0.0239	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	0.0176	0.0222	0.0000	0.0007	0.0007	0.0031	0.0000	0.0000	---	0.0000	---	0.0000	2.1501	0.0001	0.0001
	Drill Rig Engines - Tier 2	0.8309	0.5685	0.0061	0.0328	0.0328	0.2187	0.0006	0.0003	---	0.0002	---	0.0001	114.0653	0.0055	0.0012
	Drill Rig Engines - Tier 4a (2011)	*0.1093*	*0.5685*	*0.0061*	*0.0164*	*0.0164*	*0.0656*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Drill Rig Engines - Tier 4b (2015)	*0.1093*	*0.5685*	*0.0061*	*0.0048*	*0.0048*	*0.0306*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Frac Pump Engines - Tier4b	0.0496	0.2579	0.0028	0.0022	0.0022	0.0139	0.0003	0.0001	---	0.0001	---	0.0000	51.7500	0.0025	0.0006
	Subtotal	**0.1768**	**0.8490**	**0.0089**	**0.2518**	**0.0321**	**0.0476**	**0.0010**	**0.0004**	**0.0000**	**0.0003**	**0.0000**	**0.0001**	**168.0064**	**0.0081**	**0.0019**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	0.0266	0.0027	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.0020	0.0015	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	---	0.0000	---	0.0000	0.2436	0.0000	0.0000
	Completion Traffic Road Dust	---	---	---	0.0163	0.0016	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.0014	0.0014	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	---	0.0000	---	0.0000	0.1695	0.0000	0.0000
	Completion Venting and Flaring	0.0005	0.0004	---	0.0000	0.0000	0.0176	0.0003	0.0002	---	0.0001	---	---	0.6126	0.1623	0.0000
	Subtotal	**0.0039**	**0.0033**	**0.0000**	**0.0430**	**0.0045**	**0.0180**	**0.0003**	**0.0002**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**1.0258**	**0.1623**	**0.0000**
	CONSTRUCTION TOTAL[1]	**0.1890**	**0.8552**	**0.0089**	**0.3155**	**0.0393**	**0.0665**	**0.0012**	**0.0006**	**0.0000**	**0.0004**	**0.0000**	**0.0001**	**169.6234**	**0.1704**	**0.0019**
PRODUCTION	**Well Pad Emissions**															
	Wind Erosion	---	---	---	0.1398	0.0140	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	0.0133	0.0013	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	0.0010	0.0014	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	---	0.0000	---	---	0.1254	0.0000	0.0000
	Pad Heaters	0.0196	0.0164	---	0.0015	0.0015	0.0011	0.0000	0.0000	---	---	---	0.0000	23.4643	0.0004	0.0004
	Condensate Tanks	---	---	---	---	---	0.0261	0.0001	---	---	---	0.0008	---	---	---	---
	Tank Loading	---	---	---	---	---	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0000	0.0000
	Pneumatic Devices	---	---	---	---	---	0.4397	0.0063	0.0052	0.0000	0.0035	0.0437	---	0.3323	4.2640	0.0000
	Pneumatic Pumps	---	---	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0003	0.0000
	Well Blowdowns	---	---	---	---	---	0.0038	0.0001	0.0000	0.0000	0.0000	0.0004	---	0.0028	0.0365	0.0000
	Well Workover & Recompletion (Venting, Flaring)	0.0001	0.0003	---	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0831	0.0081	0.0000
	Equipment Leaks	---	---	---	---	---	0.0912	0.0014	0.0039	0.0001	0.0037	0.0096	---	0.0441	0.5648	0.0000
	Subtotal	**0.0206**	**0.0181**	**0.0000**	**0.1547**	**0.0168**	**0.5629**	**0.0079**	**0.0092**	**0.0001**	**0.0072**	**0.0546**	**0.0000**	**24.0519**	**4.8742**	**0.0004**
	Centralized Compression and Processing															
	Field Compression (2007 Emissions)	0.0000	0.0000	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Field Compression (2010 Emissions)	0.0000	0.0000	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Compressor Station Equipment Leaks	---	---	---	---	---	0.0007	0.0000	0.0000	0.0000	0.0000	0.0001	---	0.0002	0.0031	0.0000
	Compressor Station Dehydrators	0.0006	0.0005	---	0.0000	0.0000	0.0092	0.0017	0.0010	---	0.0003	0.0009	0.0000	0.7163	0.0148	0.0000
	Subtotal (with 2010 engines)	**0.0006**	**0.0005**	**0.0000**	**0.0000**	**0.0000**	**0.0099**	**0.0017**	**0.0010**	**0.0000**	**0.0003**	**0.0009**	**0.0000**	**0.7165**	**0.0179**	**0.0000**
	PRODUCTION SUBTOTAL	**0.0212**	**0.0186**	**0.0000**	**0.1547**	**0.0169**	**0.5728**	**0.0096**	**0.0102**	**0.0001**	**0.0075**	**0.0555**	**0.0000**	**24.7684**	**4.8921**	**0.0004**
	CONSTRUCTION AND PRODUCTION TOTAL	**0.2103**	**0.8738**	**0.0089**	**0.4702**	**0.0562**	**0.6392**	**0.0108**	**0.0108**	**0.0001**	**0.0080**	**0.0555**	**0.0001**	**194.3918**	**5.0625**	**0.0023**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (lb/well)

Alternative: Alternative C
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	24.700	2.470	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	15.136	1.514	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	15.282	4.333	0.053	1.395	1.395	1.415	0.006	0.003	---	0.002	---	0.007	1029.007	0.049	0.011
	Delivery/Commuter Vehicle Exhaust	1.259	1.391	0.001	0.050	0.050	0.205	0.002	0.000	---	0.000	---	0.002	153.301	0.009	0.005
	Subtotal	**16.54**	**5.72**	**0.05**	**41.28**	**5.43**	**1.62**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**1,182**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	9.619	0.962	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.683	0.513	0.001	0.025	0.025	0.088	0.000	0.000	---	0.000	---	0.001	81.983	0.004	0.002
	Drilling Traffic Road Dust	---	---	---	478.576	47.858	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	35.124	44.500	0.035	1.411	1.411	6.157	0.064	0.013	---	0.009	---	0.074	4300.265	0.256	0.145
	Drill Rig Engines - Tier 4b (2015)	218.667	1137.067	12.158	9.621	9.621	61.227	1.295	0.567	---	0.397	---	0.110	228130.560	10.970	2.463
	Frac Pump Engines - Tier4b	99.206	515.873	5.516	4.365	4.365	27.778	0.588	0.257		0.180		0.050	103500.000	4.977	1.117
	Subtotal (with Tier 4B drill rigs)	**353.68**	**1,697.95**	**17.71**	**503.62**	**64.24**	**95.25**	**1.95**	**0.84**	**0.00**	**0.59**	**0.00**	**0.23**	**336,012.81**	**16.21**	**3.73**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	53.131	5.313	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	4.058	3.050	0.004	0.151	0.151	0.523	0.002	0.001	---	0.001	---	0.003	487.213	0.023	0.011
	Completion Traffic Road Dust	---	---	---	32.541	3.254	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	2.799	2.765	0.003	0.108	0.108	0.420	0.003	0.001	---	0.001	---	0.004	339.093	0.018	0.009
	Completion Venting and Flaring	1.000	0.840	---	0.076	0.076	35.115	0.504	0.418	---	0.279	---	---	1225.287	324.530	0.022
	Subtotal	**7.86**	**6.65**	**0.01**	**86.01**	**8.90**	**36.06**	**0.51**	**0.42**	**0.00**	**0.28**	**0.00**	**0.01**	**2,051.59**	**324.57**	**0.04**
	CONSTRUCTION SUBTOTAL[1]	**378.08**	**1,710.33**	**17.77**	**630.91**	**78.57**	**132.93**	**2.46**	**1.26**	**0.00**	**0.87**	**0.00**	**0.25**	**339,247**	**341**	**4**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	279.659	27.966	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	26.650	2.665	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	2.041	2.780	0.002	0.083	0.083	0.374	0.004	0.001	---	0.001	---	---	250.741	0.016	0.009
	Pad Heaters	39.107	32.850	---	2.972	2.972	2.151	0.001	0.001	---	---	---	0.029	46928.571	0.899	0.860
	Produced Water and Condensate Tanks	---	---	---	---	---	52.144	0.240	---	---	---	1.622	---	---	---	---
	Truck Loading	---	---	---	---	---	0.138	0.002	0.004	0.000	0.001	0.017	---	0.018	0.060	0.000
	Pneumatic Devices	---	---	---	---	---	879.342	12.603	10.460	0.000	6.978	87.429	---	664.543	8528.054	0.000
	Pneumatic Pump	---	---	---	---	---	0.057	0.001	0.001	0.000	0.000	0.006	---	0.043	0.552	0.000
	Well Blowdowns	---	---	---	---	---	7.529	0.108	0.090	0.000	0.060	0.749	---	5.690	73.014	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.110	0.565	---	0.007	0.007	1.706	0.026	0.021	0.000	0.014	0.175	0.001	166.144	16.232	0.002
	Equipment Leaks	---	---	---	---	---	182.328	2.815	7.723	0.201	7.322	19.152	---	88.122	1129.588	0.000
	Subtotal	**41.26**	**36.19**	**0.00**	**309.37**	**33.69**	**1,125.77**	**15.80**	**18.30**	**0.20**	**14.38**	**109.15**	**0.03**	**48,103.87**	**9,748.41**	**0.87**
	Centralized Compression and Processing															
	Field Compression (2010 Emissions)	0.000	0.000	---	---	---	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Compressor Station Equipment Leaks	---	---	---	---	---	1.372	0.022	0.078	0.002	0.076	0.148	---	0.489	6.265	0.000
	Compressor Station Dehydrators	1.192	1.001	---	0.091	0.091	18.387	3.338	1.976	---	0.609	1.702	0.001	1432.504	29.538	0.026
	Subtotal (with 2010 engines)	**1.19**	**1.00**	**0.00**	**0.09**	**0.09**	**19.76**	**3.36**	**2.05**	**0.00**	**0.68**	**1.85**	**0.00**	**1,432.99**	**35.80**	**0.03**
	PRODUCTION SUBTOTAL	**42.45**	**37.20**	**0.00**	**309.46**	**33.78**	**1,145.53**	**19.16**	**20.35**	**0.20**	**15.06**	**111.00**	**0.03**	**49,537**	**9,784**	**1**
	CONSTRUCTION AND PRODUCTION TOTAL	**420.53**	**1,747.53**	**17.77**	**940.37**	**112.36**	**1,278.45**	**21.62**	**21.61**	**0.20**	**15.93**	**111.00**	**0.28**	**388,784**	**10,125**	**5**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (ton/well)

CRVFO Alternative: Alternative C
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category (ton/well)															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	0.0124	0.0012	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	0.0076	0.0008	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	0.0076	0.0022	0.0000	0.0007	0.0007	0.0007	0.0000	0.0000	---	0.0000	---	0.0000	0.5145	0.0000	0.0000
	Delivery/Commuter Vehicle Exhaust	0.0006	0.0007	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	---	0.0000	---	0.0000	0.0767	0.0000	0.0000
	Subtotal	**0.0083**	**0.0029**	**0.0000**	**0.0206**	**0.0027**	**0.0008**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.5912**	**0.0000**	**0.0000**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	0.0048	0.0005	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	---	0.0000	0.0410	0.0000	0.0000
	Drilling Traffic Road Dust	---	---	---	0.2393	0.0239	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	0.0176	0.0222	0.0000	0.0007	0.0007	0.0031	0.0000	0.0000	---	0.0000	---	0.0000	2.1501	0.0001	0.0001
	Drill Rig Engines - Tier 2	0.8309	0.5685	0.0061	0.0328	0.0328	0.2187	0.0006	0.0003	---	0.0002	---	0.0001	114.0653	0.0055	0.0012
	Frac Pump Engines - Tier4b	0.0496	0.2579	0.0028	0.0022	0.0022	0.0139	0.0003	0.0001	---	0.0001	---	0.0000	51.7500	0.0025	0.0006
	Subtotal	**0.1768**	**0.8490**	**0.0089**	**0.2518**	**0.0321**	**0.0476**	**0.0010**	**0.0004**	**0.0000**	**0.0003**	**0.0000**	**0.0001**	**168.0064**	**0.0081**	**0.0019**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	0.0266	0.0027	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.0020	0.0015	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	---	0.0000	---	0.0000	0.2436	0.0000	0.0000
	Completion Traffic Road Dust	---	---	---	0.0163	0.0016	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.0014	0.0014	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	---	0.0000	---	0.0000	0.1695	0.0000	0.0000
	Completion Venting and Flaring	0.0005	0.0004	---	0.0000	0.0000	0.0176	0.0003	0.0002	---	0.0001	---	---	0.6126	0.1623	0.0000
	Subtotal	**0.0039**	**0.0033**	**0.0000**	**0.0430**	**0.0045**	**0.0180**	**0.0003**	**0.0002**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**1.0258**	**0.1623**	**0.0000**
	CONSTRUCTION TOTAL[1]	**0.1890**	**0.8552**	**0.0089**	**0.3155**	**0.0393**	**0.0665**	**0.0012**	**0.0006**	**0.0000**	**0.0004**	**0.0000**	**0.0001**	**169.6234**	**0.1704**	**0.0019**
PRODUCTION	**Well Pad Emissions**															
	Wind Erosion	---	---	---	0.1398	0.0140	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	0.0133	0.0013	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	0.0010	0.0014	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	---	0.0000	---	---	0.1254	0.0000	0.0000
	Pad Heaters	0.0196	0.0164	---	0.0015	0.0015	0.0011	0.0000	0.0000	---	---	---	0.0000	23.4643	0.0004	0.0004
	Condensate Tanks	---	---	---	---	---	0.0261	0.0001	---	---	---	0.0008	---	---	---	---
	Tank Loading	---	---	---	---	---	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0000	0.0000
	Pneumatic Devices	---	---	---	---	---	0.4397	0.0063	0.0052	0.0000	0.0035	0.0437	---	0.3323	4.2640	0.0000
	Pneumatic Pump	---	---	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0003	0.0000
	Well Blowdowns	---	---	---	---	---	0.0038	0.0001	0.0000	0.0000	0.0000	0.0004	---	0.0028	0.0365	0.0000
	Well Workover & Recompletion (Venting, Flaring)	0.0001	0.0003	---	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0831	0.0081	0.0000
	Equipment Leaks	---	---	---	---	---	0.0912	0.0014	0.0039	0.0001	0.0037	0.0096	---	0.0441	0.5648	0.0000
	Subtotal	**0.0206**	**0.0181**	**0.0000**	**0.1547**	**0.0168**	**0.5629**	**0.0079**	**0.0092**	**0.0001**	**0.0072**	**0.0546**	**0.0000**	**24.0519**	**4.8742**	**0.0004**
	Centralized Compression and Processing															
	Field Compression (2007 Emissions)	0.0000	0.0000	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	Compressor Station Equipment Leaks	---	---	---	---	---	0.0007	0.0000	0.0000	0.0000	0.0000	0.0001	---	0.0002	0.0031	0.0000
	Compressor Station Dehydrators	0.0006	0.0005	---	0.0000	0.0000	0.0092	0.0017	0.0010	---	0.0003	0.0009	0.0000	0.7163	0.0148	0.0000
	Subtotal (with 2010 engines)	**0.0006**	**0.0005**	**0.0000**	**0.0000**	**0.0000**	**0.0099**	**0.0017**	**0.0010**	**0.0000**	**0.0003**	**0.0009**	**0.0000**	**0.7165**	**0.0179**	**0.0000**
	PRODUCTION SUBTOTAL	**0.0212**	**0.0186**	**0.0000**	**0.1547**	**0.0169**	**0.5728**	**0.0096**	**0.0102**	**0.0001**	**0.0075**	**0.0555**	**0.0000**	**24.7684**	**4.8921**	**0.0004**
	CONSTRUCTION AND PRODUCTION TOTAL	**0.2103**	**0.8738**	**0.0089**	**0.4702**	**0.0562**	**0.6392**	**0.0108**	**0.0108**	**0.0001**	**0.0080**	**0.0555**	**0.0001**	**194.3918**	**5.0625**	**0.0023**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (lb/well)

CRVFO Alternative: Alternative D
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	24.700	2.470	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	15.136	1.514	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	15.282	4.333	0.053	1.395	1.395	1.415	0.006	0.003	---	0.002	---	0.007	1029.007	0.049	0.011
	Delivery/Commuter Vehicle Exhaust	1.259	1.391	0.001	0.050	0.050	0.205	0.002	0.000	---	0.000	---	0.002	153.301	0.009	0.005
	Subtotal	**16.54**	**5.72**	**0.05**	**41.28**	**5.43**	**1.62**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**1,182**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	9.619	0.962	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.683	0.513	0.001	0.025	0.025	0.088	0.000	0.000	---	0.000	---	0.001	81.983	0.004	0.002
	Drilling Traffic Road Dust	---	---	---	478.576	47.858	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	35.124	44.500	0.035	1.411	1.411	6.157	0.064	0.013	---	0.009	---	0.074	4300.265	0.256	0.145
	Drill Rig Engines - Tier 4b (2015)	218.667	1137.067	12.158	9.621	9.621	61.227	1.295	0.567	---	0.397	---	0.110	228130.560	10.970	2.463
	Frac Pump Engines - Tier4b	99.206	515.873	5.516	4.365	4.365	27.778	0.588	0.257		0.180		0.050	103500.000	4.977	1.117
	Subtotal (with Tier 4B drill rigs)	**353.68**	**1,697.95**	**17.71**	**503.62**	**64.24**	**95.25**	**1.95**	**0.84**	**0.00**	**0.59**	**0.00**	**0.23**	**336,012.81**	**16.21**	**3.73**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	53.131	5.313	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	4.058	3.050	0.004	0.151	0.151	0.523	0.002	0.001	---	0.001	---	0.003	487.213	0.023	0.011
	Completion Traffic Road Dust	---	---	---	32.541	3.254	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	2.799	2.765	0.003	0.108	0.108	0.420	0.003	0.001	--	0.001	---	0.004	339.093	0.018	0.009
	Completion Venting and Flaring	1.000	0.840	---	0.076	0.076	35.115	0.504	0.418	---	0.279	---	---	1225.287	324.530	0.022
	Subtotal	**7.86**	**6.65**	**0.01**	**86.01**	**8.90**	**36.06**	**0.51**	**0.42**	**0.00**	**0.28**	**0.00**	**0.01**	**2,051.59**	**324.57**	**0.04**
	CONSTRUCTION SUBTOTAL[1]	**378.08**	**1,710.33**	**17.77**	**630.91**	**78.57**	**132.93**	**2.46**	**1.26**	**0.00**	**0.87**	**0.00**	**0.25**	**339,247**	**341**	**4**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	279.659	27.966	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	51.355	5.136	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	3.928	4.198	0.004	0.153	0.153	0.617	0.005	0.001	---	0.001	---	---	477.305	0.026	0.014
	Pad Heaters	39.107	32.850	---	2.972	2.972	2.151	0.001	0.001	---	---	---	0.029	46928.571	0.899	0.860
	Produced Water and Condensate Tanks	---	---	---	---	---	52.144	0.240	---	---	---	1.622	---	---	---	---
	Truck Loading	---	---	---	---	---	0.138	0.002	0.004	0.000	0.001	0.017	---	0.018	0.060	0.000
	Pneumatic Devices	---	---	---	---	---	879.342	12.603	10.460	0.000	6.978	87.429	---	664.543	8528.054	0.000
	Pneumatic Pumps	---	---	---	---	---	0.057	0.001	0.001	0.000	0.000	0.006	---	0.043	0.552	0.000
	Well Blowdowns	---	---	---	---	---	7.529	0.108	0.090	0.000	0.060	0.749	---	5.690	73.014	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.110	0.565	---	0.007	0.007	1.706	0.026	0.021	0.000	0.014	0.175	0.001	166.144	16.232	0.002
	Equipment Leaks	---	---	---	---	---	182.328	2.815	7.723	0.201	7.322	19.152	---	88.122	1129.588	0.000
	Subtotal	**43.15**	**37.61**	**0.00**	**334.15**	**36.23**	**1,126.01**	**15.80**	**18.30**	**0.20**	**14.38**	**109.15**	**0.03**	**48,330.44**	**9,748.43**	**0.88**
	Centralized Compression and Processing															
	Field Compression (2010 Emissions)	125.53	251.06	---	---	---	87.87	0.17	0.16	0.02	0.07	0.44	20.75	43,236.25	491.32	0.36
	Compressor Station Equipment Leaks	---	---	---	---	---	1.37	0.02	0.08	0.002	0.08	0.15	---	0.49	6.26	0.00
	Compressor Station Dehydrators	1.192	1.001	---	0.091	0.091	18.387	3.338	1.976	---	0.609	1.702	0.001	1432.504	29.538	0.026
	Subtotal (with 2010 engines)	**126.72**	**252.06**	**0.00**	**0.09**	**0.09**	**107.63**	**3.53**	**2.21**	**0.02**	**0.76**	**2.29**	**20.75**	**44,669.24**	**527.12**	**0.39**
	PRODUCTION SUBTOTAL	**169.87**	**289.67**	**0.00**	**334.24**	**36.32**	**1,233.64**	**19.33**	**20.51**	**0.22**	**15.13**	**111.43**	**20.78**	**93,000**	**10,276**	**1**
	CONSTRUCTION AND PRODUCTION TOTAL	**547.94**	**2,000.00**	**17.78**	**965.14**	**114.90**	**1,366.57**	**21.80**	**21.78**	**0.22**	**16.00**	**111.43**	**21.03**	**432,246**	**10,616**	**5**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Year 2028 Emission Summary (ton/well)

CRVFO Alternative: Alternative D
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/18/2010

Emissions by Source Category (ton/well)

	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	0.0124	0.0012	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	0.0076	0.0008	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	0.0076	0.0022	0.0000	0.0007	0.0007	0.0007	0.0000	0.0000	---	0.0000	---	0.0000	0.5145	0.0000	0.0000
	Delivery/Commuter Vehicle Exhaust	0.0006	0.0007	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	---	0.0000	---	0.0000	0.0767	0.0000	0.0000
	Subtotal	**0.0083**	**0.0029**	**0.0000**	**0.0206**	**0.0027**	**0.0008**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.5912**	**0.0000**	**0.0000**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	0.0048	0.0005	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.0003	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	---	0.0000	0.0410	0.0000	0.0000
	Drilling Traffic Road Dust	---	---	---	0.2393	0.0239	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	0.0176	0.0222	0.0000	0.0007	0.0007	0.0031	0.0000	0.0000	---	0.0000	---	0.0000	2.1501	0.0001	0.0001
	Drill Rig Engines - Tier 2	0.8309	0.5685	0.0061	0.0328	0.0328	0.2187	0.0006	0.0003	---	0.0002	---	0.0001	114.0653	0.0055	0.0012
	Drill Rig Engines - Tier 4a (2011)	*0.1093*	*0.5685*	*0.0061*	*0.0164*	*0.0164*	*0.0656*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Drill Rig Engines - Tier 4b (2015)	*0.1093*	*0.5685*	*0.0061*	*0.0048*	*0.0048*	*0.0306*	*0.0006*	*0.0003*	---	*0.0002*	---	*0.0001*	*114.0653*	*0.0055*	0.0012
	Frac Pump Engines - Tier4b	0.0496	0.2579	0.0028	0.0022	0.0022	0.0139	0.0003	0.0001	---	0.0001	---	0.0000	51.7500	0.0025	0.0006
	Subtotal	**0.1768**	**0.8490**	**0.0089**	**0.2518**	**0.0321**	**0.0476**	**0.0010**	**0.0004**	**0.0000**	**0.0003**	**0.0000**	**0.0001**	**168.0064**	**0.0081**	**0.0019**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	0.0266	0.0027	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.0020	0.0015	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	---	0.0000	---	0.0000	0.2436	0.0000	0.0000
	Completion Traffic Road Dust	---	---	---	0.0163	0.0016	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.0014	0.0014	0.0000	0.0001	0.0001	0.0002	0.0000	0.0000	---	0.0000	---	0.0000	0.1695	0.0000	0.0000
	Completion Venting and Flaring	0.0005	0.0004	---	0.0000	0.0000	0.0176	0.0003	0.0002	---	0.0001	---	---	0.6126	0.1623	0.0000
	Subtotal	**0.0039**	**0.0033**	**0.0000**	**0.0430**	**0.0045**	**0.0180**	**0.0003**	**0.0002**	**0.0000**	**0.0001**	**0.0000**	**0.0000**	**1.0258**	**0.1623**	**0.0000**
	CONSTRUCTION TOTAL[1]	**0.1890**	**0.8552**	**0.0089**	**0.3155**	**0.0393**	**0.0665**	**0.0012**	**0.0006**	**0.0000**	**0.0004**	**0.0000**	**0.0001**	**169.6234**	**0.1704**	**0.0019**
PRODUCTION	**Well Pad Emissions**															
	Wind Erosion	---	---	---	0.1398	0.0140	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	0.0257	0.0026	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	0.0020	0.0021	0.0000	0.0001	0.0001	0.0003	0.0000	0.0000	---	0.0000	---	---	0.2387	0.0000	0.0000
	Pad Heaters	0.0196	0.0164	---	0.0015	0.0015	0.0011	0.0000	0.0000	---	---	---	0.0000	23.4643	0.0004	0.0004
	Condensate Tanks	---	---	---	---	---	0.0261	0.0001	---	---	---	0.0008	---	---	---	---
	Tank Loading	---	---	---	---	---	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0000	0.0000
	Pneumatic Devices	---	---	---	---	---	0.4397	0.0063	0.0052	0.0000	0.0035	0.0437	---	0.3323	4.2640	0.0000
	Pneumatic Pumps	---	---	---	---	---	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	0.0000	0.0003	0.0000
	Well Blowdowns	---	---	---	---	---	0.0038	0.0001	0.0000	0.0000	0.0000	0.0004	---	0.0028	0.0365	0.0000
	Well Workover & Recompletion (Venting, Flaring)	0.0001	0.0003	---	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0831	0.0081	0.0000
	Equipment Leaks	---	---	---	---	---	0.0912	0.0014	0.0039	0.0001	0.0037	0.0096	---	0.0441	0.5648	0.0000
	Subtotal	**0.0216**	**0.0188**	**0.0000**	**0.1671**	**0.0181**	**0.5630**	**0.0079**	**0.0092**	**0.0001**	**0.0072**	**0.0546**	**0.0000**	**24.1652**	**4.8742**	**0.0004**
	Centralized Compression and Processing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Field Compression (2007 Emissions)	0.1255	0.2511	---	---	---	0.0628	0.0001	0.0001	0.0000	0.0000	0.0002	0.0104	21.6181	0.2457	0.0002
	Field Compression (2010 Emissions)	0.0628	0.1255	---	---	---	0.0439	0.0001	0.0001	0.0000	0.0000	0.0002	0.0104	21.6181	0.2457	0.0002
	Compressor Station Equipment Leaks	---	---	---	---	---	0.0007	0.0000	0.0000	0.0000	0.0000	0.0001	---	0.0002	0.0031	0.0000
	Compressor Station Dehydrators	0.0006	0.0005	---	0.0000	0.0000	0.0092	0.0017	0.0010	---	0.0003	0.0009	0.0000	0.7163	0.0148	0.0000
	Subtotal (with 2010 engines)	**0.0634**	**0.1260**	**0.0000**	**0.0000**	**0.0000**	**0.0538**	**0.0018**	**0.0011**	**0.0000**	**0.0004**	**0.0011**	**0.0104**	**22.3346**	**0.2636**	**0.0002**
	PRODUCTION SUBTOTAL	**0.0849**	**0.1448**	**0.0000**	**0.1671**	**0.0182**	**0.6168**	**0.0097**	**0.0103**	**0.0001**	**0.0076**	**0.0557**	**0.0104**	**46.4998**	**5.1378**	**0.0006**
	CONSTRUCTION AND PRODUCTION TOTAL	**0.2740**	**1.0000**	**0.0089**	**0.4826**	**0.0574**	**0.6833**	**0.0109**	**0.0109**	**0.0001**	**0.0080**	**0.0557**	**0.0105**	**216.1232**	**5.3082**	**0.0025**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Field Wide Year 2028 Emission Summary (tons/year)

CRVFO Alternative: Alternative A
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities (BLM and non-BLM sources)
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOCs**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylene**	**Hexane**	**Form.**	**CO_2**	**CH_4**	**N_2O**
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	4.882	0.488	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	24.929	2.493	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	3.020	0.856	0.011	0.276	0.276	0.280	0.001	0.001	---	0.000	---	0.001	203.374	0.010	0.002
	Delivery/Commuter Vehicle Exhaust	0.249	0.275	0.000	0.010	0.010	0.040	0.000	0.000	---	0.000	---	0.000	30.299	0.002	0.001
	Subtotal	**3.269**	**1.131**	**0.011**	**30.096**	**3.267**	**0.320**	**0.002**	**0.001**	**0.000**	**0.000**	**0.000**	**0.002**	**233.672**	**0.011**	**0.003**
	Drill Rig Move and Drilling	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Road Dust	---	---	---	15.842	1.584	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.135	0.101	0.000	0.005	0.005	0.017	0.000	0.000	---	0.000	---	0.000	16.203	0.001	0.000
	Drilling Traffic Road Dust	---	---	---	788.218	78.822	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	6.942	8.795	0.007	0.279	0.279	1.217	0.013	0.003	---	0.002	---	0.015	849.908	0.051	0.029
	Drill Rig Engines - Tier 4b (2015)	43.217	224.731	2.403	1.902	1.902	12.101	0.256	0.112	---	0.078	---	0.022	45087.940	2.168	0.487
	Frac Pump Engines - Tier4b	19.6072	101.9576	1.0902	0.8627	0.8627	5.4900	0.1162	0.0509	---	0.0356	---	0.0098	20455.8382	0.9837	0.2208
	Subtotal (with Tier 4B drill rigs)	**69.902**	**335.58**	**3.50**	**807.11**	**83.45**	**18.83**	**0.38**	**0.17**	**0.00**	**0.12**	**0.00**	**0.05**	**66,409.89**	**3.20**	**0.74**
	Completion and Testing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Road Dust	---	---	---	87.507	8.751	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.802	0.603	0.001	0.030	0.030	0.103	0.000	0.000	---	0.000	---	0.001	96.293	0.005	0.002
	Completion Traffic Road Dust	---	---	---	53.596	5.360	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.553	0.547	0.001	0.021	0.021	0.083	0.001	0.000	---	0.000	---	0.001	67.019	0.004	0.002
	Completion Venting and Flaring	9.882	8.301	---	0.751	0.751	347.013	4.976	4.130	---	2.755	---	---	12108.345	3207.025	0.217
	Subtotal	**11.24**	**9.45**	**0.00**	**141.90**	**14.91**	**347.20**	**4.98**	**4.13**	**0.00**	**2.76**	**0.00**	**0.00**	**12,271.66**	**3,207.03**	**0.22**
	CONSTRUCTION SUBTOTAL[1]	**84.41**	**346.17**	**3.51**	**979.11**	**101.63**	**366.34**	**5.36**	**4.30**	**0.00**	**2.87**	**0.00**	**0.05**	**78,915**	**3,210**	**1**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
	Wind Erosion	---	---	---	55.272	5.527	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	7781.063	778.106	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	71.356	61.144	0.075	2.704	2.704	9.863	0.061	0.020	---	0.014	---	---	8601.077	0.431	0.216
	Pad Heaters	236.051	198.283	---	17.940	17.940	12.983	0.005	0.008	---	---	---	0.177	283260.857	5.429	5.193
	Produced Water and Condensate Tanks	---	---	---	---	---	6294.869	28.996	---	---	---	195.763	---	---	---	---
	Truck Loading	---	---	---	---	---	0.831	0.014	0.022	0.000	0.007	0.105	---	0.109	0.364	0.000
	Pneumatic Devices	---	---	---	---	---	5307.705	76.070	63.139	0.000	42.121	527.722	---	4011.183	51475.333	0.000
	Pneumatic Pumps	---	---	---	---	---	0.343	0.005	0.004	0.000	0.003	0.034	---	0.259	3.330	0.000
	Well Blowdowns	---	---	---	---	---	45.443	0.651	0.541	0.000	0.361	4.518	---	34.342	440.713	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.666	3.409	---	0.041	0.041	10.298	0.156	0.128	0.000	0.085	1.054	0.005	1002.847	97.974	0.013
	Equipment Leaks	---	---	---	---	---	1100.533	16.993	46.615	1.215	44.198	115.599	---	531.903	6818.192	0.000
	Subtotal	**308.07**	**262.84**	**0.07**	**7,857.02**	**804.32**	**12,782.87**	**122.95**	**110.48**	**1.22**	**86.79**	**844.79**	**0.18**	**297,442.58**	**58,841.77**	**5.42**
	Centralized Compression and Processing	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
	Field Compression (2010 Emissions)	1515.387	3030.775	---	---	---	1060.771	2.088	1.936	0.188	0.873	5.267	250.535	521948.012	5931.227	4.379
	Compressor Station Equipment Leaks	---	---	---	---	---	8.280	0.132	0.468	0.013	0.457	0.891	---	2.953	37.814	0.000
	Compressor Station Dehydrators	7.194	6.043	---	0.547	0.547	1106.306	201.496	119.285	---	36.758	102.762	0.005	8771.514	1781.410	0.158
	Subtotal (with 2010 engines)	**1,522.58**	**3,036.82**	**0.00**	**0.55**	**0.55**	**2,175.36**	**203.72**	**121.69**	**0.20**	**38.09**	**108.92**	**250.54**	**530,722.48**	**7,750.45**	**4.54**
	PRODUCTION SUBTOTAL	**1,830.65**	**3,299.65**	**0.07**	**7,857.57**	**804.87**	**14,958.23**	**326.67**	**232.17**	**1.42**	**124.88**	**953.72**	**250.72**	**828,165.06**	**66,592.22**	**10**
	CONSTRUCTION AND PRODUCTION TOTAL	**1,915.06**	**3,645.82**	**3.59**	**8,836.68**	**906.50**	**15,324.57**	**332.03**	**236.46**	**1.42**	**127.75**	**953.72**	**250.77**	**907,080.28**	**69,802.47**	**11**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Field Wide Year 2028 Emission Summary (tons/year)

CRVFO Alternative: Alternative B
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities (BLM and non-BLM sources)
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	4.434	0.443	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	2.717	0.272	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	2.743	0.778	0.010	0.250	0.250	0.254	0.001	0.000	---	0.000	---	0.001	184.725	0.009	0.002
	Delivery/Commuter Vehicle Exhaust	0.226	0.250	0.000	0.009	0.009	0.037	0.000	0.000	---	0.000	---	0.000	27.520	0.002	0.001
	Subtotal	**2.969**	**1.027**	**0.010**	**7.411**	**0.974**	**0.291**	**0.001**	**0.001**	**0.000**	**0.000**	**0.000**	**0.002**	**212.245**	**0.010**	**0.003**
	Drill Rig Move and Drilling	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Road Dust	---	---	---	1.727	0.173	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.123	0.092	0.000	0.005	0.005	0.016	0.000	0.000	---	0.000	---	0.000	14.717	0.001	0.000
	Drilling Traffic Road Dust	---	---	---	85.913	8.591	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	6.305	7.988	0.006	0.253	0.253	1.105	0.012	0.002	---	0.002	---	0.013	771.972	0.046	0.026
	Drill Rig Engines - Tier 4b (2015)	39.254	204.123	2.183	1.727	1.727	10.991	0.233	0.102	---	0.071	---	0.020	40953.385	1.969	0.442
	Frac Pump Engines - Tier4b	17.8093	92.6081	0.9902	0.7836	0.7836	4.9866	0.1055	0.0462	---	0.0323	---	0.0089	18580.0419	0.8935	0.2006
	Subtotal (with Tier 4B drill rigs)	**63.492**	**304.81**	**3.18**	**90.41**	**11.53**	**17.10**	**0.35**	**0.15**	**0.00**	**0.11**	**0.00**	**0.04**	**60,320.12**	**2.91**	**0.67**
	Completion and Testing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Road Dust	---	---	---	9.538	0.954	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.729	0.547	0.001	0.027	0.027	0.094	0.000	0.000	---	0.000	---	0.001	87.463	0.004	0.002
	Completion Traffic Road Dust	---	---	---	5.842	0.584	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.503	0.496	0.001	0.019	0.019	0.075	0.001	0.000	---	0.000	---	0.001	60.873	0.003	0.002
	Completion Venting and Flaring	5.947	4.995	---	0.452	0.452	208.821	2.994	2.485	---	1.658	---	---	7286.391	1929.879	0.131
	Subtotal	**7.18**	**6.04**	**0.00**	**15.88**	**2.04**	**208.99**	**3.00**	**2.49**	**0.00**	**1.66**	**0.00**	**0.00**	**7,434.73**	**1,929.89**	**0.13**
	CONSTRUCTION SUBTOTAL[1]	**73.64**	**311.88**	**3.19**	**113.70**	**14.54**	**226.38**	**3.35**	**2.64**	**0.00**	**1.76**	**0.00**	**0.04**	**67,967**	**1,933**	**1**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Wind Erosion	---	---	---	50.204	5.020	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	146.111	14.611	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	42.083	38.456	0.044	1.608	1.608	6.031	0.041	0.012	---	0.009	---	---	5083.468	0.262	0.134
	Pad Heaters	214.405	180.100	---	16.295	16.295	11.792	0.005	0.007	---	---	---	0.161	257285.893	4.931	4.717
	Produced Water and Condensate Tanks	---	---	---	---	---	3415.144	15.731	---	---	---	106.207	---	---	---	---
	Truck Loading	---	---	---	---	---	0.755	0.012	0.020	0.000	0.006	0.095	---	0.099	0.331	0.000
	Pneumatic Devices	---	---	---	---	---	4820.990	69.094	57.349	0.000	38.258	479.330	---	3643.358	46755.055	0.000
	Pneumatic Pumps	---	---	---	---	---	0.312	0.004	0.004	0.000	0.002	0.031	---	0.236	3.024	0.000
	Well Blowdowns	---	---	---	---	---	41.276	0.592	0.491	0.000	0.328	4.104	---	31.193	400.300	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.605	3.096	---	0.037	0.037	9.353	0.141	0.116	0.000	0.077	0.958	0.004	910.886	88.990	0.012
	Equipment Leaks	---	---	---	---	---	999.614	15.435	42.340	1.104	40.145	104.999	---	483.128	6192.965	0.000
	Subtotal	**257.09**	**221.65**	**0.04**	**214.25**	**37.57**	**9,305.27**	**101.06**	**100.34**	**1.10**	**78.83**	**695.72**	**0.16**	**267,438.26**	**53,445.86**	**4.86**
	Centralized Compression and Processing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Field Compression (2010 Emissions)	792.967	1585.935	---	---	---	555.077	1.092	1.013	0.099	0.457	2.756	131.099	273123.393	3103.675	2.291
	Compressor Station Equipment Leaks	---	---	---	---	---	7.521	0.120	0.425	0.012	0.415	0.810	---	2.682	34.347	0.000
	Compressor Station Dehydrators	6.534	5.489	---	0.497	0.497	621.637	113.196	67.012	---	20.650	57.730	0.005	7919.070	1000.817	0.144
	Subtotal (with 2010 engines)	**799.50**	**1,591.42**	**0.00**	**0.50**	**0.50**	**1,184.24**	**114.41**	**68.45**	**0.11**	**21.52**	**61.30**	**131.10**	**281,045.15**	**4,138.84**	**2.43**
	PRODUCTION SUBTOTAL	**1,056.59**	**1,813.08**	**0.04**	**214.75**	**38.07**	**10,489.50**	**215.46**	**168.79**	**1.21**	**100.35**	**757.02**	**131.27**	**548,483.41**	**57,584.70**	**7**
	CONSTRUCTION AND PRODUCTION TOTAL	**1,130.23**	**2,124.95**	**3.23**	**328.45**	**52.61**	**10,715.88**	**218.81**	**171.43**	**1.21**	**102.11**	**757.02**	**131.31**	**616,450.49**	**59,517.50**	**8**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Field Wide Year 2028 Emission Summary (tons/year)

CRVFO Alternative: Alternative C
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities (BLM and non-BLM sources)
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	4.434	0.443	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	2.717	0.272	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	2.743	0.778	0.010	0.250	0.250	0.254	0.001	0.000	---	0.000	---	0.001	184.725	0.009	0.002
	Delivery/Commuter Vehicle Exhaust	0.226	0.250	0.000	0.009	0.009	0.037	0.000	0.000	---	0.000	---	0.000	27.520	0.002	0.001
	Subtotal	**2.969**	**1.027**	**0.010**	**7.411**	**0.974**	**0.291**	**0.001**	**0.001**	**0.000**	**0.000**	**0.000**	**0.002**	**212.245**	**0.010**	**0.003**
	Drill Rig Move and Drilling	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Road Dust	---	---	---	1.727	0.173	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.123	0.092	0.000	0.005	0.005	0.016	0.000	0.000	---	0.000	---	0.000	14.717	0.001	0.000
	Drilling Traffic Road Dust	---	---	---	85.913	8.591	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	6.305	7.988	0.006	0.253	0.253	1.105	0.012	0.002	---	0.002	---	0.013	771.972	0.046	0.026
	Drill Rig Engines - Tier 4b (2015)	39.254	204.123	2.183	1.727	1.727	10.991	0.233	0.102	---	0.071	---	0.020	40953.385	1.969	0.442
	Frac Pump Engines - Tier4b	17.8093	92.6081	0.9902	0.7836	0.7836	4.9866	0.1055	0.0462	---	0.0323	---	0.0089	18580.0419	0.8935	0.2006
	Subtotal (with Tier 4B drill rigs)	**63.492**	**304.81**	**3.18**	**90.41**	**11.53**	**17.10**	**0.35**	**0.15**	**0.00**	**0.11**	**0.00**	**0.04**	**60,320.12**	**2.91**	**0.67**
	Completion and Testing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Road Dust	---	---	---	9.538	0.954	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.729	0.547	0.001	0.027	0.027	0.094	0.000	0.000	---	0.000	---	0.001	87.463	0.004	0.002
	Completion Traffic Road Dust	---	---	---	5.842	0.584	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.503	0.496	0.001	0.019	0.019	0.075	0.001	0.000	---	0.000	---	0.001	60.873	0.003	0.002
	Completion Venting and Flaring	5.947	4.995	---	0.452	0.452	208.821	2.994	2.485	---	1.658	---	---	7286.391	1929.879	0.131
	Subtotal	**7.18**	**6.04**	**0.00**	**15.88**	**2.04**	**208.99**	**3.00**	**2.49**	**0.00**	**1.66**	**0.00**	**0.00**	**7,434.73**	**1,929.89**	**0.13**
	CONSTRUCTION SUBTOTAL[1]	**73.64**	**311.88**	**3.19**	**113.70**	**14.54**	**226.38**	**3.35**	**2.64**	**0.00**	**1.76**	**0.00**	**0.04**	**67,967**	**1,933**	**1**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
	Wind Erosion	---	---	---	50.204	5.020	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	146.111	14.611	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	42.083	38.456	0.044	1.608	1.608	6.031	0.041	0.012	---	0.009	---	---	5083.468	0.262	0.134
	Pad Heaters	214.405	180.100	---	16.295	16.295	11.792	0.005	0.007	---	---	---	0.161	257285.893	4.931	4.717
	Produced Water and Condensate Tanks	---	---	---	---	---	3415.144	15.731	---	---	---	106.207	---	---	---	---
	Truck Loading	---	---	---	---	---	0.755	0.012	0.020	0.000	0.006	0.095	---	0.099	0.331	0.000
	Pneumatic Devices	---	---	---	---	---	4820.990	69.094	57.349	0.000	38.258	479.330	---	3643.358	46755.055	0.000
	Pneumatic Pumps	---	---	---	---	---	0.312	0.004	0.004	0.000	0.002	0.031	---	0.236	3.024	0.000
	Well Blowdowns	---	---	---	---	---	41.276	0.592	0.491	0.000	0.328	4.104	---	31.193	400.300	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.605	3.096	---	0.037	0.037	9.353	0.141	0.116	0.000	0.077	0.958	0.004	910.886	88.990	0.012
	Equipment Leaks	---	---	---	---	---	999.614	15.435	42.340	1.104	40.145	104.999	---	483.128	6192.965	0.000
	Subtotal	**257.09**	**221.65**	**0.04**	**214.25**	**37.57**	**9,305.27**	**101.06**	**100.34**	**1.10**	**78.83**	**695.72**	**0.16**	**267,438.26**	**53,445.86**	**4.86**
	Centralized Compression and Processing	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
	Field Compression (2010 Emissions)	792.967	1585.935	---	---	---	555.077	1.092	1.013	0.099	0.457	2.756	131.099	273123.393	3103.675	2.291
	Compressor Station Equipment Leaks	---	---	---	---	---	7.521	0.120	0.425	0.012	0.415	0.810	---	2.682	34.347	0.000
	Compressor Station Dehydrators	6.534	5.489	---	0.497	0.497	621.637	113.196	67.012	---	20.650	57.730	0.005	7919.070	1000.817	0.144
	Subtotal (with 2010 engines)	**799.50**	**1,591.42**	**0.00**	**0.50**	**0.50**	**1,184.24**	**114.41**	**68.45**	**0.11**	**21.52**	**61.30**	**131.10**	**281,045.15**	**4,138.84**	**2.43**
	PRODUCTION SUBTOTAL	**1,056.59**	**1,813.08**	**0.04**	**214.75**	**38.07**	**10,489.50**	**215.46**	**168.79**	**1.21**	**100.35**	**757.02**	**131.27**	**548,483.41**	**57,584.70**	**7**
	CONSTRUCTION AND PRODUCTION TOTAL	**1,130.23**	**2,124.95**	**3.23**	**328.45**	**52.61**	**10,715.88**	**218.81**	**171.43**	**1.21**	**102.11**	**757.02**	**131.31**	**616,450.49**	**59,517.50**	**8**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Field Wide Year 2028 Emission Summary (tons/year)

CRVFO Alternative: Alternative D
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities (BLM and non-BLM sources)
Date: 5/18/2010

	Emissions by Source Category															
	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	6.334	0.633	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	3.882	0.388	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	3.919	1.111	0.014	0.358	0.358	0.363	0.001	0.001	---	0.000	---	0.002	263.887	0.013	0.003
	Delivery/Commuter Vehicle Exhaust	0.323	0.357	0.000	0.013	0.013	0.052	0.000	0.000	---	0.000	---	0.001	39.314	0.002	0.001
	Subtotal	**4.242**	**1.468**	**0.014**	**10.586**	**1.392**	**0.415**	**0.002**	**0.001**	**0.000**	**0.001**	**0.000**	**0.002**	**303.201**	**0.015**	**0.004**
	Drill Rig Move and Drilling	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Road Dust	---	---	---	2.467	0.247	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.175	0.132	0.000	0.007	0.007	0.023	0.000	0.000	---	0.000	---	0.000	21.024	0.001	0.000
	Drilling Traffic Road Dust	---	---	---	122.730	12.273	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	9.007	11.412	0.009	0.362	0.362	1.579	0.016	0.003	---	0.002	---	0.019	1102.797	0.066	0.037
	Drill Rig Engines - Tier 4b (2015)	56.077	291.599	3.118	2.467	2.467	15.701	0.332	0.145	---	0.102	---	0.028	58503.769	2.813	0.632
	Frac Pump Engines - Tier4b	25.4413	132.2949	1.4145	1.1194	1.1194	7.1236	0.1507	0.0660	---	0.0462	---	0.0127	26542.4328	1.2763	0.2865
	Subtotal (with Tier 4B drill rigs)	**90.701**	**435.44**	**4.54**	**129.15**	**16.47**	**24.43**	**0.50**	**0.21**	**0.00**	**0.15**	**0.00**	**0.06**	**86,170.02**	**4.16**	**0.96**
	Completion and Testing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Road Dust	---	---	---	13.625	1.363	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	1.041	0.782	0.001	0.039	0.039	0.134	0.001	0.000	---	0.000	---	0.001	124.945	0.006	0.003
	Completion Traffic Road Dust	---	---	---	8.345	0.835	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.718	0.709	0.001	0.028	0.028	0.108	0.001	0.000	---	0.000	---	0.001	86.960	0.005	0.002
	Completion Venting and Flaring	8.195	6.884	---	0.623	0.623	287.779	4.127	3.425	---	2.285	---	---	10041.501	2659.599	0.180
	Subtotal	**9.95**	**8.38**	**0.00**	**22.66**	**2.89**	**288.02**	**4.13**	**3.43**	**0.00**	**2.29**	**0.00**	**0.00**	**10,253.41**	**2,659.61**	**0.19**
	CONSTRUCTION SUBTOTAL[1]	**104.90**	**445.28**	**4.56**	**162.40**	**20.75**	**312.86**	**4.63**	**3.64**	**0.00**	**2.44**	**0.00**	**0.06**	**96,727**	**2,664**	**1**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Wind Erosion	---	---	---	71.718	7.172	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	402.213	40.221	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	66.382	59.643	0.069	2.531	2.531	9.422	0.063	0.019	---	0.014	---	---	8014.085	0.410	0.208
	Pad Heaters	306.287	257.281	---	23.278	23.278	16.846	0.006	0.010	---	---	---	0.230	367544.571	7.045	6.738
	Produced Water and Condensate Tanks	---	---	---	---	---	4878.628	22.472	---	---	---	151.719	---	---	---	---
	Truck Loading	---	---	---	---	---	1.079	0.018	0.029	0.000	0.009	0.136	---	0.141	0.472	0.000
	Pneumatic Devices	---	---	---	---	---	6887.003	98.704	81.926	0.000	54.654	684.745	---	5204.703	66791.718	0.000
	Pneumatic Pumps	---	---	---	---	---	0.446	0.006	0.005	0.000	0.004	0.044	---	0.337	4.321	0.000
	Well Blowdowns	---	---	---	---	---	58.964	0.845	0.701	0.000	0.468	5.863	---	44.561	571.847	0.000
	Well Workover & Recompletion (Venting, Flaring)	0.864	4.423	---	0.053	0.053	13.362	0.202	0.166	0.000	0.111	1.368	0.006	1301.243	127.126	0.017
	Equipment Leaks	---	---	---	---	---	1427.994	22.050	60.485	1.577	57.349	149.995	---	690.170	8846.932	0.000
	Subtotal	**373.53**	**321.35**	**0.07**	**499.79**	**73.25**	**13,293.74**	**144.37**	**143.34**	**1.58**	**112.61**	**993.87**	**0.24**	**382,799.81**	**76,349.87**	**6.96**
	Centralized Compression and Processing	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Field Compression (2010 Emissions)	1549.531	3099.062	---	---	---	1084.672	2.135	1.980	0.193	0.893	5.386	256.180	533708.272	6064.867	4.477
	Compressor Station Equipment Leaks	---	---	---	---	---	10.744	0.171	0.607	0.017	0.592	1.157	---	3.832	49.066	0.000
	Compressor Station Dehydrators	9.334	7.841	---	0.709	0.709	888.027	161.704	95.729	---	29.499	82.468	0.007	11312.750	1429.696	0.205
	Subtotal (with 2010 engines)	**1,558.87**	**3,106.90**	**0.00**	**0.71**	**0.71**	**1,983.44**	**164.01**	**98.32**	**0.21**	**30.98**	**89.01**	**256.19**	**545,024.85**	**7,543.63**	**4.68**
	PRODUCTION SUBTOTAL	**1,932.40**	**3,428.25**	**0.07**	**500.50**	**73.96**	**15,277.19**	**308.38**	**241.66**	**1.79**	**143.59**	**1,082.88**	**256.42**	**927,824.66**	**83,893.50**	**12**
	CONSTRUCTION AND PRODUCTION TOTAL	**2,037.30**	**3,873.53**	**4.63**	**662.90**	**94.72**	**15,590.05**	**313.01**	**245.30**	**1.79**	**146.03**	**1,082.88**	**256.49**	**1,024,551.29**	**86,557.28**	**13**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

CRVFO Total Emissions By Year — Alternative A

Estimated Number of Drill Rigs Each Year

NOTE: These totals are simplified totals and assume that all oil and gas facilities are on BLM land.

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Number of Rigs	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58	7.58

Estimated Number of Wells to be Drilled Yearly Per Above Drill Rig Schedule

Average wells drilled by rig per year (final ye 52.14

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Wells Drilled During Year	851	959	998	998	1,025	844	788	748	482	453	404	404	394	391	388	388	388	391	384	395
Total Producing Wells	851	1,811	2,809	3,807	4,831	5,675	6,463	7,211	7,693	8,146	8,550	8,954	9,348	9,739	10,127	10,514	10,902	11,293	11,677	12,072

Estimated Construction Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Tier 2 Drill Rig Engines (%)	100%	100%	100%	100%	100%	100%	80%	60%	40%	20%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tier 4a Drill Rig Engines (%)	0%	0%	0%	0%	0%	0%	20%	40%	60%	80%	80%	60%	40%	20%	0%	0%	0%	0%	0%	0%
Tier 4b Drill Rig Engines (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%
NO_X	1,074.59	1,211.30	1,260.06	1,260.06	1,293.52	1,065.02	829.85	630.64	304.92	191.70	86	86	84	83	83	83	83	83	82	84
VOC	1,021.51	1,151.47	1,197.82	1,197.82	1,229.63	1,012.42	911.00	831.32	513.71	462.86	391.22	387.11	372.95	366.11	359.33	359.33	359.33	362.13	355.82	366.34

Estimated Production Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Compressors 2007 Standards (%)	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Compressors 2010 Standards (%)	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
NO_X	235.91	274.56	425.91	577.26	732.63	860.55	980.09	1,093.55	1,166.58	1,235.25	1,296.57	1,357.89	1,417.60	1,476.86	1,535.65	1,594.44	1,653.24	1,712.49	1,770.71	1,830.65
VOC	1,086.11	2,242.21	3,478.19	4,714.17	5,982.98	7,027.66	8,003.88	8,930.39	9,526.82	10,087.60	10,588.37	11,089.14	11,576.78	12,060.67	12,540.81	13,020.95	13,501.09	13,984.98	14,460.43	14,949.95

Estimated Total Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
NO_X	1,310	1,486	1,686	1,837	2,026	1,926	1,810	1,724	1,472	1,427	1,383	1,444	1,502	1,560	1,618	1,677	1,736	1,796	1,853	1,915
VOC	2,108	3,394	4,676	5,912	7,213	8,040	8,915	9,762	10,041	10,550	10,980	11,476	11,950	12,427	12,900	13,380	13,860	14,347	14,816	15,316

CRVFO Total Emissions By Year — Alternative B and C

Estimated Number of Drill Rigs Each Year

NOTE: These totals are simplified totals and assume that all oil and gas facilities are on BLM land.

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Number of Rigs	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

Estimated Number of Wells to be Drilled Yearly Per Above Drill Rig Schedule

Average wells drilled by rig per year (final year) 52.143

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Wells Drilled During Year	773	871	907	907	931	766	716	680	437	411	367	367	358	355	352	352	352	355	349	359
Total Producing Wells	773	1,645	2,551	3,458	4,388	5,154	5,870	6,550	6,987	7,399	7,766	8,133	8,491	8,846	9,198	9,550	9,902	10,257	10,606	10,965

Estimated Construction Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Tier 2 Drill Rig Engines (%)	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tier 4a Drill Rig Engines (%)	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	80%	60%	40%	20%	0%	0%	0%	0%	0%	0%
Tier 4b Drill Rig Engines (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%
NO_X	957.11	164.74	171.37	171.37	175.92	144.84	135.35	128.46	82.69	77.75	69.43	69.43	67.61	67.09	66.57	66.57	66.57	67.09	65.92	67.87
VOCs	262.72	102.24	106.36	106.36	109.18	89.89	84.00	79.73	51.32	48.26	39.36	35.62	31.05	27.20	23.41	23.41	23.41	23.59	23.18	23.86

Estimated Production Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Compressor 2007 Standards (%)	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Compressor 2010 Standards (%)	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
NO_X	16.41	34.91	54.15	73.39	93.14	109.40	124.60	139.02	148.31	157.04	164.84	172.63	180.22	187.76	195.23	202.71	210.18	217.71	225.11	232.74
VOCs	442.27	940.81	1,459.41	1,978.02	2,510.39	2,948.73	3,358.34	3,747.10	3,997.35	4,232.65	4,442.77	4,652.88	4,857.49	5,060.53	5,261.99	5,463.45	5,664.91	5,867.95	6,067.44	6,272.83

Estimated Total Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
NO_X	974	200	226	245	269	254	260	267	231	235	234	242	248	255	262	269	277	285	291	301
VOCs	705	1,043	1,566	2,084	2,620	3,039	3,442	3,827	4,049	4,281	4,482	4,689	4,889	5,088	5,285	5,487	5,688	5,892	6,091	6,297

CRVFO Total Emissions By Year — Alternative D — Assumes All Sources on Federal Land

Estimated Number of Drill Rigs Each Year

NOTE: These totals are simplified totals and assume that all oil and gas facilities are on BLM land.

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Number of Rigs	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84	9.84
Rounded Number of Rigs	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Estimated Number of Wells to be Drilled Yearly Per Above Drill Rig Schedule

Average wells drilled by rig per year (final year) 52.143

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Wells Drilled During Year	1,104	1,245	1,295	1,295	1,329	1,095	1,023	971	625	588	525	525	511	507	503	503	503	507	498	513
Total Producing Wells	1,104	2,349	3,644	4,939	6,269	7,363	8,386	9,357	9,982	10,569	11,094	11,619	12,130	12,637	13,140	13,643	14,146	14,653	15,151	15,664

Estimated Construction Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Tier 2 Drill Rig Engines (%)	100%	100%	100%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tier 4a Drill Rig Engines (%)	0%	0%	0%	0%	0%	0%	100%	100%	100%	100%	80%	60%	40%	20%	0%	0%	0%	0%	0%	0%
Tier 4b Drill Rig Engines (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	20%	40%	60%	80%	100%	100%	100%	100%	100%	100%
NO_X	1,367.27	1,541.22	1,603.26	1,603.26	1,645.83	1,355.10	193.36	183.51	118.13	111.07	99.19	99.19	96.59	95.84	95.10	95.10	95.10	95.84	94.17	96.96
VOCs	375.31	423.06	440.09	440.09	451.78	371.97	120.00	113.89	73.32	68.94	56.22	50.88	44.35	38.85	33.44	33.44	33.44	33.70	33.11	34.09

Estimated Production Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
Compressor 2007 Standards (%)	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Compressor 2010 Standards (%)	0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
NO_X	163.12	199.53	309.52	419.51	532.43	625.39	712.27	794.72	847.79	897.70	942.26	986.82	1,030.22	1,073.28	1,116.01	1,158.74	1,201.46	1,244.52	1,286.83	1,330.40
VOCs	701.25	1,447.49	2,245.39	3,043.30	3,862.39	4,536.80	5,167.01	5,765.13	6,150.16	6,512.18	6,835.46	7,158.74	7,473.54	7,785.93	8,095.89	8,405.85	8,715.81	9,028.19	9,335.12	9,651.13

Estimated Total Emissions (tons/yr)

Year	1 2009	2 2010	3 2011	4 2012	5 2013	6 2014	7 2015	8 2016	9 2017	10 2018	11 2019	12 2020	13 2021	14 2022	15 2023	16 2024	17 2025	18 2026	19 2027	20 2028
NO_X	1,530	1,741	1,913	2,023	2,178	1,980	906	978	966	1,009	1,041	1,086	1,127	1,169	1,211	1,254	1,297	1,340	1,381	1,427
VOCs	1,077	1,871	2,685	3,483	4,314	4,909	5,287	5,879	6,223	6,581	6,892	7,210	7,518	7,825	8,129	8,439	8,749	9,062	9,368	9,685

Vernal Field Office (VFO)

5/10/2010

~~Development Scenario~~	Values
~~Wells Developed Over 20 Years (2006 through 2028)~~	5,400
~~Natural Gas (NG) Wells Operating in 2028~~	2,154
~~Oil Wells Operating in 2028~~	2,055
~~Number of NG Well Pads~~	615
~~Number of Oil Well Pads~~	1,370
~~Typical NG Wells Per Pad~~	3.5
~~Typical Oil Wells Per Pad~~	1.5
~~Maximum Additional Drill Rigs~~	20
~~Maximum Gas Production (MMscfd)~~	1,939
~~Gas Production Per Well (MMscfd/well)~~	0.900
~~Gas Production at Well Pad (MMscfd/well pad)~~	3.150
~~Gas Wells Constructed in Year 2028~~	800
~~Maximum Oil Production (bbl/day)~~	82,200
~~Oil Production Per Well (bbl/day/well)~~	40.0
~~Oil Production at Well Pad (bbl/day/well pad)~~	140.0
~~Oil Wells Constructed in Year 2028~~	200

~~Gas Processing~~	Values
~~Total Gas Processing Needed (MMscfd)~~	1,939
~~Assumed Gas Processing Plant Size (MMscfd)~~	200
~~Number of Gas Processing Plants~~	10

Emission Controls

Emission Source	Controlled Pollutant	Values
Local Roads	PM_{10}, $PM_{2.5}$	50
Resource Roads	PM_{10}, $PM_{2.5}$	50
Construction Activities	PM_{10}, $PM_{2.5}$	50
Compressor Engines[1]	All (due to electrification)	50
Well Completion	VOC, HAP	47.5
Glycol Dehydrators[2]	VOC, HAP	0
Condensate and Produced Water Tanks[2]	VOC, HAP	0

Emission Source	Controlled Pollutant	Values
Local Roads	PM_{10}, $PM_{2.5}$	Watering or chemical suppression.
Resource Roads	PM_{10}, $PM_{2.5}$	Watering.
Construction Activities	PM_{10}, $PM_{2.5}$	Watering or chemical suppression.
Drill Rig Engines	SO_2	Ultra-low sulfur diesel fuel (15 ppm).
Drill Rig Engines	NO_x, PM_{10}, $PM_{2.5}$, VOC	Turnover and transitioning to Tier 4 engines (or better); all Tier 4 engines beginning in 2019.
Frac Pump Engines	NO_x, PM_{10}, $PM_{2.5}$, VOC	Turnover and transitioning to Tier 4 engines (or better); all Tier 4 engines beginning in 2019.
Well Completion	VOC, HAP	No green completion. Of emitted gas, 50% is vented and 50% is flared with 95% control of flared gas.
Compressor Engines[1]	CO, NO_x, VOC	Meet EPA and Utah standards.
Compressor Engines[1]	All	50% of compression will be electrically powered.
Glycol Dehydrators[2]	VOC, HAP	Meet EPA and Utah standards.
Condensate and Produced Water Tanks[3]	VOC, HAP	No control, unless required by EPA or Utah regulations.

[1] Compressor engines will meet engine manufacturer emission control standards in accordance federal and state regulations. These controls are reflected in the emission factors used to calculate emissions; consequently, zero emission control is shown for most compressor engines. At least 50 percent of all compression will be electrically driven. This is accounted for by including 50 percent "control" of all emissions associated with compressor engines.

[2] Equipment located at major sources of air pollution could be subject to more stringent control, as determined by Utah DEQ on a case-by-case basis.

Year 2028 Oil and Natural Gas Emission Summary (tons)

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/10/2010

Actitivty Description for Oil and NG Wells

2028 Activity	Total	Natural Gas (NG)	Oil
Wells Constructed During 2028 [1]	1,000	800	200
Drill Rigs Operating During 2028 [1]	20	16	4
Wells Operating During 2028 [1]	4,209	2,154	2,055
Operating Gas Plants (CTFs) [2]	10	10	0

[1] Approximate locations of wells, drill rigs, and compressor stations were provided by the BLM.
[2] All gas plants are conservatively assumed to be located on BLM land.

Total Oil and NG Emissions

		Emissions (ton/yr)														
		NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethyl-benzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
VFO	Oil	1,586	3,087	7	3,448	401	4,555	210	161	1	63	122	151	1,019,099	15,239	9
	NG	2,219	1,781	4	3,034	498	537	0	0	0	0	0	0	123,739	4	2
	Total	**3,805**	**4,869**	**11**	**6,482**	**899**	**5,092**	**210**	**161**	**1**	**63**	**122**	**151**	**1,142,838**	**15,242**	**11**

Scaling Factors for VFO

NOTE: These scaling factors are used throughout the emission calculation worksheets in order to streamline calculations throughout this worksheet.

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Date: 5/10/2010

Source Category	Parameter Value (Units shown at left)	Scaling Factor for Alternative Calculations (Units are number of wells, number of sources, or percentage)
Land Disturbance From Well Pad, Resource Road to Well Pad, an equal portion of the divided Local Road for each well pad, an equal portion of the divided area for other associated infrastructure, and pipeline disturbance per pad (acres)	**6**	1
Ratio of Months with Frozen or Muddy Roads	**0.33**	0.33
Vehicle Road Dust Local Road -- Control Percent (%)	**50**	0.5
Vehicle Road Dust Resource Road -- Control Percent (%)	**50**	0.5
NG Well Count Per Pad	**3.5**	3.5
Oil Well Count Per Pad	**1.5**	1.5
Condensate Tank -- Control Percent (%)	**0**	1
Produced Water Tank -- Control Percent (%)	**0**	1
Glycol Dehydrator -- Control Percent (%)	**0**	1
Percent of producing wells that are recompleted each year (%)	**1**	54
Number of pneumatic pumps for all gas plants	**0**	0.00000
Number of pneumatic pumps for all compressor stations	**0**	0.00000
Number of pneumatic pumps for all consolidated field facilities	**0**	0.00000
Number of pneumatic pumps per well	**---**	1.00000
For well completion -- percentage of wells with green completion	**0**	1.00000
Well Pad Wind Erosion Emissions During Production -- Control Percent (%)	**50**	0.4785
Electrification of Compressor Engines (%)	**50**	0.5000

Land Disturbance From Well Pad, Resource Road, and Local Road Construction

VFO Alternative: RFD
Phase: Construction
Activity: Well Pad Construction
Emissions: Fugitive Particulate Emissions from Well Pad and Resource Road Construction
Date: 5/10/2010

Well Pad, Resource Road, Local Road Area [1]	Construction Activity TSP Emission Factor[2]	Construction Activity Duration	Construction Activity Duration	Manual Emission Control Efficiency	Rainfall Emission Control Efficiency[3]	PM_{10} Emissions (controlled)	$PM_{2.5}$ Emissions (controlled)[4]	Wells per Well Pad	PM_{10} Emissions (controlled)	$PM_{2.5}$ Emissions (controlled)
(acre)	(tons/acre-month)	(days/well pad)	(hours/day)	(%)	(%)	(lb/well pad)	(lb/well pad)		(lb/well)	(lb/well)
6.0	1.2	7.5	12	50	100	212.38	21.24	3.5	60.68	6.07
		Well Pad Construction Emissions (lb/well/day)				8.09	0.81		2.31	0.23

[1] Total disturbance area per well pad is estimated to be 7.25 acres for the well pad, 1.0 acre for a portion of compressor station and central treating facility (CTF), 1.75 acres for resource road and portion of local road area, and 2 acres for a portion of pipeline disturbance.

[2] AP-42 (EPA 2006), Section 13.2.3, "Heavy Construction Operations".

[3] Frequency is 4.3% of annual hours have measurable precipitation -- Western Regional Climate Center (http://www.wrcc.dri.edu/htmlfiles/hrsofppt.html).

[4] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on "Analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).

Vehicle Road Dust From Well Pad/Resource Road Construction

VFO Alternative: RFD
Phase: Construction
Activity: Well Pad/Resource Road
Emissions: Fugitive Particulate From Well Pad and Resource Road Construction Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/pad)	(miles)	(VMT/pad)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/pad)	(lb/pad)
Low boy hauler	Local	water/chemical	85,000	25	20	4	10	40	0.333	0	5.22	0.52	208.83	20.88
	Resource	water	85,000	25	20	4	0.8	3.2	0.333	0	5.22	0.52	16.71	1.67
Gravel haul trucks	Local	water/chemical	54,000	25	20	50	10	500	0.333	0	4.26	0.43	2128.35	212.83
	Resource	water	54,000	25	20	50	0.8	40	0.333	0	4.26	0.43	170.27	17.03
Fuel tanker	Local	water/chemical	54,000	25	20	1	10	10	0.333	0	4.26	0.43	42.57	4.26
	Resource	water	54,000	25	20	1	0.8	0.8	0.333	0	4.26	0.43	3.41	0.34
Water tanker (100 bbl)	Local	water/chemical	54,000	25	20	20	10	200	0.333	0	4.26	0.43	851.34	85.13
	Resource	water	54,000	25	20	20	0.8	16	0.333	0	4.26	0.43	68.11	6.81
Light trucks/pickups	Local	water/chemical	8,000	35	20	30	10	300	0.333	0	1.80	0.18	540.76	54.08
	Resource	water	8,000	35	20	30	0.8	24	0.333	0	1.80	0.18	43.26	4.33
												Total Unpaved Road Traffic Emissions (lb/pad)	4,073.60	407.36
												Wells per Pad	3.5	3.5
												Total Unpaved Road Traffic Emissions (lb/well)	1,163.89	116.39

[1] Silt content was confirmed by VFO personnel (September 4, 2009).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Pad/Resource Road Heavy Construction Equipment Exhaust

VFO Alternative: RFD
Phase: Construction
Activity: Well Pad/Resource Road
Emissions: Diesel Combustion Emissions from Heavy Equipment Exhaust
Date: 5/10/2010

Heavy Equipment	Engine Horsepower	Operating Load Factor[1]	Pollutant Emission Factor												Construction Activity Duration	Pollutant Emissions											
	(hp)		(g/hp-hr)												(hr)	(lb/well pad)											
			CO	NO_x	SO_2	VOC	PM_{10}[4]	CO_2[5]	CH_4[6]	N_2O[9]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]		CO	NO_x	SO_2[8]	VOC	PM_{10}[4]	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Backhoe[2]	100	0.4	2.45	7.46	0.027	0.55	0.789	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	9	1.94	5.92	0.02	0.44	0.63	414.37	0.02	0.00	0.00	0.00	0.00	0.00
Motor Grader[2]	165	0.4	2.45	7.46	0.027	0.55	0.789	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	12	4.28	13.03	0.05	0.96	1.38	911.60	0.04	0.01	0.01	0.01	0.00	0.00
D8 Dozer[3]	300	0.4	2.15	7.81	0.027	0.75	0.692	522.1	0.0251	0.0056	0.0037	0.00296	0.00129	0.000905	50	28.44	103.31	0.36	9.92	9.15	6906.08	0.33	0.07	0.05	0.04	0.02	0.01
															Total Heavy Equipment Exhaust Emissions (lb/well pad)	34.66	122.25	0.43	11.32	11.16	8232.05	0.40	0.09	0.06	0.05	0.02	0.01
															Wells per Pad	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
															Total Heavy Equipment Exhaust Emissions (lb/well)	9.90	34.93	0.12	3.23	3.19	2352.02	0.11	0.03	0.02	0.01	0.01	0.00

1 Taken from "Surface Mining" (Pfleider 1972) for average service duty.
2 AP-42 (EPA 1985), Volume II Mobile Sources. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).
3 Emission factor for track-type tractor.
4 $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.
5 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"; lb/hp-hr = pounds per horsepower-hour.
6 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).
7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; converted to g/hp-hr
8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.
9 Based on N_2O emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

Well Pad/Resource Road Construction Vehicle Exhaust

VFO Alternative: RFD
Phase: Construction
Activity: Well Pad/Resource Road Construction
Emissions: Construction Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well pad)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[9]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Low boy hauler	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	4	10.8	43.2	0.58	1.35	0.00	0.10	0.05	161.90	0.01	0.00	0.00	0.00	0.00	0.00
Gravel hauler	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	50	10.8	540	7.19	16.88	0.02	1.27	0.57	2023.81	0.10	0.05	0.01	0.01	0.00	0.00
Fuel tanker	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	1	10.8	10.8	0.14	0.34	0.00	0.03	0.01	40.48	0.00	0.00	0.00	0.00	0.00	0.00
Water tanker (100 bbl)	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	3.88E-02	0.0107	0.0085	0.00371	0.0026	20	10.8	216	2.88	6.75	0.01	0.51	0.23	809.52	0.04	0.02	0.01	0.00	0.00	0.00
Light duty diesel truck	3.2965	1.786	0.00516	1.612	0.2843	230	0.018	4.59E-02	0.0622	0.03224	0.00371	0.0026	18	10.8	194.4	1.41	0.77	---	0.69	0.12	98.57	0.01	0.02	0.03	0.01	0.00	0.00
Light duty gasoline truck	45.965	2.01075	0.00437	2.967	0.0302	330	0.119	4.92E-02	0.0448	0.0798	0.00371	0.0026	12	10.8	129.6	13.13	0.57	---	0.85	0.01	94.29	0.03	0.01	0.01	0.02	0.00	0.00
Total Heavy Equipment Exhaust Emissions (lb/well pad)																25.33	26.66	0.02	3.44	0.99	3228.57	0.19	0.10	0.06	0.05	0.01	0.01
Wells per Pad																3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Total Heavy Equipment Exhaust Emissions (lb/well)																7.24	7.62	0.01	0.98	0.28	922.45	0.05	0.03	0.02	0.01	0.00	0.00

1 Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

5 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

6 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

9 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust From Drill Rig Transport

VFO Alternative: RFD
Phase: Construction
Activity: Drill Rig Transport
Emissions: Fugitive Particulate from Drill Rig Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Rig Hauler	Local	water/chemical	100,000	25	20	35	10	350	0.333	0	5.62	0.56	1965.91	196.59
	Resource	water	100,000	25	20	35	0.8	28	0.333	0	5.62	0.56	157.27	15.73
Water tanker (130 bbl)	Local	water/chemical	85,000	25	20	276	10	2760	0.333	0	5.22	0.52	14409.32	1440.93
	Resource	water	85,000	25	20	276	0.8	220.8	0.333	0	5.22	0.52	1152.75	115.27
												Total Unpaved Road Traffic Emissions (lb/well)	17,685.25	1,768.52

[1] Silt content was confirmed by VFO personnel (September 4, 2009).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Drill Rig and Drilling Water Transport Exhaust Emissions

VFO Alternative: RFD
Phase: Construction
Activity: Drill Rig and Water Transport
Emissions: Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor												Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Pollutant Emissions											
	(g/mi)												(RT/well)	(miles)	(mi)	(lb/well)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[3]	CH_4[4]	N_2O[7]	Form.[5]	Benzene[5]	Toluene[5]	Xylene[5]				CO	NO_x	SO_2[6]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Rig haulers	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	35	10.8	378	5.03	11.81	0.01	0.89	0.40	1416.67	0.07	0.03	0.01	0.01	0.00	0.00
Water truck (130 bbl)	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	276	10.8	2980.8	39.69	93.17	0.09	7.01	3.16	11171.43	0.53	0.25	0.07	0.06	0.02	0.02
												Total Heavy Equipment Exhaust Emissions (lb/well)				44.72	104.98	0.10	7.89	3.56	12588.10	0.60	0.29	0.08	0.06	0.03	0.02

1 Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.
2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).
3 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.
4 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).
5 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.
6 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.
7 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust During Drilling

VFO Alternative: RFD
Phase: Construction
Activity: Drilling
Emissions: Fugitive Particulate From Drilling Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Fuel tanker	Local	water/chemical	54,000	25	20	10	10	100	0.333	0	4.26	0.43	425.67	42.57
	Resource	water	54,000	25	20	10	0.8	8	0.333	0	4.26	0.43	34.05	3.41
Logging truck	Local	water/chemical	35,000	25	20	1	10	10	0.333	0	3.50	0.35	35.02	3.50
	Resource	water	35,000	25	20	1	0.8	0.8	0.333	0	3.50	0.35	2.80	0.28
Cement truck	Local	water/chemical	54,000	25	20	2	10	20	0.333	0	4.26	0.43	85.13	8.51
	Resource	water	54,000	25	20	2	0.8	1.6	0.333	0	4.26	0.43	6.81	0.68
Cement supply truck	Local	water/chemical	66,000	25	20	2	10	20	0.333	0	4.66	0.47	93.18	9.32
	Resource	water	66,000	25	20	2	0.8	1.6	0.333	0	4.66	0.47	7.45	0.75
Water tanker (100 bbl)	Local	water/chemical	54,000	25	20	0	10	0	0.333	0	4.26	0.43	0.00	0.00
(road dust control)	Resource	water	54,000	25	20	0	0.8	0	0.333	0	4.26	0.43	0.00	0.00
Light duty vehicles (bits)	Local	water/chemical	8,000	35	20	4	10	40	0.333	0	1.80	0.18	72.10	7.21
	Resource	water	8,000	35	20	4	0.8	3.2	0.333	0	1.80	0.18	5.77	0.58
Light duty vehicles	Local	water/chemical	3000	35	20	100	10	1000	0.333	0	1.16	0.12	1159.31	115.93
(commuting)	Resource	water	3000	35	20	100	0.8	80	0.333	0	1.16	0.12	92.74	9.27
												Total Unpaved Road Traffic Emissions (lb/well)	2,020.05	202.01

[1] Silt content was confirmed by VFO personnel (September 4, 2009).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/well x control efficiency.

Drilling Operation Vehicle Exhaust

VFO Alternative: RFD
Phase: Construction
Activity: Drilling
Emissions: Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/well)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[9]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Fuel tanker	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	10	10.8	108	1.44	3.38	0.00	0.25	0.11	404.76	0.02	0.01	0.00	0.00	0.00	0.00
Logging truck	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1	10.8	10.8	0.14	0.34	0.00	0.03	0.01	40.48	0.00	0.00	0.00	0.00	0.00	0.00
Cement truck	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	10.8	21.6	0.29	0.68	0.00	0.05	0.02	80.95	0.00	0.00	0.00	0.00	0.00	0.00
Cement supply truck	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	10.8	21.6	0.29	0.68	0.00	0.05	0.02	80.95	0.00	0.00	0.00	0.00	0.00	0.00
Water truck (100 bbl)	6.04	14.1775	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	0	10.8	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck (bits)	3.2965	1.786	0.00516	1.612	0.2843	230	0.018	0.0459	0.0622	0.03224	0.00371	0.0026	3	10.8	32.4	0.24	0.13	---	0.12	0.02	16.43	0.00	0.00	0.00	0.00	0.00	0.00
Light duty gasoline truck (bits)	45.965	2.01075	0.00437	2.967	0.0302	330	0.119	0.0492	0.0448	0.0798	0.00371	0.0026	1	10.8	10.8	1.09	0.05	---	0.07	0.00	7.86	0.00	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck (commuting)	3.2965	1.786	0.00516	1.612	0.2843	230	0.018	0.0459	0.0622	0.03224	0.00371	0.0026	60	10.8	648	4.71	2.55	---	2.30	0.41	328.57	0.03	0.07	0.09	0.05	0.01	0.00
Light duty gasoline truck (commuting)	45.965	2.01075	0.00437	2.967	0.0302	330	0.119	0.0492	0.0448	0.0798	0.00371	0.0026	40	10.8	432	43.78	1.92	---	2.83	0.03	314.29	0.11	0.05	0.04	0.08	0.00	0.00
															Total Heavy Equipment Exhaust Emissions (lb/well)	51.97	9.71	0.00	5.70	0.63	1274.29	0.17	0.13	0.14	0.13	0.01	0.01

[1] Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

[5] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

[6] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

[9] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Drilling Emissions - Tier 4b - Directional Drilling

VFO Alternative: RFD
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA Tier 4b (2015)
Date: 5/10/2010

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions	Emissions
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	3,000	0.40	5	24	825.40	6.88
NO_x	0.5000	3,000	0.40	5	24	158.73	1.32
SO_2[4]	0.0278	3,000	0.40	5	24	8.83	0.07
VOC	0.1400	3,000	0.40	5	24	44.44	0.37
PM_{10}[5]	0.0220	3,000	0.40	5	24	6.98	0.06
	(lb/hp-hr)						
CO_2[6]	1.15000	3,000	0.40	5	24	165,600.00	1,380.00
CH_4[7]	5.53E-05	3,000	0.40	5	24	7.96	0.07
N_2O[8]	1.24E-05	3,000	0.40	5	24	1.79	0.01
Formaldehyde[9]	5.52E-07	3,000	0.40	5	24	0.08	0.00
Benzene[10]	6.53E-06	3,000	0.40	5	24	0.94	0.01
Toluene[10]	2.86E-06	3,000	0.40	5	24	0.41	0.00
Xylene[10]	2.00E-06	3,000	0.40	5	24	0.29	0.00

1 Emission factors for Tier 4 (2015) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for generator sets greater than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 4, "Tier 4 Emission Standards—Engines Above 560 kW (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

2 Drilling engine total horsepower is based on three 1,000 hp engines, fueled with ultra low sulfur diesel fuel (15 ppm).

3 The overall load factor is 0.4.

4 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjusting for low-sulfur fuel (15 ppm).

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

6 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"; lb/hp-hr = pounds per horsepower-hour.

7 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

8 Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

9 AP-42 (EPA 1996), Section 3.4, "Large Stationary Diesel and All Stationary Dual-Fuel Engines. Table 3.4-3, "Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

10 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

Frac Pump Emissions - Tier 4b

VFO Alternative: RFD
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Frac Pump Engines - EPA Tier 4b (2015)
Date: 5/10/2010

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Fracing Activity Duration	Fracing Activity Duration	Emissions	Emissions
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	12,000	0.85	0.5	12	350.79	58.47
NO_x	0.5000	12,000	0.85	0.5	12	67.46	11.24
SO_2[4]	0.0278	12,000	0.85	0.5	12	3.75	0.63
VOC	0.1400	12,000	0.85	0.5	12	18.89	3.15
PM_{10}[5]	0.02200	12,000	0.85	0.5	12	2.97	0.49
	(lb/hp-hr)						
CO_2[6]	1.15000	12,000	0.85	0.5	12	70,380.00	11,730.00
CH_4[7]	5.53E-05	12,000	0.85	0.5	12	3.38	0.56
N_2O[8]	1.24E-05	12,000	0.85	0.5	12	0.76	0.13
Formaldehyde[9]	5.52E-07	12,000	0.85	0.5	12	0.03	0.01
Benzene[10]	6.53E-06	12,000	0.85	0.5	12	0.40	0.07
Toluene[10]	2.86E-06	12,000	0.85	0.5	12	0.18	0.03
Xylene[10]	2.00E-06	12,000	0.85	0.5	12	0.12	0.02

1 Emission factors for Tier 4 (2015) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for generator sets greater than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 4, "Tier 4 Emission Standards—Engines Above 560 kW (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

2 Drilling engine total horsepower is based on eight 1,500 hp engines, fueled with ultra low sulfur diesel fuel (15 ppm).

3 The overall load factor is 0.85.

4 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjusting for ultra-low sulfur fuel (15 ppm).

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

6 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"; lb/hp-hr = pounds per horsepower-hour.

7 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

8 Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

9 AP-42 (EPA 1996), Section 3.4, "Large Stationary Diesel and All Stationary Dual-Fuel Engines. Table 3.4-3, "Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

10 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average BSFC of 7,000 Btu/hp-hr.

Oil Well Pumpjack Engine

Field Office: Vernal
Phase: Production
Activity: Well Pumpjack Engine
Emissions: Emissions from Diesel-Fueled Engine
Date: 5/10/2010

Pumpjack Engine

Power Rating	105	hp
Operating Load Factor	50	%
Fuel	Ultra-low Sulfur Diesel (15 ppm)	
Engines per Oil Well	1	

Operating Parameters:

Operating Hours	8760	hr/yr

	Emission Factor	Emissions			Emissions per Well	Emissions per Pad
	(g/hp-hr)	(g/hr)	(lb/hr)	(lb/yr)	(lb/well)	(lb/pad)
CO[1]	1.5000	78.750	0.1736	1,520.83	1520.83	3041.67
NO_x[1]	2.0000	105.000	0.2315	2,027.78	2027.78	304.17
PM_{10}[1]	0.2000	10.500	0.0231	202.78	202.78	304.17
$PM_{2.5}$[1]	0.2000	10.500	0.0231	202.78	202.78	4.56
SO_2[1]	0.00300	0.158	0.0003	3.04	3.04	760.42
VOC[1]	0.5000	26.250	0.0579	506.94	506.94	0.00
	(lb/hp-hr)					
CO_2[2]	1.15000	---	1.1500	10,074.00	10074.00	0.73
CH_4[4]	5.53E-05	---	0.0001	0.48	0.48	0.16
N_2O[5]	1.24E-05	---	0.0000	0.11	0.11	0.11
Formaldehyde[3]	8.2407E-06	---	0.0000	0.07	0.07	0.09
Benzene[3]	6.53E-06	---	0.0000	0.06	0.06	0.04
Toluene[3]	2.86E-06	---	0.0000	0.03	0.03	0.03
Xylene[3]	2.00E-06	---	0.0000	0.02	0.02	0.00

[1] Emission rates supplied by BLM on 6/11/08.

[2] 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"; lb/hp-hr = pounds per horsepower-hour.

[3] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

[4] Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

[5] Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

Vehicle Road Dust During Completion Watering

VFO Alternative: RFD
Phase: Construction
Activity: Completion and Testing
Emissions: Fugitive Particulate From Completion and Testing Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Water tanker (100 bbl)	Local	water/chemical	85,000	25	20	238	10	2380	0.333	0	5.22	0.52	12425.43	1242.54
	Resource	water	85,000	25	20	238	0.8	190.4	0.333	0	5.22	0.52	994.03	99.40
												Total Unpaved Road Traffic Emissions (lb/well)	13,419.46	1,341.95

[1] Silt content was confirmed by VFO personnel (September 4, 2009).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Completion Watering Vehicle Exhaust

VFO Alternative: RFD
Phase: Construction
Activity: Well Completion and Testing
Emissions: Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor												Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Pollutant Emissions											
	(g/mi)												(RT/well)	(miles)	(mi)	(lb/well)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[11]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}[4]	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Water truck (100 bbl)	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	238	10.8	2570.4	34.23	80.34	0.08	6.04	2.72	9633.33	0.46	0.22	0.06	0.05	0.02	0.01
	Total Heavy Equipment Exhaust Emissions (lb/well)															34.23	80.34	0.08	6.04	2.72	9633.33	0.46	0.22	0.06	0.05	0.02	0.01

[1] Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

[2] AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

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

[5] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

[6] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

[7] AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

[8] Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

[9] Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[10] Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

[11] Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Vehicle Road Dust During Completion

VFO Alternative: RFD
Phase: Construction
Activity: Completion and Testing
Emissions: Fugitive Particulate From Completion and Testing Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[1]	Round Trips (RTs)	RT Distance	Vehicle Miles Traveled (VMT)[2]	Ratio of Months with Frozen or Muddy Roads	Emission Control Efficiency[3]	PM_{10} Emission Factor[4]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (uncontrolled)	$PM_{2.5}$ Emissions[5] (uncontrolled)
			(lb)	(mph)	(%)	(RT/well)	(miles)	(VMT/well)	(unitless)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Casing hauler	Local	water/chemical	100,000	25	20	3	10	30	0.333333	0	5.62	0.56	168.51	16.85
	Resource	water	100,000	25	20	3	0.8	2.4	0.333333	0	5.62	0.56	13.48	1.35
Completion rig	Local	water/chemical	85,000	25	20	1	10	10	0.333333	0	5.22	0.52	52.21	5.22
	Resource	water	85,000	25	20	1	0.8	0.8	0.333333	0	5.22	0.52	4.18	0.42
Logging truck	Local	water/chemical	35,000	25	20	2	10	20	0.333333	0	3.50	0.35	70.04	7.00
	Resource	water	35,000	25	20	2	1	2	0.333333	0	3.50	0.35	7.00	0.70
Cement truck	Local	water/chemical	54,000	25	20	6	10	60	0.333333	0	4.26	0.43	255.40	25.54
	Resource	water	54,000	25	20	6	1	6	0.333333	0	4.26	0.43	25.54	2.55
Sand truck	Local	water/chemical	85,000	25	20	20	10	200	0.333333	0	5.22	0.52	1044.15	104.42
	Resource	water	85,000	25	20	20	1	20	0.333333	0	5.22	0.52	104.42	10.44
Frac pumper	Local	water/chemical	85,000	25	20	30	10	300	0.333333	0	5.22	0.52	1566.23	156.62
	Resource	water	85,000	25	20	30	1	30	0.333333	0	5.22	0.52	156.62	15.66
Fracmaster delivery	Local	water/chemical	85,000	25	20	2	10	20	0.333333	0	5.22	0.52	104.42	10.44
	Resource	water	85,000	25	20	2	1	2	0.333333	0	5.22	0.52	10.44	1.04
Water tanker (100 bbl)	Local	water/chemical	54,000	25	20	0	10	0	0.333333	0	4.26	0.43	0.00	0.00
	Resource	water	54,000	25	20	0	1	0	0.333333	0	4.26	0.43	0.00	0.00
Light duty gasoline trucks	Local	water/chemical	3,000	35	20	30	10	300	0.333333	0	1.16	0.12	347.79	34.78
	Resource	water	3,000	35	20	30	1	30	0.333333	0	1.16	0.12	34.78	3.48
										Total Unpaved Road Traffic Emissions (lb/well)			3,965.21	396.52

[1] Silt content was confirmed by VFO personnel (September 4, 2009).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.

Well Completion Vehicle Exhaust

VFO Alternative: RFD
Phase: Construction
Activity: Well Completion and Testing
Emissions: Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/well)	RT Distance (miles)	Vehicle Miles Traveled (VMT)[2] (mi)	Pollutant Emissions (lb/well)											
	CO^1	NO_x^1	SO_2^2	VOC^1	PM_{10}^1	CO_2^5	CH_4^6	N_2O^{11}	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2^8	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Casing hauler	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	3	10.8	32.4	0.43	1.01	0.00	0.08	0.03	121.43	0.01	0.00	0.00	0.00	0.00	0.00
Completion rig	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	1	10.8	10.8	0.14	0.34	0.00	0.03	0.01	40.48	0.00	0.00	0.00	0.00	0.00	0.00
Logging truck	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	10.8	21.6	0.29	0.68	0.00	0.05	0.02	80.95	0.00	0.00	0.00	0.00	0.00	0.00
Cement truck	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	6	10.8	64.8	0.86	2.03	0.00	0.15	0.07	242.86	0.01	0.01	0.00	0.00	0.00	0.00
Sand truck	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	20	10.8	216	2.88	6.75	0.01	0.51	0.23	809.52	0.04	0.02	0.01	0.00	0.00	0.00
Frac pumper	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	30	10.8	324	4.31	10.13	0.01	0.76	0.34	1214.29	0.06	0.03	0.01	0.01	0.00	0.00
Fracmaster delivery	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	2	10.8	21.6	0.29	0.68	0.00	0.05	0.02	80.95	0.00	0.00	0.00	0.00	0.00	0.00
Water truck (100 bbl)	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	0	10.8	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Light duty diesel truck[9]	3.2965	1.786	0.00516	1.612	0.2843	230	0.019	0.0459	0.0622	0.03224	0.00371	0.0026	18	10.8	194.4	1.41	0.77	0.00	0.69	0.12	98.57	0.01	0.02	0.03	0.01	0.00	0.00
Light duty gasoline truck[10]	45.965	2.0108	0.00437	2.967	0.0302	330	0.119	0.0492	0.0448	0.0798	0.00371	0.0026	12	10.8	129.6	13.13	0.57	0.00	0.85	0.01	94.29	0.03	0.01	0.01	0.02	0.00	0.00
												Total Heavy Equipment Exhaust Emissions (lb/well)				23.75	22.94	0.02	3.16	0.86	2783.33	0.17	0.09	0.06	0.05	0.01	0.01

1 Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

5 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO_2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

6 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

9 Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

10 Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

11 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

Completion Venting and Flaring

VFO Alternative: RFD
Phase: Construction
Activity: Completion/Testing Flaring
Emissions: Gas Flaring without High Pressure Flowback Separator Units
Date: 5/10/2010

Specifications:

Total Volume of Gas Emitted[1]	1.00	MMscf
Total Volume of Gas Vented[1]	0.50	MMscf
Total Volume of Flared Gas[1]	0.50	MMscf
Average Heat Content	1,050	BTU/scf
Total Hours in which Gas is Vented or Flared[1]	36	hrs

50% of well completions will use venting and 50% will use flaring. For simplicity, single-well emissions are shown with both venting and flaring.

	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (lb/well)	Total Emissions (ton/well)	Duration (hours)	Hourly Emissions (lb/hr/well)
Venting - Natural Gas [2]	0.50	MMscf	VOC	7,549.85	lb/MMscf	Extended Natural Gas Analysis[1]	3774.9	1.89	36	104.86
			CO_2	193.05	lb/MMscf	Extended Natural Gas Analysis[1]	96.5	0.05	36	2.68
			CH_4	28,481.69	lb/MMscf	Extended Natural Gas Analysis[1]	14240.8	7.12	36	395.58
			N_2O	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.0	0.00	36	0.00
			HAP (total)	504.46	lb/MMscf	Extended Natural Gas Analysis[1]	252.2	0.13	36	7.01
			Benzene	54.12	lb/MMscf	Extended Natural Gas Analysis[1]	27.1	0.01	36	0.75
			Toluene	44.92	lb/MMscf	Extended Natural Gas Analysis[1]	22.5	0.01	36	0.62
			Ethylbenzene	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.0	0.00	36	0.00
			Xylenes	29.97	lb/MMscf	Extended Natural Gas Analysis[1]	15.0	0.01	36	0.42
			Hexane	375.45	lb/MMscf	Extended Natural Gas Analysis[1]	187.7	0.09	36	5.21
Flaring - Natural Gas	0.50	MMscf	NOx	100.00	lb/MMscf	AP-42 Section 1.4	50.0	0.03	36	1.39
			CO	84.00	lb/MMscf	AP-42 Section 1.4	42.0	0.02	36	1.17
			PM10	7.60	lb/MMscf	AP-42 Section 1.4	3.8	0.00	36	0.11
			VOC	5.50	lb/MMscf	AP-42 Section 1.4	2.8	0.00	36	0.08
			CO_2	120,000.00	lb/MMscf	AP-42 Section 1.4	60000.0	30.00	36	1666.67
			CH_4	2.30	lb/MMscf	AP-42 Section 1.4	1.2	0.00	36	0.03
			N_2O	2.20	lb/MMscf	AP-42 Section 1.4	1.1	0.00	36	0.03
			HAP (total)	25.22	lb/MMscf	Assume 95% Reduction[3]	12.6	0.01	36	0.35
			Benzene	2.71	lb/MMscf	Assume 95% Reduction[3]	1.4	0.00	36	0.04
			Toluene	2.25	lb/MMscf	Assume 95% Reduction[3]	1.1	0.00	36	0.03
			Ethylbenzene	0.00	lb/MMscf	Assume 95% Reduction[3]	0.0	0.00	36	0.00
			Xylenes	1.50	lb/MMscf	Assume 95% Reduction[3]	0.7	0.00	36	0.02
			Hexane	18.77	lb/MMscf	Assume 95% Reduction[3]	9.4	0.00	36	0.26
Evaporation from condensate/water to waste pit (for wells not using green completion)	5	bbl	VOC	10.00	lb VOC/bbl	Tests conducted by Williams E&P for CDPHE	50.0	0.02500	36	1.39

[1] Based on data collected from oil and gas operators in the Piceance Basin (July 2009).
[2] Based on extended gas analysis for typical Piceance Basin gas (see gas analysis worksheet).
[3] For VOC and HAP emission factors that used the constituent analysis, a 95% destruction rate was assumed.

Workover Rig Emissions - Tier 4b

VFO Alternative: RFD
Phase: Construction
Activity: Drilling
Emissions: Diesel Combustion Emissions from Workover Rig Engines - EPA Tier 4b (2015)
Date: 5/10/2010

Percentage of Producing Wells **1.00%** Only 1% of producing wells are expected to be worked over in any single year.

Pollutant	Pollutant Emission Factor[1]	Total Horsepower All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions Allocated Across All Producing Wells	Emissions Allocated Across All Producing Wells
	(g/hp-hr)	(hp)		(days/well)	(hrs/day)	(lb/well)	(lb/hr/well)
CO	2.6000	475	0.40	1.5	24	0.3921	0.0109
NO_x	0.3000	475	0.40	1.5	24	0.0452	0.0013
SO_2[4]	0.0278	475	0.40	1.5	24	0.0042	0.0001
VOC	0.1400	475	0.40	1.5	24	0.0211	0.0006
PM_{10}[5]	0.01500	475	0.40	1.5	24	0.0023	0.0001
	(lb/hp-hr)						
CO_2[6]	1.15000	475	0.40	1.5	24	78.6600	2.1850
CH_4[7]	5.53E-05	475	0.40	1.5	24	0.0038	0.0001
N_2O[8]	1.24E-05	475	0.40	1.5	24	0.0008	0.0000
Formaldehyde[9]	8.26E-06	475	0.40	1.5	24	0.0006	0.0000
Benzene[9]	6.53E-06	475	0.40	1.5	24	0.0004	0.0000
Toluene[9]	2.86E-06	475	0.40	1.5	24	0.0002	0.0000
Xylene[9]	2.00E-06	475	0.40	1.5	24	0.0001	0.0000

1 Emission factors for Tier 4 (2014) engines taken from "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel: Final Rule" (69 FR 38980, June 29, 2004) for engines less than 750 hp and from Diesel Net, Emissions Standards: USA: Nonroad Diesel Engines, Table 3, "Tier 4 Emission Standards—Engines Up To 560 kW, g/kWh (g/bhp-hr)." Available on-line at http://www.dieselnet.com/standards/us/offroad.html.

2 Drilling engine total horsepower is based on one 475 hp engine, fueled with ultra low sulfur diesel fuel (15 ppm).

3 The overall load factor is 0.4.

4 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". Emission rate of 0.00205 lb/hp-hr converts to 0.0278 g/hp-hr when converting units and adjust

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

6 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"; lb/hp-hr = pounds per horsepower-hour.

7 Based on methane emissions of 0.13 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

8 Based on nitrous oxide emissions of 0.08 g/L of diesel fuel (diesel density of 850 g/L and heating value of 19,300 Btu/lb) from the "Compendium of GHG Emission Methodologies for the Oil and Gas Industry," Table 4-9 (2004).

9 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines", converted from lb/MMBtu to lb/hp-hr using an average brake-specific fuel consumption (BSFC)

Recompletion Venting and Flaring

VFO Alternative: RFD
Phase: Production
Activity: Recompletion, Flaring
Emissions: Recompletion without High Pressure Flowback Separator Units
Date: 5/10/2010

Specifications:

Total Volume of Gas Emitted per recompleted well[1]	1.00	MMscf	
Total Volume of Gas Vented	0.50	MMscf	During recompletion, 50% of well recompletions will use venting and 50% will use flaring. For simplicity, single-well emissions are shown with both venting and flaring.
Total Volume of Flared Gas	0.50	MMscf	
Average Heat Content	1,050	BTU/scf	
Percentage of Operating Wells Recompleted in Year	**1.00%**		Only 1% of operating wells are expected to be recompleted in any single year.
Total Hours in which Gas is Vented or Flared[1]	24	hrs	

	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (lb/well/yr)[4]	Total Emissions (ton/well)[4]	Duration (hours)	Hourly Emissions (lb/hr/well)[4]
Venting - Natural Gas [2]	0.50	MMscf	VOC	7,549.85	lb/MMscf	Extended Natural Gas Analysis[1]	37.749	0.019	24	37.749
			CO_2	193.05	lb/MMscf	Extended Natural Gas Analysis[1]	0.965	0.000	24	0.965
			CH_4	28,481.69	lb/MMscf	Extended Natural Gas Analysis[1]	142.408	0.071	24	142.408
			N_2O	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.000	0.000	24	0.000
			HAP (total)	504.46	lb/MMscf	Extended Natural Gas Analysis[1]	2.522	0.001	24	2.522
			Benzene	54.12	lb/MMscf	Extended Natural Gas Analysis[1]	0.271	0.000	24	0.271
			Toluene	44.92	lb/MMscf	Extended Natural Gas Analysis[1]	0.225	0.000	24	0.225
			Ethylbenzene	0.00	lb/MMscf	Extended Natural Gas Analysis[1]	0.000	0.000	24	0.000
			Xylenes	29.97	lb/MMscf	Extended Natural Gas Analysis[1]	0.150	0.000	24	0.150
			Hexane	375.45	lb/MMscf	Extended Natural Gas Analysis[1]	1.877	0.001	24	1.877
Flaring - Natural Gas	0.50	MMscf	NOx	100.00	lb/MMscf	AP-42 Section 1.4	0.500	0.000	24	0.021
			CO	84.00	lb/MMscf	AP-42 Section 1.4	0.420	0.000	24	0.018
			PM10	7.60	lb/MMscf	AP-42 Section 1.4	0.038	0.000	24	0.002
			VOC	5.50	lb/MMscf	AP-42 Section 1.4	0.028	0.000	24	0.001
			CO_2	120,000.00	lb/MMscf	AP-42 Section 1.4	600.000	0.300	24	25.000
			CH_4	2.30	lb/MMscf	AP-42 Section 1.4	0.012	0.000	24	0.000
			N_2O	2.20	lb/MMscf	AP-42 Section 1.4	0.011	0.000	44	0.000
			HAP (total)	25.22	lb/MMscf	Assume 95% Reduction[3]	0.126	0.000	24	0.005
			Benzene	2.71	lb/MMscf	Assume 95% Reduction[3]	0.014	0.000	24	0.001
			Toluene	2.25	lb/MMscf	Assume 95% Reduction[3]	0.011	0.000	24	0.000
			Ethylbenzene	0.00	lb/MMscf	Assume 95% Reduction[3]	0.000	0.000	24	0.000
			Xylenes	1.50	lb/MMscf	Assume 95% Reduction[3]	0.007	0.000	24	0.000
			Hexane	18.77	lb/MMscf	Assume 95% Reduction[3]	0.094	0.000	24	0.004
Evaporation from condensate/water to waste pit	3	bbl	VOC	0.07	lb VOC/bbl	Tests conducted by Williams E&P for CDPHE	0.002	0.00000	24	0.0001

[1] Based on data collected from oil and gas operators in the Piceance Basin (July 2009).
[2] Based on extended gas analysis for typical Piceance Basin gas (see gas analysis worksheet).
[3] For VOC and HAP emission factors that used the constituent analysis, a 95% destruction rate was assumed.
[4] Per-well totals provide emissions for each operating well based on allocation of emissions from the 1 percent of wells that are recompleted.

Condensate Analysis

VFO Alternative: All
Phase: Production
Activity: Analysis
Date: 5/10/2010

Component	Molecular Weight (lb/lb-mol)	Weight Percent (wt%)	Carbon Content for TOC (lb C/lb)	Contribution to TOC Carbon Content (lb C/lb TOC)
Methane	16.040	0.579	0.749	0.434
Ethane	30.070	0.458	0.799	0.366
Nitrogen	28.020	0.007	---	---
Carbon Dioxide	43.990	0.168	---	---
Nitrous Oxide	44.020	0.000	---	---
Hydrogen Sulfide	34.060	0.000	---	---
Non-reactive, non-HAP	---	1.212	---	
Propane	44.100	0.771	0.817	0.630
Iso-butane	58.120	0.688	0.827	0.569
n-butane	58.120	0.906	0.827	0.749
i-pentane	72.150	1.515	0.832	1.261
n-pentane	72.150	1.502	0.499	0.750
Hexanes	100.210	9.368	0.719	6.736
Heptanes	100.200	19.328	0.839	16.217
Octanes	114.230	17.614	0.841	14.815
Nonanes	128.258	13.309	0.843	11.216
Decanes+	142.29	16.491	0.844	13.919
Reactive VOC	---	81.492		66.862
Benzene	78.110	1.418	0.923	1.308
Ethylbenzene	106.160	0.249	0.905	0.225
n-Hexane	---	*9.368*	---	---
Toluene	92.130	7.837	0.913	7.151
Xylenes	106.160	7.912	0.905	7.161
HAPs	---	26.784		15.846
Totals	**---**	**100.120**		**83.507** [3]

[1] Extended condensate analysis of typical Piceance Basin condensate.
[2] n-Hexane is a VOC and a HAP. To be conservative, all non-speciated hexanes are assumed to be HAPs.
[3] The carbon contribution to hydrocarbons in the liquid mixture is used to calculate CO2 emissions from the model gas plant thermal oxidizer and flare.

Wind Erosion at Producing Well Pads

VFO Alternative: RFD
Phase: Production
Activity: Wind Erosion
Emissions: Fugitive Particulate Emissions from Wind Blown Dust at Well Pads
Date: 5/10/2010

Well Pad and Resource Road Area [1]	Silt Content[2]	Days with Wind Speed Greater Than 5.4 m/s [3]	Total Suspended Particulate[4]	Days Before Interim Reclamation Complete [5]	Total Suspended Particulate	Emission Control Efficiency[6]	PM_{10} Emissions (uncontrolled)[7]	$PM_{2.5}$ Emissions (uncontrolled)[8]	Wells per Well Pad	PM_{10} Emissions (uncontrolled)[3]	$PM_{2.5}$ Emissions (uncontrolled)[4]
(acre)	(%)	(%)	(lb/acre/month)	(months)	(lb/well pad)	(%)	(lb/well pad)	(lb/well pad)		(lb/well)	(lb/well)
6.0	20	27.4	64.309	24.0	9,260.50	0	2,315.13	231.51	3.5	661.46	66.15

1 Total disturbance area per well pad is estimated to be 7.25 acres for the well pad, 1.0 acre for a portion of compressor station and central treating facility (CTF), 1.75 acres for resource road and portion of local road area, and 2 acres for a portion of pipeline disturbance.

2 Silt content was confirmed by VFO personnel (September 4, 2009).

3 "Control of Fugitive Dust Sources" EPA-450/3-98-008 (EPA 1998). TSP (lb/acre/month) = 1.7 × (s/1.5) × ([365-p]/235) × (f/15), where:
p = number of days with > 0.001 in precipitation (not used)
f = percent of time wind speed exceeds 5.4 (m/s) [equivalent to 12 mph] = 27.4% based on WRCC Ernie Gulch RAWS stations August 1, 1984 through March 1, 2008.

4 AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", Background Document.

5 Interim reclamation is expected to be complete within two years. Emissions for two years are calculated and attributed to each constructed well pad for one year, since emissions from pads constructed during the previous year would be occurring simultaneously.

6 Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.

7 AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", Background Document. Assuming that PM10 accounts for 25% of TSP. Daily and hourly emissions based on 30.4-day month.

8 Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on "Analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).

Natural Gas Extended Gas Analysis

VFO Alternative: RFD
Phase: Both
Activity: Gas Analysis
Date: 5/10/2010

Gas Component	Volumetric Concentration[1] (vol%)	Molecular Weight (lb/lb-mol)	Gas Weight (lb/lb-mol)	Weight Percent (wt%)	Weight[2] (lb/MMscf)	Carbon Content for TOC (lb C/lb)	Contribution to TOC Carbon Content (lb C/lb TOC)
Methane	83.512	16.040	13.395	67.079	28,481.7	0.749	50.226
Ethane	9.141	30.070	2.749	13.765	5,844.4	0.799	10.995
Nitrogen	0.440	28.020	0.123	0.617	262.0	---	---
Carbon Dioxide	0.206	43.990	0.091	0.455	193.1	---	---
Nitrous Oxide	0.000	44.020	0.000	0.000	0.0	---	---
Hydrogen Sulfide	0.000	34.060	0.000	0.000	0.0	---	---
Non-reactive, non-HAP	93.299	---	16.358	81.915	34,781.1	---	61.221
Propane	3.996	44.100	1.762	8.824	3,746.5	0.817	7.209
Iso-butane	0.577	58.120	0.336	1.680	713.5	0.827	1.389
n-butane	1.074	58.120	0.624	3.125	1,326.8	0.827	2.583
i-pentane	0.283	72.150	0.204	1.023	434.5	0.832	0.852
n-pentane	0.335	72.150	0.242	1.211	514.1	0.499	0.605
Hexanes	0.176	100.210	0.177	0.884	375.5	0.719	0.636
Heptanes	0.112	100.200	0.112	0.563	239.1	0.839	0.473
Octanes	0.053	114.230	0.061	0.304	129.0	0.841	0.256
Nonanes	0.019	128.258	0.025	0.124	52.7	0.843	0.105
Decanes+	0.006	142.29	0.009	0.043	18.3	0.844	0.036
Reactive VOC	6.632	---	3.551	17.781	7,549.8		14.142
Benzene	0.033	78.110	0.025	0.127	54.1	0.923	0.118
Ethylbenzene	0.000	106.160	0.000	0.000	0.0	0.905	0.000
n-Hexane [3]	*0.176*	*100.210*	*0.177*	*0.884*	*375.5*	---	---
Toluene	0.023	92.130	0.021	0.106	44.9	0.913	0.097
Xylenes	0.013	106.160	0.014	0.071	30.0	0.905	0.064
HAPs	0.245	---	0.237	1.188	504.5		0.278
Totals	**100.000**	**---**	**19.970**	**100.000**	**42,460.0**	**---**	75.640 [4]

[1] Based on gas analysis dated August 24, 2009 supplied by VFO personnel. C6+ speciation based on C6+ speciation from WRFO.
[2] Gas density is 0.04246 lb/scf (19.26 g/scf).
[3] n-Hexane is a VOC and a HAP. To be conservative, all non-speciated hexanes are assumed to be HAPs.
[4] The carbon contribution to hydrocarbons in the gas mixture is used to calculate CO_2 emissions from the model gas plant thermal oxidizer and flare.

Vehicle Road Dust Associated With Producing Well Pads

VFO Alternative: RFD
Phase: Production
Activity: Production Traffic
Emissions: Fugitive Particulate From Production Traffic on Unpaved Roads
Date: 5/10/2010

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight (lb)	Average Vehicle Speed (mph)	Silt Content[1] (%)	Round Trips (RTs) (RT/pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT) (VMT/pad)	Ratio of Months with Frozen or Muddy Roads (unitless)	Emission Control Efficiency[3] (%)	PM_{10} Emission Factor[4] (lb/VMT)	$PM_{2.5}$ Emission Factor[5] (lb/VMT)	PM_{10} Emissions[6] (uncontrolled) (lb/well pad)	$PM_{2.5}$ Emissions[5] (uncontrolled) (lb/well pad)
Water truck (130 bbl)	Local	water/chemical	85,000	25	20	52	10	520	0.333	0	5.22	0.52	2714.80	271.48
(process water)	Resource	water	85,000	25	20	52	0.8	41.6	0.333	0	5.22	0.52	217.18	21.72
Condensate tanker (200 bbl)	Local	water/chemical	75,000	25	20	12	10	120	0.333	0	4.93	0.49	592.18	59.22
	Resource	water	75,000	25	20	12	0.8	9.6	0.333	0	4.93	0.49	47.37	4.74
Light duty vehicles	Local	water/chemical	3,000	35	20	173	0.66	114.18	0.333	0	1.16	0.12	132.37	13.24
	Resource	water	3,000	35	20	173	0.8	138.4	0.333	0	1.16	0.12	160.45	16.04
									Total Unpaved Road Traffic Emissions (lb/well pad)				3,864.36	386.44

[1] Silt content was determined by soil testing of samples collected by WRFO personnel (April 2008).
[2] Calculated as Round Trips per Vehicle Type x Round Trip Distance.
[3] Emissions are calculated for each Alternative using this template and applying emission control factors from the "Alternative Description" Worksheet in calculations on the "Year 2028 Emission Summary" Worksheet for each Alternative.
[4] AP-42 (EPA 2006), Section 13.2.2 "Unpaved Roads", equation 1a.
[5] Assuming that $PM_{2.5}$ accounts for 10% of PM_{10} based on analysis of the Fine Fraction of PM in Fugitive Dust," Midwest Research Institute (MRI) Report 110397 (2005).
[6] Calculated as lb/VMT x VMT/pad x control efficiency.
[7] All trips are made to the consolidated facilities, which assumes that distance traveled on well pad roads (resource roads) is 0.

Vehicle Exhaust Associated With Producing Well Pads

VFO Alternative: RFD
Phase: Production
Activity: Production Vehicle Traffic Exhaust
Emissions: Vehicle Exhaust Emissions
Date: 5/10/2010

Heavy Equipment	Pollutant Emission Factor (g/mi)												Round Trips (RTs) (RT/pad)	RT Distance (miles)	Vehicle Miles Traveled (VMT) (mi)	Pollutant Emissions (lb/well pad)											
	CO[1]	NO_x[1]	SO_2[2]	VOC[1]	PM_{10}[1]	CO_2[5]	CH_4[6]	N_2O[11]	Form.[7]	Benzene[7]	Toluene[7]	Xylene[7]				CO	NO_x	SO_2[8]	VOC	PM_{10}	CO_2	CH_4	N_2O	Form.	Benzene	Toluene	Xylene
Water truck (130 bbl, process)	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	52	10.8	561.6	7.48	17.55	0.02	1.32	0.59	2104.76	0.10	0.05	0.01	0.01	0.00	0.00
Condensate tanker (200 bbl)	6.04	14.178	0.0136	1.066	0.4805	1700	0.081	0.0388	0.0107	0.0085	0.00371	0.0026	12	10.8	129.6	1.73	4.05	0.00	0.30	0.14	485.71	0.02	0.01	0.00	0.00	0.00	0.00
Light duty diesel truck[9]	3.2965	1.786	0.0052	1.612	0.2843	230	0.019	0.0459	0.0622	0.03224	0.00371	0.0026	173	1.46	252.58	1.84	0.99	0.00	0.90	0.16	128.07	0.01	0.03	0.03	0.02	0.00	0.00
Light duty gasoline truck[10]	45.965	2.0108	0.0044	2.967	0.0302	330	0.119	0.0492	0.0448	0.0798	0.00371	0.0026	173	1.46	252.58	25.59	1.12	0.00	1.65	0.02	183.76	0.07	0.03	0.02	0.04	0.00	0.00
	Total Heavy Equipment Exhaust Emissions (lb/well pad)															36.63	23.72	0.03	4.17	0.91	2902.30	0.20	0.11	0.08	0.08	0.01	0.01

1 Emission factors reflect the Uintah County, Utah, season average, local road MOBILE6 emission factors used for 2006 base case photochemical modeling.

2 AP-42 (EPA 1985), Volume II Mobile Sources "Heavy Duty Diesel Engine Powered Trucks" high altitude, "aged" with 50,000 miles service, 1997+ model year. The SO_2 emission factor is updated to reflect ultra-low sulfur fuel (15 ppm).

5 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-11, CO2 Mobile Source Emission Factors, American Petroleum Institute, Feb 2004.

6 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different

7 AP-42 (EPA 1996), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-2, "Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines"; lb/hp-hr = pounds per horsepower-hour.

8 Assumes ultra low sulfur diesel fuel (15 ppm), adjusted from 500-ppm low sulfur diesel fuel.

9 Light duty diesel truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

10 Light duty gasoline truck benzene and formaldehyde emissions are based on "Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation" (EPQ420-R-02-029) Table 2.3 and 30-ppm sulfur fuel specifications for Denver, CO, with average winter/summer concentrations.

11 Compendium of Greenhouse Gas Emission Methodologies for the Oil and Gas Industry, Table 4-9 for N2O (HDDV moderate control, LDGT oxidation catalyst, LDDT moderate control) , Mobile Source Combustion Factors, Table 4-10, Default Fuel Economy Factors for Different Types of Mobile Sources, American Petroleum Institute (2004).

12 All trips are made to the consolidated facilities, which assumes that distance traveled on well pad roads (resource roads) is 0.

Well Pad Heaters

VFO Alternative: RFD
Phase: Production
Activity: Well Pad Heating
Emissions: Combustion Emissions from Natural Gas Fired Heater
Date: 5/10/2010

Fuel Combustion Source:

Heater Fuel Input[1]	1.0	MMBtu/hr

Operating Parameters:

Operated	24	hr/day,	7	days/week	
Operating hours	2,628	hr/yr			
Capacity (%)	100	(while operating)			
Seasonal Usage (%)	Winter	20	Spring	5	
	Summer	0	Fall	5	

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	2.50	MMscf/yr
Heat Content	1050	Btu/scf

	Emission Factor[2] (lb/MMscf)	Emissions (lb/well pad)	Wells per Pad	Emissions per Well (lb/well)
CO	84.0	210.24	3.5	60.07
NOx	100.0	250.29	3.5	71.51
PM_{10}	7.6	19.02	3.5	5.43
$PM_{2.5}$	7.6	19.02	3.5	5.43
SO_2	---	---	3.5	---
VOC	5.5	13.77	3.5	3.93
CO_2	120,000.0	300342.86	3.5	85812.24
CH_4	2.3	5.76	3.5	1.64
N_2O[2]	2.2	5.51	3.5	1.57
Formaldehyde	0.0750	0.19	3.5	0.05
Benzene	0.0021	0.01	3.5	0.00
Ethylbenzene	---	---	3.5	---
Toluene	0.0034	0.01	3.5	0.00
Xylene	---	---	3.5	---

[1] Assumes four 0.25-MMBtu natural gas fired heaters per well pad.

[2] EPA AP-42, Volume I, Fifth Edition - August 2000, Tables 1.4-1, 1.4-2, and 1.4-3, Uncontrolled Emission Factors for Natural Gas Combustion.

Well Pad Heaters

VFO Alternative: RFD
Phase: Production
Activity: Well Pad Heating
Emissions: Combustion Emissions from Natural Gas Fired Heater
Date: 5/10/2010

Fuel Combustion Source:

Heater Fuel Input[1]	0.1	MMBtu/hr

Operating Parameters:

Operated	24	hr/day,	7	days/week
Operating hours	8,760	hr/yr		
Capacity (%)	100	(while operating)		
Seasonal Usage (%)	Winter	25	Spring	25
	Summer	25	Fall	25

Potential Fuel Combustion for the Year for Unit:

Volume of Natural Gas Combusted	1.04	MMscf/yr
Heat Content	1050	Btu/scf

	Emission Factor[2] (lb/MMscf)	Emissions (lb/well pad)	Wells per Pad	Emissions per Well (lb/well)
CO	84.0	87.60	1.5	58.40
NOx	100.0	104.29	1.5	69.52
PM_{10}	7.6	7.93	1.5	5.28
$PM_{2.5}$	7.6	7.93	1.5	5.28
SO_2	---	---	1.5	---
VOC	5.5	5.74	1.5	3.82
CO_2	120,000.0	125142.86	1.5	83428.57
CH_4	2.3	2.40	1.5	1.60
N_2O[2]	2.2	2.29	1.5	1.53
Formaldehyde	0.0750	0.08	1.5	0.05
Benzene	0.0021	0.00	1.5	0.00
Ethylbenzene	---	---	1.5	---
Toluene	0.0034	0.00	1.5	0.00
Xylene	---	---	1.5	---

[1] Assumes four 0.25-MMBtu natural gas fired heaters per well pad.

[2] EPA AP-42, Volume I, Fifth Edition - August 2000, Tables 1.4-1, 1.4-2, and 1.4-3, Uncontrolled Emission Factors for Natural Gas Combustion.

Field Dehydration [1]

VFO Alternative: RFD
Phase: Production
Activity: Field Glycol Dehydrator
Emissions: Emissions From Ethylene Glycol Dehydrator
Date: 5/10/2010

Ethylene Glycol Dehydrator

Throughput at Example Facility	70.00	MMscfd
Percentage of Gas Needing Dehydration Before Gas Plant	50.00%	
Average Gas Production Per Well	0.900	MMscfd
Number of Wells Served	155.56	

Operating Parameters:

Operating Hours	8760	hr/yr
Vent Control Efficiency (%)	90	(Alternatives B, C, and D)
Wet Gas Temperature	85	° F
Wet Gas Pressure	900	psig
Wet Gas Water Content	Saturated	
Dry Gas Water Content	5	lb water/MMscf
Glycol Type	DEG	
Glycol Circulation Rate	15.0	gal/minute

Flash Tank and Condenser Parameters:

Flash Tank Temperature	140	° F
Flash Tank Pressure	70	psig
Condenser Temperature	90	° F
Condenser Pressure	10	psig

Reboiler Fuel Combustion:

Reboiler Fuel Input	1.00	MMBtu/hr
Volume of Natural Gas Combusted	8.34	MMscf/yr
Heat Content	1050	Btu/scf

Glycol Dehydrator Vent and Flash Gas Emissions	Uncontrolled Emissions[2] (ton/yr)	Uncontrolled Emissions (lb/yr)	Controlled Emissions (lb/yr)	Uncontrolled Emissions (lb/well/yr)	Controlled Emissions (lb/well/yr)
VOC	64.1267	128,253.40	12,825.34	824.49	82.45
Benzene	11.6838	23,367.60	2,336.76	150.22	15.02
Toluene	6.9168	13,833.60	1,383.36	88.93	8.89
Ethylbenzene	0.0000	0.00	0.00	0.00	0.00
Xylene	2.1314	4,262.80	426.28	27.40	2.74
Hexane	5.9587	11,917.40	1,191.74	76.61	7.66
CO_2	0.7001	1,400.17	140.02	9.00	0.90
CH_4	103.2862	206,572.40	20,657.24	1,327.97	132.80
N_2O	0.0000	0.00	0.00	0.00	0.00

Reboiler Emissions	Emission Factor (lb/MMscf)	Uncontrolled Emissions (lb/yr)	Uncontrolled Emissions per Well (lb/well/yr)
CO	84.0	700.80	4.505
NOx	100.0	834.29	5.363
PM_{10}	7.6	63.41	0.408
$PM_{2.5}$	7.6	63.41	0.408
SO_2	---	---	---
VOC	5.5	45.89	0.295
CO_2	120,000.0	1,001,142.86	6,435.918
CH_4	2.3	19.19	0.123
N_2O	2.2	18.35	0.118
Formaldehyde	0.0750	0.63	0.004
Benzene	0.0021	0.02	0.000
Ethylbenzene	---	---	---
Toluene	0.0034	0.03	0.000
Xylene	---	---	---

[1] In-field glycol dehydration may occur at consolidated facilities or well pads. To avoid double-counting, field glycol dehydration is assumed to occur at well pads. Gas dehydration at gas plants is included in the model gas plant calculations.

[2] Emissions obtained from GRI GlyCalc 4.0 based on parameters provided by oil and gas operator. Emissions include combined regenerator vent and flash gas emissions.

Field Compressor Stations

Phase: Production
Activity: Field Gas Compression
Emissions: Natural Gas Fired Compressor Engine Emissions
Date: 5/10/2010

Operating Parameters:

Throughput Capacity at Compressor Station	200	MMscfd		
Number of Wells Served	222	Assuming that all of producing gas wells need compression		
Operating hours	8,760			
Capacity (%)	100			
Annual Load (%)	Winter	25	Spring	25
	Summer	25	Fall	25
Engine design (hp)	19,444			

Potential Fuel Combustion for the Year for Unit:

Example Plant Volume of Natural Gas Combusted	1119.82	MMscf
Assumes gas consumed at rate of	6903	Btu/hp-hr
Heat Content	1050	Btu/scf
Example Plant Heat Input	1,175,811	MMBtu/yr

				Compressor Station Total			Emissions Per Well	
Emission Data:	2007 Emission Factor[2]	2010 Emission Factor[2]	Reference	2007 Emissions	2010 Emissions	Number of Wells Served[3]	2007 Emissions	2010 Emissions
	(g/hp-hr)	(g/hp-hr)		(lb)	(lb)		(lb/well)	(lb/well)
CO	4.0	2.0	NSPS Subpart JJJJ	1,502,058	751,029	222	6,759.26	3,379.63
NOx	2.0	1.0	NSPS Subpart JJJJ	751,029	375,514	222	3,379.63	1,689.81
PM_{10}	---	---	---	---	---	222	---	---
$PM_{2.5}$	---	---	---	---	---	222	---	---
SO_2	---	---	---	---	---	222	---	---
VOC	1.0	0.7	NSPS Subpart JJJJ	375,514	262,860	222	1,689.81	1,182.87
	(lb/MMBtu)	(lb/MMBtu)						
CO_2	110.000	110.000	AP-42[2]	129,339,210	129,339,210	222	582,026.45	582,026.45
CH_4	1.250	1.250	AP-42[2]	1,469,764	1,469,764	222	6,613.94	6,613.94
N_2O[4]	0.001	0.001	IPCC[4]	1,085	1,085	222	4.88	4.88
Formaldehyde	0.052800	0.052800	AP-42[2]	62,083	62,083	222	279.37	279.37
Benzene	0.000440	0.000440	AP-42[2]	517	517	222	2.33	2.33
Ethylbenzene	0.000040	0.000040	AP-42[2]	47	47	222	0.21	0.21
Toluene	0.000408	0.000408	AP-42[2]	480	480	222	2.16	2.16
Xylene	0.000184	0.000184	AP-42[2]	216	216	222	0.97	0.97
n-Hexane	0.001110	0.001110	AP-42[2]	1,305	1,305	222	5.87	5.87

[1] Based on the Williams Webster Hill Compressor Station. Five natural gas-fired 3,500-hp lean-burn compressor engines (17,500 hp total) are designed to transport 180 MMscf/day to a central gas treatment facility. ["Construction Permit Application for Webs

[2] EPA AP-42, Volume I, Fifth Edition - August 2000, Table 3.2-2, Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, converted to lb/MMBtu.

[3] Based on individual well production estimates, this compressor station is estimated to have enough capacity to serve 605 wells.

[4] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 2 Energy, Table 2.2, Default Emission Factors for Stationary Combustion in the Energy Industries, default factors for N_2O (IPCC) 2000.

Gas Processing and Recompression

VFO Alternative: RFD
Phase: Production
Activity: Gas Processing
Emissions: Gas Processing and Recompression
Date: 5/10/2010

Example Gas Processing Plant

Example Gas Plant Throughput[1]	200	MMscf/day	**Operating Parameters:**	
Needed Throughput	1,939	MMscf/day	Operating hours	8,760
Scaling Factor	9.69		Capacity (%)	100

	Example Plant Emissions						Capacity Scaling Factor	Number of Wells	Gas Processing Emissions Per Well					
	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	VOC			CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	VOC
Emission Source	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)			(lb/well)	(lb/well)	(lb/well)	(lb/well)	(lb/well)	(lb/well)
Sources Directed to Thermal Oxidizer[2]	8.836	3.630	0.000	0.753	0.753	0.616	9.693	2,154	348.30	143.10	0.00	29.70	29.70	24.30
Sources Directed to Flare[3]	1.895	0.342	0.000	0.000	0.000	0.776	9.693	2,154	74.70	13.50	0.00	0.00	0.00	30.60
Medium Fired Heater	3.151	3.744	0.000	0.297	0.297	0.205	9.693	2,154	124.20	147.60	0.00	11.70	11.70	8.10
Compressor Seal Gas[4]	0.000	0.000	0.000	0.000	0.000	1.187	9.693	2,154	0.00	0.00	0.00	0.00	0.00	46.80
Fugitive Emissions	1.142	0.205	0.000	0.000	0.000	26.119	9.693	2,154	45.00	8.10	0.00	0.00	0.00	1,029.60
Emergency Generator[5]	0.502	2.215	0.046	0.068	0.068	0.068	9.693	2,154	19.80	87.30	1.80	2.70	2.70	2.70
Amine Drain Sump	0.000	0.000	0.000	0.000	0.000	0.002	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Treated Water Tank	0.000	0.000	0.000	0.000	0.000	0.030	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Evaporation Pond[6]	0.000	0.000	0.000	0.000	0.000	2.648	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Produced Liquids and Storage Tanks[7]	0.000	0.000	0.000	0.000	0.000	1.826	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Total	**15.53**	**10.14**	**0.05**	**1.12**	**1.12**	**33.48**		**Total**	**612.00**	**399.60**	**1.80**	**44.10**	**44.10**	**1,142.10**

	Example Plant Emissions						Capacity Scaling Factor	Number of Wells	Gas Processing Emissions Per Well					
	Benzene	Toluene	Ethylbenzene	Xylene	Formaldehyde	Hexane			Benzene	Toluene	Ethylbenzene	Xylene	Form.	Hexane
Emission Source	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)			(lb/well)	(lb/well)	(lb/well)	(lb/well)	(lb/well)	(lb/well)
Sources Directed to Thermal Oxidizer[2]	0.036	0.022	0.000	0.004	0.000	0.006	9.693	2,154	1.41	0.88	0.00	0.14	0.00	0.25
Sources Directed to Flare[3]	0.002	0.001	0.000	0.000	0.000	0.007	9.693	2,154	0.09	0.05	0.00	0.00	0.00	0.28
Medium Fired Heater	0.000	0.000	0.000	0.000	0.003	0.067	9.693	2,154	0.00	0.01	0.00	0.00	0.11	2.66
Compressor Seal Gas[4]	0.003	0.002	0.000	0.000	0.000	0.011	9.693	2,154	0.14	0.08	0.00	0.01	0.00	0.42
Fugitive Emissions	0.232	0.326	0.004	0.194	0.000	0.640	9.693	2,154	9.16	12.84	0.15	7.64	0.00	25.24
Emergency Generator[5]	0.000	0.000	0.000	0.000	0.000	0.000	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Amine Drain Sump	0.000	0.000	0.000	0.000	0.000	0.000	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.00
Treated Water Tank	0.000	0.000	0.000	0.000	0.000	0.000	9.693	2,154	0.00	0.00	0.00	0.00	0.00	0.01
Evaporation Pond[6]	0.470	0.817	0.016	0.365	0.000	0.016	9.693	2,154	18.54	32.22	0.63	14.40	0.00	0.63
Produced Liquids and Storage Tanks[7]	0.064	0.101	0.002	0.048	0.000	0.057	9.693	2,154	2.54	3.99	0.09	1.89	0.00	2.25
Total	**0.81**	**1.27**	**0.02**	**0.61**	**0.00**	**0.81**		**Total**	**31.88**	**50.08**	**0.87**	**24.09**	**0.11**	**31.74**

		VOC Pollutant Scaling Factor			Example Plant Emissions			Capacity Scaling Factor	Number of Wells	Emissions Per Well		
	Scaling	CO_2	CH_4	N_2O[8]	CO_2	CH_4	N_2O			CO_2	CH_4	N_2O
Emission Source	Pollutant	(unitless)	(unitless)	(unitless)	(lb/hr)	(lb/hr)	(lb/hr)			(lb/well)	(lb/well)	(lb/well)
Sources Directed to Thermal Oxidizer[8]	---	---	---	---	943.278	0	0	9.693	2,154	37,184.02	0.62	0.00
Sources Directed to Flare[8]	---	---	---	---	234.774	0.020	0.002	9.693	2,154	9,254.78	0.78	0.07
Medium Fired Heater (38.2 MMBtu/hr)[9]	---	---	---	---	4461.877	0.076	0.008	9.693	2,154	175,887.19	2.99	0.33
Compressor Seal Gas[10]	VOC	0.000	3.772	0.000	0.000	4.479	0.000	9.693	2,154	0.00	176.55	0.00
Fugitive Emissions[10]	VOC	0.000	3.772	0.000	0.000	98.533	0.000	9.693	2,154	0.00	3,884.15	0.00
Emergency Generator (35.4 MMBtu/hr, 200 hr/yr)[9]	---	---	---	---	5703.379	0.234	0.047	9.693	2,154	5,133.04	0.21	0.04
Amine Drain Sump[10]	VOC	0.000	3.772	0.000	0.000	0.009	0.000	9.693	2,154	0.00	0.34	0.00
Treated Water Tank[10]	VOC	0.000	0.007	0.000	0.000	0.000	0.000	9.693	2,154	0.00	0.01	0.00
Evaporation Pond[10]	VOC	0.000	0.007	0.000	0.000	0.019	0.000	9.693	2,154	0.00	0.74	0.00
Produced Liquids and Storage Tanks[10]	VOC	0.000	0.007	0.000	0.000	0.013	0.000	9.693	2,154	0.00	0.51	0.00
				Total	**11,343.31**	**103.40**	**0.06**		**Total**	**227,459.02**	**4,066.91**	**0.44**

[1] Gas processing and recompression emissions are based on the Enterprise Piceance Development Project -- Central Treating Facility (CTF), which was initially permitted by ExxonMobil Corp. Emissions for this "model plant" facility were obtained from the preconstruction permit application submitted by ExxonMobil Production on March 16, 2006. This CTF is designed to process up to 200 MMScf/day of plant feed gas to produce pipeline quality sales gas. The Valley Sludge Catcher is a series of condensate and process water tanks that moderate flow of condensate and process water as they proceed to the CTF. The Black Sulfur Tank Battery consists of a seperator tank for segregating the condensate and process water gathered from wells. Seperator and Tanks emissions associated with these facilities are vented to the same flare; these with Truck Loadout operations emissions are included in the Fugitive Emissions line.

[2] The thermal oxidizer controls emissions from Amine Vent Gas, Glycol Vent Gas and Thermal Oxidizer Purge Gases. The thermal oxidizer achieves 99 percent VOC/HAP control efficiency.

[3] The Flare controls emissions from Pilot and Purge Gases.

[4] Seal gas from the inlet/booster compressor. This is an electric compressor; no combustion emissions are generated.

[5] The emergency generator is a rated 3.0 MW diesel fired engine, with heat input of 35.4 MMBtu/hr up to 200 hr/yr. Emission calculation based on AP-42 emission factor (Table 3.4-1 and 3.4-2), assuming uncontrolled NOx, and sulfur content of fule is 500 ppm. GHG emission factors are from proposed 40 CFR Part 98, Subpart C, Tables C-1 and C-2.

[6] Control effeciency for fugitive emissions from the evaporation pond is an average of 90%. The controlled emission rate shown here includes emissions resulting from times when the Produced Water Stripper Compressor is shutdown, which is 5% of the time.

[7] All storage tanks at the facility which consists of Produced Liquids Skim Tanks (2), Produced Liquids Surge Tank, and Condensate Storage Tanks (2). Emissions calculations are based on the assumption that the Produced Liquids Skim Tanks and the Produced Liquids Surge Tank will vent 1% of the time, and the Condensate Storage Tanks will vent 5% of the time.

[8] Thermal oxidizer and flare GHG emissions are estimated using methods included in the "API Compendium of GHG Emission Estimation Methodologies for the Oil and Gas Industry," Sections 4.7 and 4.6, respectively. See the next page for detailed calculations.

[9] GHG emissions from the medium fired heater and the emergency generator are based on heat input and emission factors in proposed 40 CFR Part 98, Tables C-1 and C-2.

[10] GHG emissions from these sources are scaled based on VOC content and natural gas composition.

Flare and Incinerator Greenhouse Gas Emissions From Gas Processing and Recompression

VFO Alternative: RFD
Phase: Production
Activity: GHG Emissions From Gas Processing
Emissions: Gas Processing and Recompression
Date: 5/10/2010

Example Gas Processing Plant

Example Gas Plant Throughput[1]	200	MMscf/day	**Operating Parameters:**					
Needed Throughput	1,939	MMscf/day	Operating hours	8,760		Gas Heating Value	1050	Btu/scf
Scaling Factor	9.69		Capacity (%)	100		Gas Molecular Weight	19.88	lb/lb-mol

CO_2 Formed During Combustion	Controlled VOC Emissions	TOC/VOC	Controlled TOC Emissions	Control Device Control Efficiency [3]	Uncontrolled TOC Emissions	Carbon Content of Flared Gas	MW CO_2/MW C	CO_2 Formation Efficiency	CO_2 Emissions
	(lb/hr)	(unitless)	(lb/hr)	(%)	(lb/hr)	(lb C/lb)	(unitless)	(%)	(lb/hr)
Thermal Oxidizer [1]	0.616	5.564	3.430	99.000	342.967	0.756	3.667	99	941.70
Flare [2]	0.776	5.564	4.319	95.000	86.377	0.756	3.667	98	234.77

CO_2 Entering as Part of Gas	CO_2/TOC	Uncontrolled TOC Emissions	CO_2 Emissions
	(unitless)	(lb/hr)	(lb/hr)
Thermal Oxidizer [1]	0.005	342.967	1.576
Flare [2]	0.005	86.377	0.397

CH_4 Uncombusted	CH_4/TOC	Uncontrolled TOC Emissions	Uncontrolled CH_4 Emissions	Control Device Control Efficiency [3]	Controlled CH_4 Emissions
	(unitless)	(lb/hr)	(lb/hr)	(%)	(lb/hr)
Thermal Oxidizer [1]	0.005	342.967	1.576	99.000	0.016
Flare [2]	0.005	86.377	0.397	95.000	0.020

N_2O Combustion Byproduct	Uncontrolled TOC Emissions	Gas MW $^{-1}$	Gas Density	Control Device Control Efficiency [3]	Heating Value	N_20 Emission Factor	N_2O Emissions	N_2O Emissions
	(lb/hr)	(lb-mol/lb)	(scf/lb-mol)	(%)	(Btu/scf)	(tonnes N_2O/MMBtu)	(tonnes/hr)	(lb/hr)
Thermal Oxidizer [4]								
Flare [2]	86.377	0.050	379.300	95.000	1050.000	9.50E-08	0.000	1.69E-03

[1] Thermal oxidizer emissions are calculated using procedures from Section 4.7 of the "API Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry".

[2] Flare emissions are calculated using procedures from Section 4.6 of the "API Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry" (DATE??).

[3] Control efficiencies are given in the preconstruction permit application submitted by ExxonMobil Production on March 16, 2006 for the Enterprise Piceance Development Project -- Central Treating Facility (CTF).

[4] The "API Compendium of Greenhouse Gas Emissions Estimation Methodologies for the Oil and Gas Industry" does not include a methodology for estimating N_2O emissions from thermal oxidizers.

Natural Gas Well Year 2028 Emission Summary (lb/well)

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/10/2010

	Emissions by Source Category															
	Source Type	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOCs**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylene**	**Hexane**	**Form.**	**CO_2**	**CH_4**	**N_2O**
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	60.680	6.070	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	581.943	58.194	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	34.929	9.903	0.122	3.188	3.188	3.234	0.013	0.006	---	0.004	---	0.017	2352.015	0.113	0.025
	Delivery/Commuter Vehicle Exhaust	7.616	7.238	0.007	0.282	0.282	0.983	0.015	0.003	---	0.002	---	0.017	922.449	0.053	0.029
	Subtotal	**42.55**	**17.14**	**0.13**	**646.09**	**67.73**	**4.22**	**0.03**	**0.01**	**0.00**	**0.01**	**0.00**	**0.03**	**3,274**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	2526.464	252.646	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	29.995	12.779	0.029	1.017	1.017	2.255	0.018	0.008	---	0.006	---	0.023	3596.599	0.171	0.082
	Drilling Traffic Road Dust	---	---	---	1010.026	101.003	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	9.705	51.972	0.005	0.627	0.627	5.695	0.129	0.011	---	0.007	---	0.141	1274.286	0.172	0.131
	Drill Rig Engines - Tier 4b (2015)	158.730	825.397	8.825	6.984	6.984	44.444	0.940	0.412	---	0.288	---	0.079	165600.000	7.963	1.788
	Frac Pump Engines - Tier4b	67.460	350.794	3.751	2.968	2.968	18.889	0.400	0.175		0.122		0.034	70380.000	3.384	0.760
	Subtotal (with Tier 4B drill rigs)	**265.89**	**1,240.94**	**12.61**	**3,548.09**	**365.25**	**71.28**	**1.49**	**0.61**	**0.00**	**0.42**	**0.00**	**0.28**	**240,850.88**	**11.69**	**2.76**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	1917.066	191.707	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	22.954	9.779	0.022	0.778	0.778	1.726	0.014	0.006	---	0.004	---	0.017	2752.381	0.131	0.063
	Completion Traffic Road Dust	---	---	---	566.459	56.646	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	6.555	6.786	0.007	0.246	0.246	0.904	0.014	0.002	--	0.002	---	0.016	795.238	0.047	0.027
	Completion Venting and Flaring	50.000	42.000	---	3.800	3.800	3827.673	28.413	23.583	---	15.733	---	---	60096.526	14241.994	1.100
	Subtotal	**79.51**	**58.56**	**0.03**	**2,488.35**	**253.18**	**3,830.30**	**28.44**	**23.59**	**0.00**	**15.74**	**0.00**	**0.03**	**63,644.15**	**14,242.17**	**1.19**
	CONSTRUCTION SUBTOTAL[1]	**387.95**	**1,316.65**	**12.77**	**6,682.53**	**686.16**	**3,905.80**	**29.96**	**24.21**	**0.00**	**16.17**	**0.00**	**0.34**	**307,769**	**14,254**	**4**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	316.511	31.651	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	552.051	55.205	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	6.777	10.467	0.007	0.259	0.259	1.193	0.022	0.003	---	0.002	---	---	829.230	0.057	0.032
	Pad Heaters	71.510	60.069	---	5.435	5.435	3.933	0.002	0.002	---	---	---	0.054	85812.245	1.645	1.573
	Well Workover & Recompletion (Venting, Flaring)	0.545	0.812	---	0.040	0.040	37.800	0.285	0.236	0.000	0.157	1.971	0.001	679.625	142.424	0.012
	Subtotal	**78.83**	**71.35**	**0.01**	**874.30**	**92.59**	**42.93**	**0.31**	**0.24**	**0.00**	**0.16**	**1.97**	**0.05**	**87,321.10**	**144.13**	**1.62**
	Gas Processing															
	Field Dehydrators	5.363	4.505	---	0.408	0.408	824.781	150.220	88.930	---	27.404	76.612	0.004	6444.919	1328.089	0.118
	Gas Processing	1244.507	2301.815	1.800	44.100	44.100	1911.195	33.044	51.159	0.974	24.574	34.677	139.797	738166.401	7382.890	4.685
	Subtotal (with 2010 engines)	**1,249.87**	**2,306.32**	**1.80**	**44.51**	**44.51**	**2,735.98**	**183.26**	**140.09**	**0.97**	**51.98**	**111.29**	**139.80**	**744,611.32**	**8,710.98**	**4.80**
	PRODUCTION SUBTOTAL	**1,328.70**	**2,377.67**	**1.81**	**918.80**	**137.10**	**2,778.90**	**183.57**	**140.33**	**0.97**	**52.14**	**113.26**	**139.86**	**831,932**	**8,855**	**6**
	CONSTRUCTION AND PRODUCTION TOTAL	**1,716.65**	**3,694.31**	**14.57**	**7,601.33**	**823.25**	**6,684.71**	**213.53**	**164.54**	**0.97**	**68.30**	**113.26**	**140.20**	**1,139,702**	**23,109**	**10**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Natural Gas Well Year 2028 Emission Summary (ton/well)

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/10/2010

	Emissions by Source Category (ton/well)															
	Source Type	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOCs**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylene**	**Hexane**	**Form.**	**CO_2**	**CH_4**	**N_2O**
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	0.0303	0.0030	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	0.2910	0.0291	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	0.0175	0.0050	0.0001	0.0016	0.0016	0.0016	0.0000	0.0000	---	0.0000	---	0.0000	1.1760	0.0001	0.0000
	Delivery/Commuter Vehicle Exhaust	0.0038	0.0036	0.0000	0.0001	0.0001	0.0005	0.0000	0.0000	---	0.0000	---	0.0000	0.4612	0.0000	0.0000
	Subtotal	**0.0213**	**0.0086**	**0.0001**	**0.3230**	**0.0339**	**0.0021**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**1.6372**	**0.0001**	**0.0000**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	1.2632	0.1263	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	0.0150	0.0064	0.0000	0.0005	0.0005	0.0011	0.0000	0.0000	---	0.0000	---	0.0000	1.7983	0.0001	0.0000
	Drilling Traffic Road Dust	---	---	---	0.5050	0.0505	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	0.0049	0.0260	0.0000	0.0003	0.0003	0.0028	0.0001	0.0000	---	0.0000	---	0.0001	0.6371	0.0001	0.0001
	Drill Rig Engines - Tier 4b (2015)	*0.0794*	*0.4127*	*0.0044*	*0.0035*	*0.0035*	*0.0222*	*0.0005*	*0.0002*	---	*0.0001*	---	*0.0000*	*82.8000*	*0.0040*	0.0009
	Frac Pump Engines - Tier4b	0.0337	0.1754	0.0019	0.0015	0.0015	0.0094	0.0002	0.0001	---	0.0001	---	0.0000	35.1900	0.0017	0.0004
	Subtotal	**0.1329**	**0.6205**	**0.0063**	**1.7740**	**0.1826**	**0.0356**	**0.0007**	**0.0003**	**0.0000**	**0.0002**	**0.0000**	**0.0001**	**120.4254**	**0.0058**	**0.0014**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	0.9585	0.0959	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	0.0115	0.0049	0.0000	0.0004	0.0004	0.0009	0.0000	0.0000	---	0.0000	---	0.0000	1.3762	0.0001	0.0000
	Completion Traffic Road Dust	---	---	---	0.2832	0.0283	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	0.0033	0.0034	0.0000	0.0001	0.0001	0.0005	0.0000	0.0000	---	0.0000	---	0.0000	0.3976	0.0000	0.0000
	Completion Venting and Flaring	0.0250	0.0210	---	0.0019	0.0019	1.9138	0.0142	0.0118	---	0.0079	---	---	30.0483	7.1210	0.0006
	Subtotal	**0.0398**	**0.0293**	**0.0000**	**1.2442**	**0.1266**	**1.9152**	**0.0142**	**0.0118**	**0.0000**	**0.0079**	**0.0000**	**0.0000**	**31.8221**	**7.1211**	**0.0006**
	CONSTRUCTION TOTAL[1]	**0.1940**	**0.6583**	**0.0064**	**3.3413**	**0.3431**	**1.9529**	**0.0150**	**0.0121**	**0.0000**	**0.0081**	**0.0000**	**0.0002**	**153.8847**	**7.1270**	**0.0020**
PRODUCTION	**Well Pad Emissions**															
	Wind Erosion	---	---	---	0.1583	0.0158	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	0.2760	0.0276	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	0.0034	0.0052	0.0000	0.0001	0.0001	0.0006	0.0000	0.0000	---	0.0000	---	---	0.4146	0.0000	0.0000
	Pad Heaters	0.0358	0.0300	---	0.0027	0.0027	0.0020	0.0000	0.0000	---	---	---	0.0000	42.9061	0.0008	0.0008
	Well Workover & Recompletion (Venting, Flaring)	0.0003	0.0004	---	0.0000	0.0000	0.0189	0.0001	0.0001	0.0000	0.0001	0.0010	0.0000	0.3398	0.0712	0.0000
	Subtotal	**0.0394**	**0.0357**	**0.0000**	**0.4371**	**0.0463**	**0.0215**	**0.0002**	**0.0001**	**0.0000**	**0.0001**	**0.0010**	**0.0000**	**43.6605**	**0.0721**	**0.0008**
	Centralized Compression and Processing															
	Compressor Station Dehydrators	0.0027	0.0023	---	0.0002	0.0002	0.4124	0.0751	0.0445	---	0.0137	0.0383	0.0000	3.2225	0.6640	0.0001
	Gas Processing and Recompression	0.6223	1.1509	0.0009	0.0221	0.0221	0.9556	0.0165	0.0256	0.0005	0.0123	0.0173	0.0699	369.0832	3.6914	0.0023
	Subtotal (with 2010 engines)	**0.6249**	**1.1532**	**0.0009**	**0.0223**	**0.0223**	**1.3680**	**0.0916**	**0.0700**	**0.0005**	**0.0260**	**0.0556**	**0.0699**	**372.3057**	**4.3555**	**0.0024**
	PRODUCTION SUBTOTAL	**0.6644**	**1.1888**	**0.0009**	**0.4594**	**0.0685**	**1.3895**	**0.0918**	**0.0702**	**0.0005**	**0.0261**	**0.0566**	**0.0699**	**415.9662**	**4.4276**	**0.0032**
	CONSTRUCTION AND PRODUCTION TOTAL	**0.8583**	**1.8472**	**0.0073**	**3.8007**	**0.4116**	**3.3424**	**0.1068**	**0.0823**	**0.0005**	**0.0342**	**0.0566**	**0.0701**	**569.8510**	**11.5546**	**0.0052**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Oil Well Year 2028 Emission Summary (lb/well)

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities
Date: 5/10/2010

	Emissions by Source Category															
	Source Type	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOCs**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylene**	**Hexane**	**Form.**	**CO_2**	**CH_4**	**N_2O**
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	141.580	14.160	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	1357.866	135.787	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	81.502	23.108	0.284	7.438	7.438	7.545	0.031	0.014	---	0.010	---	0.039	5488.035	0.264	0.059
	Delivery/Commuter Vehicle Exhaust	17.771	16.888	0.016	0.659	0.659	2.295	0.035	0.006	---	0.004	---	0.039	2152.381	0.124	0.069
	Subtotal	**99.27**	**40.00**	**0.30**	**1,507.54**	**158.04**	**9.84**	**0.07**	**0.02**	**0.00**	**0.01**	**0.00**	**0.08**	**7,640**	**0**	**0**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	5895.082	589.508	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	69.987	29.817	0.067	2.372	2.372	5.262	0.042	0.018	---	0.013	---	0.053	3596.599	0.171	0.082
	Drilling Traffic Road Dust	---	---	---	1010.026	101.003	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	9.705	51.972	0.005	0.627	0.627	5.695	0.129	0.011	---	0.007	---	0.141	1274.286	0.172	0.131
	Drill Rig Engines - Tier 4b (2015)	158.730	825.397	8.825	6.984	6.984	44.444	0.940	0.412	---	0.288	---	0.079	165600.000	7.963	1.788
	Frac Pump Engines - Tier4b	67.460	350.794	3.751	2.968	2.968	18.889	0.400	0.175		0.122		0.034	70380.000	3.384	0.760
	Subtotal (with Tier 4B drill rigs)	**305.88**	**1,257.98**	**12.65**	**6,918.06**	**703.46**	**74.29**	**1.51**	**0.62**	**0.00**	**0.43**	**0.00**	**0.31**	**240,850.88**	**11.69**	**2.76**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	4473.153	447.315	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	53.559	22.818	0.051	1.815	1.815	4.027	0.032	0.014	---	0.010	---	0.040	6422.222	0.306	0.147
	Completion Traffic Road Dust	---	---	---	1321.737	132.174	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	15.296	15.833	0.016	0.575	0.575	2.109	0.033	0.006	--	0.004	---	0.037	1855.556	0.110	0.062
	Subtotal	**68.86**	**38.65**	**0.07**	**5,797.28**	**581.88**	**6.14**	**0.07**	**0.02**	**0.00**	**0.01**	**0.00**	**0.08**	**8,277.78**	**0.42**	**0.21**
	CONSTRUCTION SUBTOTAL[1]	**474.01**	**1,336.63**	**13.02**	**14,222.88**	**1,443.39**	**90.27**	**1.64**	**0.65**	**0.00**	**0.46**	**0.00**	**0.46**	**256,769**	**12**	**3**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	738.525	73.852	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	1288.119	128.812	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	15.812	24.423	0.017	0.605	0.605	2.783	0.050	0.007	---	0.005	---	---	1934.869	0.134	0.075
	Pad Heaters	69.524	58.400	---	5.284	5.284	3.824	0.001	0.002	---	---	---	0.052	83428.571	1.599	1.530
	Pump Jack	2027.778	1520.833	3.042	202.778	202.778	506.944	0.057	0.025	---	0.018	---	0.072	10074.000	0.484	0.108
	Subtotal	**2,113.11**	**1,603.66**	**3.06**	**2,235.31**	**411.33**	**513.55**	**0.11**	**0.03**	**0.00**	**0.02**	**0.00**	**0.12**	**95,437.44**	**2.22**	**1.71**
	PRODUCTION SUBTOTAL	**2,113.11**	**1,603.66**	**3.06**	**2,235.31**	**411.33**	**513.55**	**0.11**	**0.03**	**0.00**	**0.02**	**0.00**	**0.12**	**95,437**	**2**	**2**
	CONSTRUCTION AND PRODUCTION TOTAL	**2,587.13**	**2,940.28**	**16.07**	**16,458.19**	**1,854.72**	**603.82**	**1.75**	**0.69**	**0.00**	**0.48**	**0.00**	**0.59**	**352,207**	**15**	**5**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Oil and Natural Gas Year 2028 Emission Summary (tons/year)

VFO Alternative: RFD
Phase: Construction and Production
Activity: All
Emissions: Emissions From All Production and Construction Activities (NG and Oil sources)
Date: 5/10/2010

	Source Type	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOCs	Benzene	Toluene	Ethylbenzene	Xylene	Hexane	Form.	CO_2	CH_4	N_2O
		Emissions by Source Category														
CONSTRUCTION	**Well Pad and Resource Road Const.**															
	Land Disturbance	---	---	---	38.430	3.844	---	---	---	---	---	---	---	---	---	---
	Construction Traffic Road Dust	---	---	---	368.564	36.856	---	---	---	---	---	---	---	---	---	---
	Construction Equipment Exhaust	22.122	6.272	0.077	2.019	2.019	2.048	0.008	0.004	---	0.003	---	0.011	1489.610	0.072	0.016
	Delivery/Commuter Vehicle Exhaust	4.824	4.584	0.004	0.179	0.179	0.623	0.009	0.002	---	0.001	---	0.011	584.218	0.034	0.019
	Subtotal	**26.946**	**10.856**	**0.082**	**409.192**	**42.898**	**2.671**	**0.018**	**0.005**	**0.000**	**0.004**	**0.000**	**0.021**	**2073.827**	**0.105**	**0.035**
	Drill Rig Move and Drilling															
	Drill Rig Transport Road Dust	---	---	---	1600.094	160.009	---	---	---	---	---	---	---	---	---	---
	Drill Rig Transport Exhaust	18.997	8.093	0.018	0.644	0.644	1.428	0.011	0.005	---	0.003	---	0.014	1798.299	0.086	0.041
	Drilling Traffic Road Dust	---	---	---	505.013	50.501	---	---	---	---	---	---	---	---	---	---
	Drilling Delivery/Commuter Vehicle Exhaust	4.853	25.986	0.002	0.314	0.314	2.848	0.065	0.005	---	0.004	---	0.070	637.143	0.086	0.065
	Drill Rig Engines - Tier 4b (2015)	79.365	412.698	4.413	3.492	3.492	22.222	0.470	0.206	---	0.144	---	0.040	82800.000	3.982	0.894
	Frac Pump Engines - Tier4b	33.7302	175.3968	1.8754	1.4841	1.4841	9.4444	0.1998	0.0875	---	0.0612	---	0.0169	35190.0000	1.6922	0.3799
	Subtotal (with Tier 4B drill rigs)	**136.944**	**622.17**	**6.31**	**2,111.04**	**216.44**	**35.94**	**0.75**	**0.30**	**0.00**	**0.21**	**0.00**	**0.14**	**120,425.44**	**5.85**	**1.38**
	Completion and Testing															
	Completion Watering Truck Road Dust	---	---	---	1214.142	121.414	---	---	---	---	---	---	---	---	---	---
	Completion Watering Truck Vehicle Exhaust	14.538	6.193	0.014	0.493	0.493	1.093	0.009	0.004	---	0.003	---	0.011	1743.175	0.083	0.040
	Completion Traffic Road Dust	---	---	---	358.757	35.876	---	---	---	---	---	---	---	---	---	---
	Completion Delivery/Commuter Vehicle Exhaust	4.152	4.298	0.004	0.156	0.156	0.572	0.009	0.002	---	0.001	---	0.010	503.651	0.030	0.017
	Completion Venting and Flaring	20.000	16.800	---	1.520	1.520	1531.069	11.365	9.433	---	6.293	---	---	24038.610	5696.797	0.440
	Subtotal	**38.69**	**27.29**	**0.02**	**1,575.07**	**159.46**	**1,532.73**	**11.38**	**9.44**	**0.00**	**6.30**	**0.00**	**0.02**	**26,285.44**	**5,696.91**	**0.50**
	CONSTRUCTION SUBTOTAL[1]	**202.58**	**660.32**	**6.41**	**4,095.30**	**418.80**	**1,571.35**	**12.15**	**9.75**	**0.00**	**6.51**	**0.00**	**0.18**	**148,785**	**5,703**	**2**
PRODUCTION	**Well Pad and Consolidated Facility Emissions**															
	Wind Erosion	---	---	---	200.457	20.046	---	---	---	---	---	---	---	---	---	---
	Production Traffic Road Dust	---	---	---	1918.102	191.810	---	---	---	---	---	---	---	---	---	---
	Production Equipment Exhaust	23.545	36.367	0.026	0.901	0.901	4.144	0.075	0.010	---	0.007	---	---	2881.158	0.199	0.111
	Pad Heaters	148.452	124.700	---	11.282	11.282	8.165	0.003	0.005	---	---	---	0.111	178142.645	3.414	3.266
	Pump Jack	2083.542	1562.656	3.125	208.354	208.354	520.885	0.059	0.026	---	0.018	---	0.074	10351.035	0.498	0.111
	Well Workover & Recompletion (Venting, Flaring)	0.587	0.875	---	0.043	0.043	40.711	0.306	0.254	0.000	0.170	2.123	0.001	731.956	153.390	0.013
	Subtotal	**2,256.13**	**1,724.60**	**3.15**	**2,339.14**	**432.44**	**573.90**	**0.44**	**0.29**	**0.00**	**0.19**	**2.12**	**0.19**	**192,106.79**	**157.50**	**3.50**
	Centralized Compression and Processing															
	Compressor Station Dehydrators	5.776	4.852	---	0.439	0.439	888.289	161.787	95.778	---	29.514	82.511	0.004	6941.178	1430.352	0.127
	Gas Processing and Recompression	1340.334	2479.055	1.939	47.496	47.496	2058.357	35.588	55.098	1.049	26.466	37.347	150.561	795005.214	7951.372	5.046
	Subtotal (with 2010 engines)	**1,346.11**	**2,483.91**	**1.94**	**47.93**	**47.93**	**2,946.65**	**197.38**	**150.88**	**1.05**	**55.98**	**119.86**	**150.57**	**801,946.39**	**9,381.72**	**5.17**
	PRODUCTION SUBTOTAL	**3,602.24**	**4,208.50**	**5.09**	**2,387.07**	**480.37**	**3,520.55**	**197.82**	**151.17**	**1.05**	**56.17**	**121.98**	**150.75**	**994,053.19**	**9,539.23**	**9**
	CONSTRUCTION AND PRODUCTION TOTAL	**3,804.82**	**4,868.83**	**11.50**	**6,482.37**	**899.17**	**5,091.90**	**209.97**	**160.92**	**1.05**	**62.69**	**121.98**	**150.94**	**1,142,837.89**	**15,242.09**	**11**

[1] Construction emissions are based on a per well constructed/drilled basis. Construction emissions occur only in the year that a well pad is constructed and associated wells are drilled. All drilling is assumed to be completed in the year of well pad construction.

Little Snake Field Office
RFD Emission Total

Field Office: Little Snake
Date: 6/30/2008

Development Scenario (Based on Little Snake Alternative C)

Wells Developed Over 20 Years (Ending 2027) [1]	2,243
Gas Wells	1,637
Oil Wells	606

Data Source

Air Quality Impact Assessment Technical Support Document, Little Snake Resource Management Plan, Moffat, Routt, and Rio Blanco Counties, Colorado, ENVIRON International Corporation, June 2008.

[1] Although a total of 3,031 wells are included in the RFD, 788 wells would be non-productive or would not be oil or gas wells.

Total RFD Emissions (from Table 2-8 of the AQTSD) for Year 2027. [2]

Pollutant	Total Emissions (tpy)
NOx	1,066
PM10	2,044
PM2.5	608
SO2	15
VOC [3]	1,983
CO [4]	1,684
Total	7,400

[2] Per BLM (June 2008), emissions from 2027 are considered to be representative of 2028 emissions for the purpose of the WRFO air quality analysis. Year 2027 emissions are the maximum projected emissions for the 20-year development time period analyzed for the AQTSD.

[3] VOC emissions were not quantified in the AQTSD. To estimate VOC emissions, the ratio (1.86) of VOC to NOx emissions given in Table I-11 of the "Little Snake RMP Draft Environmental Impact Statement" (January 2007), was used to scale emissions based on the quantity of NOx emissions given above.

[4] CO emissions were not quantified in the AQTSD. To estimate CO emissions, the ratio (1.58) of CO to NOx emissions given in Table I-11 of the "Little Snake RMP Draft Environmental Impact Statement" (January 2007), was used to scale emissions based on the quantity of NOx emissions given above.

Little Snake Field Office
Existing (2000-2006) Well Production Emissions

Field Office: Little Snake
Date: 6/30/2008

Existing Wells Drilled Between 2000 and 2006

Total Wells [1]	174
Gas Well Fraction of Total Wells [2]	0.73
Number of Gas Wells	127
Number of Oil Wells	47

Data Source

Air Quality Impact Assessment Technical Support Document, LIttle Snake Resource Management Plan, Moffat, Routt, and Rio Blanco Counties, Colorado, ENVIRON International Corporation, June 2008.

NOTE: Emissions for existing wells are assumed to be similar to emissions from producing RFD wells.

	Per-Well Production Emissions (tpy)[3]						Total Emissions from Existing Wells (tpy)					
Emission Source	**NOx**	**PM10**	**PM2.5**	**SO2**	**VOC**	**CO**	**NOx**	**PM10**	**PM10**	**SO2**	**VOC**	**CO**
Gas Wells												
Traffic Emissions	1.8E-01	2.6E-01	2.0E-02	3.0E-03	3.3E-01	2.8E-01	2.3E+01	3.3E+01	2.5E+00	3.8E-01	4.3E+01	3.6E+01
Production Emissions	1.2E-04	1.5E-05	1.5E-05	3.0E-07	2.2E-04	1.9E-04	1.5E-02	1.9E-03	1.9E-03	3.8E-05	2.8E-02	2.4E-02
Total Gas Well Emissions	**1.80E-01**	**2.60E-01**	**2.00E-02**	**3.00E-03**	**3.35E-01**	**2.85E-01**	**2.3E+01**	**3.3E+01**	**2.5E+00**	**3.8E-01**	**4.25E+01**	**3.61E+01**
Oil Wells												
Traffic Emissions	1.8E-01	2.6E-01	2.0E-02	3.0E-03	3.3E-01	2.8E-01	8.5E+00	1.2E+01	9.4E-01	1.4E-01	1.6E+01	1.3E+01
Production Emissions	1.3E-03	2.5E-02	2.5E-02	4.8E-04	2.4E-03	2.1E-03	6.1E-02	1.2E+00	1.2E+00	2.3E-02	1.1E-01	9.7E-02
Total Oil Well Emissions	**1.8E-01**	**2.9E-01**	**4.5E-02**	**3.5E-03**	**3.4E-01**	**2.86E-01**	**8.5E+00**	**1.3E+01**	**2.1E+00**	**1.6E-01**	**1.59E+01**	**1.35E+01**

[1] Based on information obtained from the Colorado Oil and Gas Conservation Commission.
[2] Based on the proportion of gas and oil wells projected for future development based on the AQTSD.
[3] Taken from Tables 2-2 and 2-3 of the AQTSD.