

Laura
G70-A129
CPS-00044



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General Permit Application G70-A

Zinn Well Pad

Prepared for: Antero Resources Corporation



Conestoga-Rovers & Associates

6320 Rothway, Suite 100
Houston, Texas 77040

December 2014 • 082715 • Report No. 87



SAFETY DATA SHEET

Material Name: Produced Water

US GHS

Persistence / Degradability

No information available

Bioaccumulation

No information available

Mobility in Soil

No information available

***** Section 13 – DISPOSAL CONSIDERATIONS *****

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment Recommendations.

Disposal of Contaminated Containers or Packaging

Recover or recycle if possible. It is the responsibility of the generator to determine the toxicity and physical properties of the material generated so as to properly classify the waste and ensure disposal methods comply with applicable regulations.

This material, if discarded as produced, is not a RCRA "listed" hazardous waste, and is not believed to exhibit characteristics of hazardous waste. Consult state and local regulations regarding the proper disposal of this material. Do not dispose of brine water by draining onto the ground. This will result in soil and groundwater contamination. Waste arising from spillage or tank cleaning should be disposed of in accordance with applicable regulations.

Container contents should be completely used and containers should be emptied prior to discard. Container rinsate should not be considered a RCRA hazardous waste but must be disposed of with care and in full compliance with federal, state and local regulations. Larger empty containers, such as drums, should be returned to the distributor or to a qualified drum reconditioner. To assure proper disposal of smaller empty containers, consult with state and local regulations and disposal authorities.

***** Section 14 – TRANSPORTATION INFORMATION *****

DOT Information

Shipping Description: Not Regulated

UN #: Not Regulated

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

*** Section 15 – REGULATORY INFORMATION ***

CERCLA/SARA – Section 302 Extremely Hazardous Substances and TPQs (in pounds):

This material does not contain any chemicals subject to the reporting requirements of SARA 302 and 40 CFR 372,

CERCLA/SARA – Section 313 and 40 CFR 372):

This material does not contain any chemicals subject to the reporting requirements of SARA 313 and 40 CFR 372.

EPA (CERCLA) Reportable Quantity (in pounds):

This material does not contain any chemicals with CERCLA Reportable Quantities.

State Regulations

Component Analysis

The following components appear on one or more of the following state hazardous substances list.

California Proposition 65:

This material does not contain any chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm at concentrations that trigger the warning requirements of California Proposition 65.

National Chemical Inventories:

All components are either listed on the US TSCA Inventory, or are not regulated under TSCA.

U.S. Export control classification Number: EAR99.

*** Section 16 – OTHER INFORMATION ***

NFPA® Hazard Rating

Health 1
Fire 0
Reactivity 0

HMIS® Hazard Rating

Health 1 Slight
Fire 0 Minimal
Physical 0 Minimal

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; NJTSR = New Jersey Trade Secret Registry.

Literature References

None

Other Information

The information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Date of Preparation: January 28, 2014

Date of Last Revision: March 4, 2014

End of Sheet

FESCO, Ltd.
 1100 FESCO Avenue- Alice, Texas 78332

For: Antero Resources Appalachian Corp.
 1625 17th Street
 Denver, Colorado 80202

Sample: Prunty No. 1H (Lockhart Heirs Pad)
 Separator Hydrocarbon Liquid
 Sampled @ 200 psig & 66 oF

Date Sampled: 09/05/13

Job Number: 35453.002

CHROMATOGRAPH EXTENDED ANALYSIS- GPA 2186-M

COMPONENT	MOL%	LIQ VOL%	WT%
Nitrogen	0.018	0.004	0.005
Carbon Dioxide	0.031	0.011	0.013
Methane	4.766	1.667	0.703
Ethane	5.726	3.161	1.584
Propane	6.545	3.722	2.654
Isobutane	2.067	1.396	1.105
n-Butane	5.909	3.845	3.159
2,2 Dimethylpropane	0.174	0.138	0.116
Isopentane	3.770	2.846	2.502
n-Pentane	4.872	3.645	3.233
2,2 Dimethylbutane	0.188	0.162	0.149
Cyclopentane	0.000	0.000	0.000
2,3 Dimethylbutane	0.408	0.345	0.323
2 Methylpentane	2.525	2.163	2.001
3 Methylpentane	1.645	1.386	1.304
n-Hexane	4.430	3.760	3.511
Heptanes Plus	56.925	71.749	77.639
Totals:	100.000	100.000	100.000

Characteristics of Heptanes Plus:

Specific Gravity-----	0.7695	(Water=1)
API Gravity -----	52.38	@ 60°F
Molecular Weight -----	148.3	
Vapor Volume -----	16.47	CF/Gal
Weight -----	6.41	Lbs/Gal

Characteristics of Total Sample:

Specific Gravity -----	0.7111	(Water=1)
API Gravity -----	67.48	@ 60°F
Molecular Weight -----	108.7	
Vapor Volume -----	20.76	CF/Gal
Weight -----	5.93	Lbs/Gal

Base Conditions: 14.850 PSI & 60 oF

Certified: FESCO, Ltd. - Alice, Texas

Analyst: XG
 Processor: JCdjv
 Cylinder ID: W-1106

David Dannhaus 361-661-7015

TANKS DATA INPUT REPORT

COMPONENT	Mol%	LiqVol%	Wt%
Carbon Dioxide	0.031	0.011	0.013
Nitrogen	0.018	0.004	0.005
Methane	4.766	1.667	0.703
Ethane	5.726	3.161	1.584
Propane	6.545	3.722	2.654
Isobutane	2.067	1.396	1.105
n-Butane	6.083	3.983	3.274
Isopentane	3.770	2.846	2.502
n-Pentane	4.872	3.645	3.233
Other C-6's	4.766	4.057	3.778
Heptanes	10.970	9.986	9.818
Octanes	13.091	12.723	13.001
Nonanes	5.657	6.431	6.603
Decanes Plus	24.100	40.280	45.352
Benzene	0.283	0.163	0.203
Toluene	0.744	0.514	0.630
E-Benzene	0.510	0.406	0.498
Xylenes	1.570	1.245	1.533
n-Hexane	4.430	3.760	3.511
2,2,4 Trimethylpentane	0.000	0.000	0.000
Totals:	100.000	100.000	100.000

Characteristics of Total Sample:

Specific Gravity -----	0.7111 (Water-1)
API Gravity -----	67.48 @ 60°F
Molecular Weight -----	108.7
Vapor Volume -----	20.76 CF/Gal
Weight -----	5.93 Lbs/Gal

Characteristics of Decanes (C10) Plus:

Specific Gravity -----	0.8007 (Water-1)
Molecular Weight -----	204.6

Characteristics of Atmospheric Sample:

API Gravity -----	59.13 @ 60°F
Reid Vapor Pressure (ASTM D-5191) -----	3.41 psi

QUALITY CONTROL CHECK			
	Sampling Conditions	Test Samples	
Cylinder Number	-----	W-1106*	W-1020
Pressure, PSIG	200	176	173
Temperature, °F	66	70	70

* Sample used for analysis

TOTAL EXTENDED REPORT

COMPONENT	Mol%	LiqVol%	Wt%
Nitrogen	0.018	0.004	0.005
Carbon Dioxide	0.031	0.011	0.013
Methane	4.766	1.667	0.703
Ethane	5.726	3.161	1.584
Propane	6.545	3.722	2.654
Isobutane	2.067	1.396	1.105
n-Butane	5.909	3.845	3.159
2,2 Dimethylpropane	0.174	0.138	0.116
Isopentane	3.770	2.846	2.502
n-Pentane	4.872	3.645	3.233
2,2 Dimethylbutane	0.188	0.162	0.149
Cyclopentane	0.000	0.000	0.000
2,3 Dimethylbutane	0.408	0.345	0.323
2 Methylpentane	2.525	2.163	2.001
3 Methylpentane	1.645	1.386	1.304
n-Hexane	4.430	3.760	3.511
Methylcyclopentane	0.924	0.675	0.715
Benzene	0.283	0.163	0.203
Cyclohexane	0.990	0.695	0.766
2-Methylhexane	2.385	2.288	2.198
3-Methylhexane	1.879	1.780	1.732
2,2,4 Trimethylpentane	0.000	0.000	0.000
Other C-7's	0.950	0.888	0.867
n-Heptane	3.842	3.658	3.540
Methylcyclohexane	3.402	2.823	3.072
Toluene	0.744	0.514	0.630
Other C-8's	6.777	6.822	6.870
n-Octane	2.912	3.079	3.059
E-Benzene	0.510	0.406	0.498
M & P Xylenes	0.777	0.622	0.758
O-Xylene	0.793	0.623	0.775
Other C-9's	3.760	4.227	4.366
n-Nonane	1.897	2.203	2.238
Other C-10's	3.702	4.574	4.810
n-decane	1.350	1.710	1.766
Undecanes(11)	3.614	4.581	4.885
Dodecanes(12)	2.655	3.636	3.932
Tridecanes(13)	2.209	3.243	3.555
Tetradecanes(14)	1.728	2.718	3.020
Pentadecanes(15)	1.331	2.242	2.521
Hexadecanes(16)	1.068	1.923	2.181
Heptadecanes(17)	0.926	1.763	2.018
Octadecanes(18)	0.821	1.647	1.896
Nonadecanes(19)	0.691	1.442	1.670
Eicosanes(20)	0.601	1.304	1.519
Heneicosanes(21)	0.459	1.048	1.228
Docosanes(22)	0.372	0.884	1.042
Tricosanes(23)	0.349	0.862	1.021
Tetracosanes(24)	0.313	0.800	0.952
Pentacosanes(25)	0.261	0.693	0.829
Hexacosanes(26)	0.243	0.668	0.803
Heptacosanes(27)	0.193	0.550	0.664
Octacosanes(28)	0.192	0.565	0.684
Nonacosanes(29)	0.157	0.479	0.582
Triacosanes(30)	0.150	0.470	0.574
Hentriacosanes Plus(31+)	0.717	2.481	3.199
Total	100.000	100.000	100.000



FESCO, Ltd.
 1100 Fesco Avenue- Alice, Texas 78332

For: Antero Resources Appalachian Corp.
 1625 17th Street
 Denver, Colorado 80202

Date Sampled: 09/05/13

Date Analyzed: 09/13/13

Job Number: J35434

Sample: Prunty No. 1H (Lockhart Heirs Pad)

FLASH LIBERATION OF SEPARATOR WATER		
	Separator	Stock Tank
Pressure, psig	200	0
Temperature, "F	66	70
Gas Water Ratio (1)	-----	1.55
Gas Specific Gravity (2)	-----	0.922

(1) - Scf of water saturated vapor per barrel of stock tank water

(2)- Air= 1.000

(3) - Separator volume / Stock tank volume

Analyst: O. A.

Piston No.: WF-133*

Base Conditions: 14.85 PSI & 60 "F

Certified: FESCO, Ltd.

Alice, Texas

David Dannhaus 361-661-7015

FESCO, Ltd.
 1100 Fesco Ave. Alice, Texas 78332

For: Antero Resources Appalachian Corp.
 1625 17th Street
 Denver, Colorado 80202

Sample: Prunty No. 1H (Lockhart Heirs Pad)
 Gas Liberated from Separator Water
 From 200 psig & 66 oF to 0 psig & 70 oF

Date Sampled: 09/05/13

Job Number: 35453.001

CHROMATOGRAPH EXTENDED ANALYSIS SUMMATION REPORT

COMPONENT	MOL%	GPM
Hydrogen Sulfide*	< 0.001	
Nitrogen	0.000	
Carbon Dioxide	1.891	
Methane	63.614	
Ethane	17.120	4.615
Propane	7.633	2.119
Isobutane	1.356	0.447
n-Butane	3.304	1.050
2-2 Dimethylpropane	0.064	0.025
Isopentane	1.192	0.439
n-Pentane	1.225	0.448
Hexanes	1.136	0.472
Heptanes Plus	1.465	0.652
Totals	100.000	10.266

Computed Real Characteristics Of Heptanes Plus:

Specific Gravity ----- 3.802 (Air=1)
 Molecular Weight----- 103.68
 Gross Heating Value ----- 5501 BTU/CF

Computed Real Characteristics Of Total Sample:

Specific Gravity ----- 0.922 (Air=1)
 Compressibility (Z) ----- 0.9937
 Molecular Weight----- 26.54
 Gross Heating Value
 Dry Basis ----- 1548 BTU/CF
 Saturated Basis----- 1522 BTU/CF

*Hydrogen Sulfide tested in laboratory by: Stained Tube Method (GPA 2377)

Results: <0.013 Gr/100 CF, <0.2 PPMV or <0.001 Mol%

Base Conditions: 14.850 PSI & 60 Deg F

Certified: FESCO, Ltd. Alice, Texas

Analyst: MR
 Processor: ANB
 Cylinder ID: WF# 13 S

David Dannhaus 361-661-7015

**CHROMATOGRAPH EXTENDED ANALYSIS
TOTAL REPORT**

COMPONENT	MOL%	GPM	WT%
Hydrogen Sulfide*	< 0.001		< 0.001
Nitrogen	0.000		0.000
Carbon Dioxide	1.891		3.135
Methane	63.614		38.445
Ethane	17.120	4.615	19.393
Propane	7.633	2.119	12.680
Isobutane	1.356	0.447	2.969
n-Butane	3.304	1.050	7.234
2,2 Dimethylpropane	0.064	0.025	0.174
Isopentane	1.192	0.439	3.240
n-Pentane	1.225	0.448	3.330
2,2 Dimethylbutane	0.035	0.015	0.114
Cyclopentane	0.019	0.008	0.050
2,3 Dimethylbutane	0.060	0.025	0.195
2 Methylpentane	0.334	0.140	1.084
3 Methylpentane	0.207	0.085	0.672
n-Hexane	0.481	0.199	1.562
Methylcyclopentane	0.071	0.025	0.225
Benzene	0.042	0.012	0.124
Cyclohexane	0.089	0.031	0.282
2-Methylhexane	0.113	0.053	0.427
3-Methylhexane	0.108	0.050	0.408
2,2,4 Trimethylpentane	0.000	0.000	0.000
Other C7's	0.121	0.053	0.452
n-Heptane	0.183	0.085	0.691
Methylcyclohexane	0.161	0.065	0.596
Toluene	0.057	0.019	0.198
Other C8's	0.217	0.102	0.901
n-Octane	0.070	0.036	0.301
Ethylbenzene	0.003	0.001	0.012
M & P Xylenes	0.031	0.012	0.124
O-Xylene	0.005	0.002	0.020
Other C9's	0.099	0.051	0.471
n-Nonane	0.033	0.019	0.159
Other C10's	0.044	0.026	0.234
n-Decane	0.010	0.006	0.054
Undecanes (11)	0.008	0.005	0.044
Totals	100.000	10.266	100.000

Computed Real Characteristics Of Total Sample:

Specific Gravity----- 0.922 (Air-1)
 Compressibility (Z)----- 0.9937
 Molecular Weight----- 26.54

Gross Heating Value

Dry Basis ----- 1548 BTU/CF
 Saturated Basis ----- 1522 BTU/CF

Antero Resources
Prunty Unit 1H - Lockhart Heirs Pad

Tag Name	Value	Units	Timestamp
Accumulated Gas Flow	560999.8	MCF	10/16/2013 16:11:13
Casing Pressure	450.96	PSIA	10/16/2013 17:05:05
Current Day Gas Flow	2287.78	MCF	10/16/2013 16:11:13
Differential Pressure	57.03	inH2O	10/16/2013 16:11:13
Flow Rate	7454.35	MCF Per Day	10/16/2013 16:11:13
Pressure	108.81	PSIA	10/16/2013 16:11:13
Previous Day Energy	9462.83	MBTU	10/16/2013 16:11:15
Previous Day Gas Flow	7588.11	MCF	10/16/2013 16:11:15
Temperature	60.11	F	10/16/2013 16:11:13
Tubing Pressure	748.58	PSIA	10/16/2013 17:05:05
Daily AP	63.93	PSIA	10/16/2013 09:00:00
Daily DP	111.06	inH2O	10/16/2013 09:00:00
Daily Energy	9462.83	MBTU	10/16/2013 09:00:00
Daily Flow	7588.11	MCF	10/16/2013 09:00:00
Daily Tf	59.56	F	10/16/2013 09:00:00
Hourly AP	110.1	PSIA	10/16/2013 10:00:00
Hourly DP	61.64	Inches	10/16/2013 10:00:00
Hourly Energy	399.7	MBTU	10/16/2013 10:00:00
Hourly Flow Time	3600	Seconds	10/16/2013 10:00:00
Hourly Tf	61.1	F	10/16/2013 10:00:00
Hourly Volume	320.5	MCF	10/16/2013 10:00:00
Argon	0	%	10/16/2013 16:11:25
BTU	1247.06	BTU	10/16/2013 16:11:13
CO2	0.1467	%	10/16/2013 16:11:25
Carbon Monoxide	0	%	10/16/2013 16:11:25
Decane	0	%	10/16/2013 16:11:25
Ethane	14.1987	%	10/16/2013 16:11:25
Helium	0	%	10/16/2013 16:11:25
Heptane	0	%	10/16/2013 16:11:25
Hexane	0.5451	%	10/16/2013 16:11:25
Hydrogen	0	%	10/16/2013 16:11:25
Hydrogen Sulfide	0	%	10/16/2013 16:11:25
Iso-Butane	0.5666	%	10/16/2013 16:11:25
Iso-Pentane	0.3749	%	10/16/2013 16:11:25
Methane	77.6927	%	10/16/2013 16:11:25
N2	0.4946	%	10/16/2013 16:11:25
N-Butane	1.1838	%	10/16/2013 16:11:25
Nonane	0	%	10/16/2013 16:11:25
N-Pentane	0.2914	%	10/16/2013 16:11:25
Octane	0	%	10/16/2013 16:11:25
Oxygen	0.0117	%	10/16/2013 16:11:25
Plate Size	3.75	Inches	10/16/2013 16:11:20
Propane	4.4938	%	10/16/2013 16:11:25
SPG	0.7248		10/16/2013 16:11:13
Water	0	%	10/16/2013 16:11:25

Attachment O

Emissions Summary Sheet

Attachment O: G70-A Emissions Summary Sheet
Emission Points Data Summary Sheet

Emission Point ID No. (Must match Emission Units Table & Plot Plan)	Emission Point Type	Emission Unit Vented Through This Point (Must match Emission Units Table & Plot Plan)		Air Pollution Control Device (Must match Emission Units Table & Plot Plan)		All Regulated Pollutants - Chemical Name/CAS (Specify VOCs & HAPs)		Maximum Potential Uncontrolled Emissions ⁴		Maximum Potential Controlled Emissions ⁵		Emission Form or Phase (At exit conditions, Solid, Liquid or Gas/Vapor)	Est. Method Used ⁶
		ID No.	Source	ID No.	Device Type	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr		
EP-H001, EP-H002, EP-H003, EP-H004, EP-H005, EP-H006, EP-H007, EP-H008, EP-H009, EP-H010, EP-H011, EP-H012	Vertical Stack	H001, H002, H003, H004, H005, H006, H007, H008, H009, H010, H011, H012	Gas Production Unit Heater	N/A		CO (690080)	1.2125	5.3105	1.2125	5.3105	Gas/Vapor	MB AP-42	
						NOx (10102439)	1.4934	6.3221	1.4934	6.3221			
						Pb (7439-92-1)	7.22E-06	3.16E-05	7.22E-06	3.16E-05			
						CO2 Equivalent (10000972, CO2 (124389), CH4 (7529)	1742.3667	7631.5661	1742.3667	7631.5661			
						SO2 (7446095)	0.0001	0.0006	0.0001	0.0006			
						PM, PM10, PM2.5	0.1097	0.4805	0.1097	0.4805			
						Benzene (71432)	3.09E-05	0.0001	3.09E-05	0.0001			
						Toluene (108883)	4.91E-05	0.0002	4.91E-05	0.0002			
						Hexane (110543)	0.0260	0.1138	0.0260	0.1138			
						Formaldehyde (50000)	0.0011	0.0047	0.0011	0.0047			
						2-Methylnaphthalene (91376)	3.46E-07	1.52E-06	3.46E-07	1.52E-06			
						Dichlorobenzene (95501)	1.73E-05	7.59E-05	1.73E-05	7.59E-05			
						Fluoranthene (206440)	4.33E-08	1.90E-07	4.33E-08	1.90E-07			
						Fluorene (86737)	4.04E-08	1.77E-07	4.04E-08	1.77E-07			
						Naphthalene (91203)	8.80E-06	3.86E-05	8.80E-06	3.86E-05			
						Phenanthrene (85018)	2.45E-07	1.07E-06	2.45E-07	1.07E-06			
						Total VOCs	0.0794	0.3477	0.0794	0.3477			
						Benzene (71432)	0.0078	0.0343	0.0078	0.0343			
						Toluene (108883)	0.0243	0.1063	0.0243	0.1063			
						Ethyl benzene (100414)	0.0192	0.0840	0.0192	0.0840			
Hexane (110543)	0.3286	1.4393	0.3286	1.4393									
o,m,p-xylenes (95476,108883,106423)	0.0590	0.2585	0.0590	0.2585									
CO2 Equivalent (10000972, CO2 (124389), CH4 (7529))	96.8695	424.2884	96.8695	424.2884									
VOCs	4.5634	19.9875	4.5634	19.9875									
TAPs (benzene)	0.0078	0.0343	0.0078	0.0343									
VOCs	9.5318	3.4861	9.5318	3.4861									
Toluene (108883)	0.0018	0.0006	0.0018	0.0006									
Ethyl benzene (100414)	0.0009	0.0003	0.0009	0.0003									
Hexane (110543)	0.0274	0.0100	0.0274	0.0100									
o,m,p-xylenes (95476,108883,106423)	0.0026	0.0009	0.0026	0.0009									
CO2 Equivalent (10000972, CO2 (124389), CH4 (7529))	9.2290	7.2054	9.2290	7.2054									
Benzene (71432)	0.0009	0.0003	0.0009	0.0003									
TAPs (benzene)	0.0009	0.0003	0.0009	0.0003									
PM, PM10, PM2.5	4.8968	13.7260	4.8968	13.7260									
EP-L001, EP-L002	n/a												
EP-HR001	n/a	HR001	Haul Truck	N/A		PM, PM10, PM2.5	2.4484	6.8630	2.4484	6.8630	Solid	MB	
						Total VOCs	0.0009	0.0003	0.0009	0.0003			

Attachment O: G70-A Emissions Summary Sheet
Emission Points Data Summary Sheet

Emission Point ID No. (Must match Emission Units Table & Plot Plan)	Emission Point Type	Emission Unit Vented Through This Point (Must match Emission Units Table & Plot Plan)	Air Pollution Control Device (Must match Emission Units Table & Plot Plan)	All Regulated Pollutants - Chemical Name/CAS (Specify VOCs & HAPs)		Maximum Potential Uncontrolled Emissions ⁴		Maximum Potential Controlled Emissions ⁵		Emission Form or Phase (At exit conditions. Solid, Liquid or Gas/Vapor)	Est. Method Used ⁶
				ID No.	Source	ID No.	Device Type	lb/hr	ton/yr		
F001	n/a	TANKCOND001 Condensate Tank and PW Tank and TANKW001-002 and F001	N/A	Flare	CO (630080)	0.00E+00	0.00E+00	0.3717	1.6280	Gas/Vapor/Solid (for PM)	MB
					NOx (10102439)	0.00E+00	0.00E+00	0.4425	1.9361		
					Pb (7439-92-1)	0.00E+00	0.00E+00	2.21E-06	9.69E-06		
					CO2 Equivalent H2O (1004972), CO2 (124489), CH4	1.660.0136	6394.8595	1566.7009	6599.3498		
					SO2 (7446095)	0.00E+00	0.00E+00	7.56E-06	3.31E-05		
					PM, PM10, PM2.5	0.00E+00	0.00E+00	0.0336	0.1473		
					Benzene (71432)	0.5690	2.4920	0.0314	0.0498		
					Toluene (108883)	0.5121	2.2430	0.0102	0.0449		
					ethyl benzene (100414)	0.1372	0.6011	0.0027	0.0120		
					hexane (110543)	12.9635	56.7801	0.2593	1.1356		
					o,m,p-xylenes (95476,108383,106423)	0.3360	1.4715	0.0067	0.0294		
					Formaldehyde (50000)	0.00E+00	0.00E+00	9.45E-07	4.14E-06		
					VOCs	309.1158	1353.9271	6.1824	27.0788		
					toluene (108883)	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
					ethyl benzene (100414)	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
					hexane (110543)	0.0163	0.0716	0.0163	0.0716		
					o,m,p-xylenes (95476,108383,106423)	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
					CO2 Equivalent CO (124489), CH4	10.8393	47.4760	10.8393	47.4760		
					VOCs	0.1374	0.6017	0.1374	0.6017		
					TAPs (benzene)	0.00E+00	0.00E+00	0.00E+00	0.00E+00		
EP-PCV	valve	PCV	Pneumatic CV	N/A	CO (630080)	5.6445	24.7228	5.6445	24.7228	Gas/Vapor/Solid (for PM)	MB
					NOx (10102439)	0.3158	1.3831	0.3158	1.3831		
					CO2 Equivalent H2O (1004972), CO2 (124489), CH4 (124489)	27.7765	121.6612	27.7765	121.6612		
					SO2 (7446095)	0.0001	0.0006	0.0001	0.0006		
					PM, PM10, PM2.5	0.0023	0.0100	0.0023	0.0100		
					TAPs Benzene (71432)	0.0004	0.0017	0.0004	0.0017		
					Toluene (108883)	0.0001	0.0006	0.0001	0.0006		
					TAPs Formaldehyde (50000)	0.0049	0.0215	0.0049	0.0215		
					Ethyl Benzene (100414)	0.0000	0.0000	0.0000	0.0000		
					Naphthalene (91203)	0.0000	0.0001	0.0000	0.0001		
					o,m,p-xylenes (95476,108383,106423)	0.0000	0.0002	0.0000	0.0002		
					Total VOCs	0.0071	0.0311	0.0071	0.0311		
EP-ENG001	Vertical Stack	ENG001	Compressor Engine	N/A	CO (630080)	5.6445	24.7228	5.6445	24.7228	Gas/Vapor/Solid (for PM)	MB
					NOx (10102439)	0.3158	1.3831	0.3158	1.3831		
					CO2 Equivalent H2O (1004972), CO2 (124489), CH4 (124489)	27.7765	121.6612	27.7765	121.6612		
					SO2 (7446095)	0.0001	0.0006	0.0001	0.0006		
					PM, PM10, PM2.5	0.0023	0.0100	0.0023	0.0100		
					TAPs Benzene (71432)	0.0004	0.0017	0.0004	0.0017		
					Toluene (108883)	0.0001	0.0006	0.0001	0.0006		
					TAPs Formaldehyde (50000)	0.0049	0.0215	0.0049	0.0215		
					Ethyl Benzene (100414)	0.0000	0.0000	0.0000	0.0000		
					Naphthalene (91203)	0.0000	0.0001	0.0000	0.0001		
					o,m,p-xylenes (95476,108383,106423)	0.0000	0.0002	0.0000	0.0002		
					Total VOCs	0.0071	0.0311	0.0071	0.0311		

Attachment C/O: G70-A Emissions Summary Sheet
Fugitive Emissions Data Summary Sheet

FUGITIVE EMISSIONS SUMMARY	All Regulated Pollutants Chemical Name/CAS 1	Maximum Potential Uncontrolled Emissions 2		Maximum Potential Controlled Emissions 3		Est. Method Used 4
		lb/hr	ton/yr	lb/hr	ton/yr	
Haul Road/Road Dust Emissions	n/a					
Paved Haul Roads						
Unpaved Haul Roads						
Loading/Unloading Operations						
	PM, PM10, PM2.5	4.8968	13.7260	2.4484	6.8630	MB
	VOCs	9.5318	3.4861	9.5318	3.4861	MB
	toluene (108883)	0.0018	0.0006	0.0018	0.0006	
	ethyl benzene (100414)	0.0009	0.0003	0.0009	0.0003	
	hexane (110543)	0.0274	0.0100	0.0274	0.0100	
	o,m,p-xylenes (95476,108383,106423)	0.0026	0.0009	0.0026	0.0009	
	CO2 Equivalent	9.2290	7.2054	9.2290	7.2054	
	CO2 (124389), CH4	0.0009	0.0003	0.0009	0.0003	
	benzene (71432)	0.0009	0.0003	0.0009	0.0003	
	TAPs (benzene)	0.0009	0.0003	0.0009	0.0003	
Equipment Leaks (Components)						MB
	Benzene (71432)		0.0343		0.0343	
	Toluene (108883)		0.1063		0.1063	
	Ethyl benzene (100414)		0.0840		0.0840	
	Hexane (110543)		1.4393		1.4393	
	o,m,p-xylenes (95476,108383,106423)		0.2585	Does not apply	0.2585	
	CO2 Equivalent		424.2884		424.2884	
	CO2 (124389), CH4					
	VOCs		19.9875		19.9875	
	TAPs (benzene)		0.0343		0.0343	
Equipment Leaks (PCVs)						MB
	toluene (108883)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
	ethyl benzene (100414)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
	hexane (110543)	0.0163	0.0716	0.0163	0.0716	
	o,m,p-xylenes (95476,108383,106423)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
	CO2 Equivalent		47.4760		47.4760	
	CO2 (124389), CH4	10.8393		10.8393		
	VOCs	0.1374	0.6017	0.1374	0.6017	
	TAPs (benzene)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

1 List all regulated air pollutants. Speciate VOCs, including all HAPs. Follow chemical name with Chemical Abstracts Service (CAS) number. LIST Acids, CO, CS2, VOCs, H2S, Inorganics, Lead, Organics, O3, NO, NO2, SO2, SO3, all applicable Greenhouse Gases (including CO2 and methane), etc. DO NOT LIST H2, H2O, N2, O2, and Noble Gases.

2 Give rate with no control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

3 Give rate with proposed control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

4 Indicate method used to determine emission rate as follows: MB = material balance; ST = stack test (give date of test); EE = engineering estimate; O = other (specify).

Attachment P

Other Supporting Documentation
(Engine EPA's Certificate of Conformity and Technical Information)

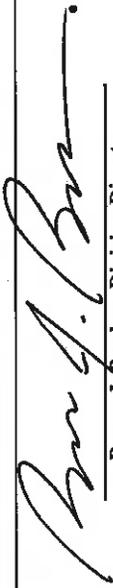


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
2013 MODEL YEAR
CERTIFICATE OF CONFORMITY
WITH THE CLEAN AIR ACT OF 1990

OFFICE OF TRANSPORTATION
AND AIR QUALITY
ANN ARBOR, MICHIGAN 48105

Certificate Issued To: **Kubota Corporation**
(U.S. Manufacturer or Importer)
Certificate Number: **DKBXS.9622HP-002**

Effective Date:
11/20/2012
Expiration Date:
12/31/2013


Byron J. Bunker, Division Director
Compliance Division

Issue Date:
11/20/2012
Revision Date:
N/A

Manufacturer: Kubota Corporation
Engine Family: DKBXS.9622HP
Certificate Number: DKBXS.9622HP-002
Useful Life : 1000 Hours / 5 Years
Engine Class : Nonhandheld-Class II
Fuel : Natural Gas (CNG/LNG)
Emission Standards : NMHC + NOx (g/kW-hr) : 8
CO (g/kW-hr) : 610

Pursuant to Section 213 of the Clean Air Act (42 U.S.C. section 7547), 40 CFR Part 1054, 40 CFR Part 1068 and 40 CFR Part 60 (stationary only and combined stationary and mobile), and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued for the following small nonroad engine family, more fully described in the documentation required by 40 CFR Part 1054 and produced in the stated model year.

This certificate of conformity covers only those new small nonroad engines which conform in all material respects to the design specifications that applied to those engines described in the documentation required by 40 CFR Part 1054 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 1054. This certificate of conformity does not cover small nonroad engines imported prior to the effective date of the certificate.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 1068.20 and 1068, Subpart E and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 1054. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void *ab initio* for other reasons specified in 40 CFR Part 1054, 40 CFR Part 1068.

This certificate does not cover small nonroad engines sold, offered for sale, or introduced, or delivered for introduction, into commerce in the U.S. prior to the effective date of the certificate.

TECHNICAL INFORMATION

DG972-SAEH-S1

NATURAL GAS FUEL ENGINE

July, 2006

KUBOTA Corporation

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5. FUEL SYSTEM AND FUEL DIAGRAM

Specifications and dimensions are subject to change without prior notice.

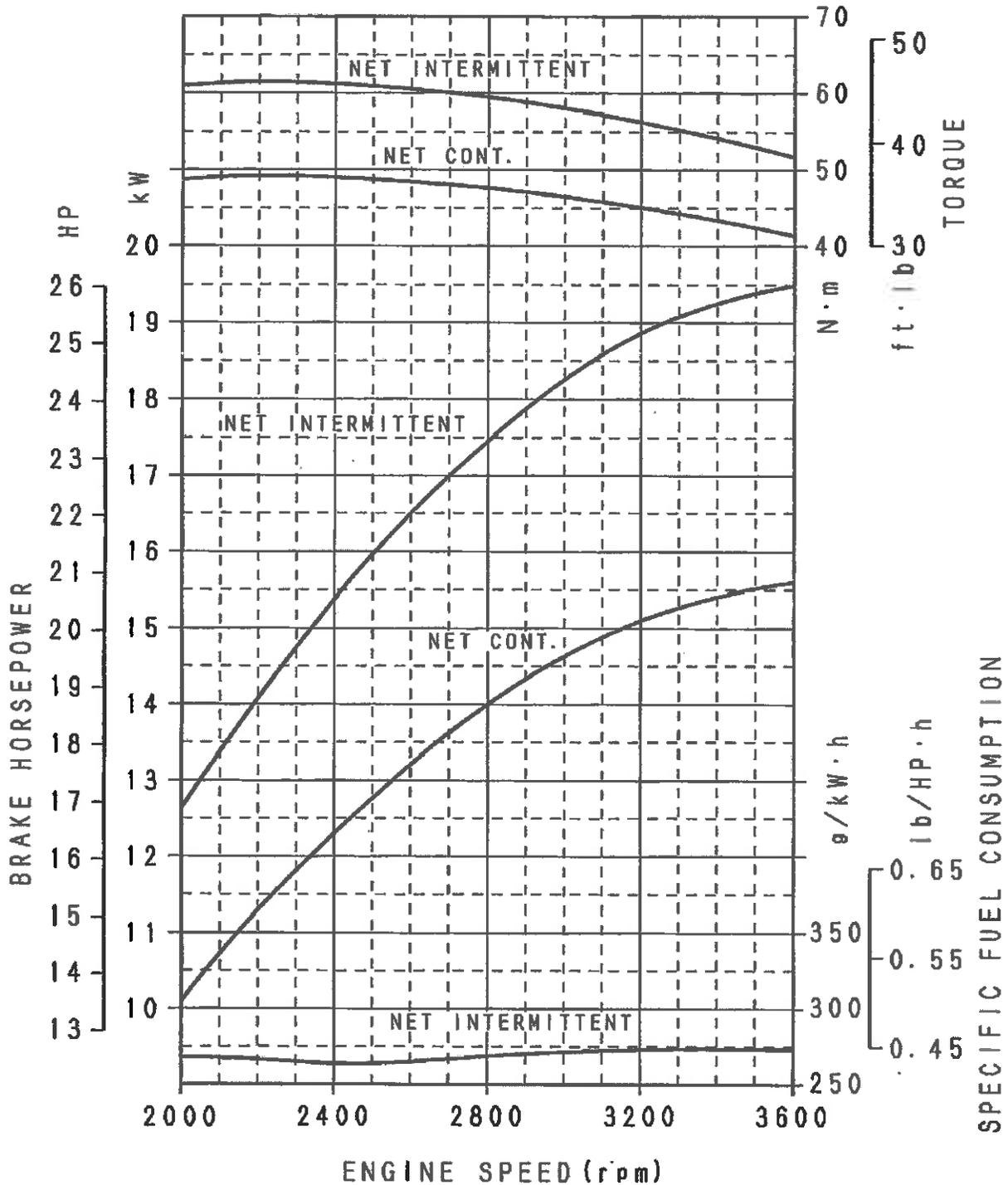
1. GENERAL SPECIFICATIONS

ITEM	UNIT	SPECIFICATIONS
Engine model		DG972-SAEH-S1
Type		Vertical, In line, 4cycle Natural Gas engine
Cooling system		Water cooling with water pump
Number of cylinders		3
Cylinder bore	mm(in)	74.5 (2.93)
Stroke	mm(in)	73.6 (2.90)
Total displacement	L(cu. in)	0.962 (58.7)
High idle	rpm	3850
Low idle	rpm	1500
Horsepower	kW(HP)	19.5(26.1)
Max. torque (SAE J1349)	Nm(ft-lb) /rpm	61.2 (45.2)/2400
Compression ratio		9.2
Firing order		1-2-3
Ignition timing		B.T.D.C.15° /1000rpm B.T.D.C.28° /3600rpm
Ignition system		Distributor-less Solid State type
Fuel		Natural Gas only
Direction of rotation		Counter-clockwise from flywheel side
Starting system		Electric starting with cell starter
Starter output	V-kW	12-1.0
Alternator output	V-W	12-480 (Standard)
Lubricating system		Forced lubricating by trochoid pump
Lubricating oil		Quality better than SH class
Lube. oil capacity	L(US gal)	3.4 (0.90)
Coolant capacity	L(US gal)	1.22 (0.32)
Governor type		Centrifugal flyweight mechanical type governor
Dimensions (LxBxH)	mm(in)	526x415x503 (20.7x16.3x19.8)
Dry weight	kg(lb)	Approx. 95.4(210)
Application		Stationary only

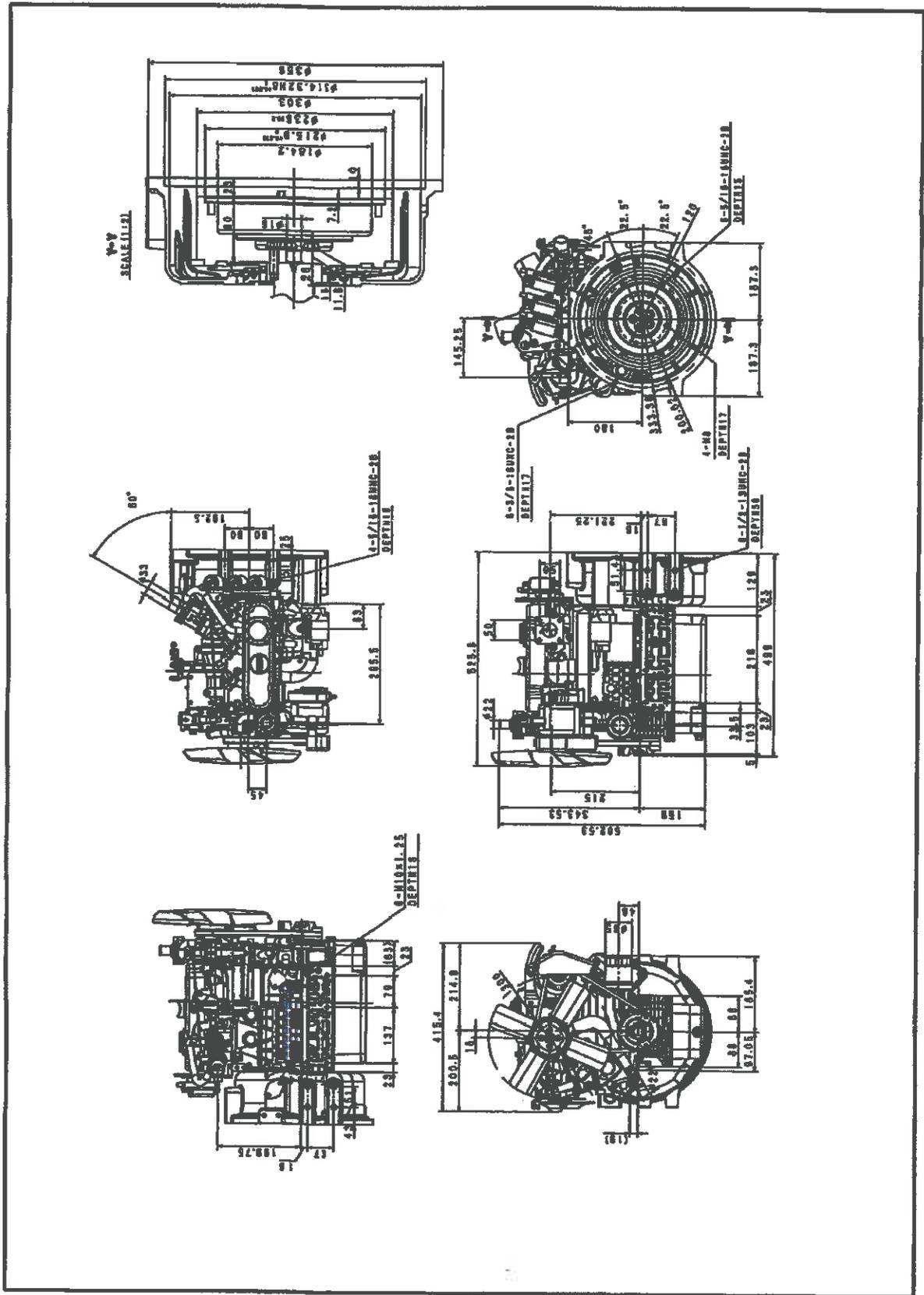
2. PERFORMANCE CURVES

DG972 PERFORMANCE CURVES

Higher calorific value : 11000kcal/m³ (1236BTU/ft³)



3. DIMENSIONS



4. TECHNICAL DATA

ITEM		SPECIFICATIONS
Engine model		DG972-SAEH-S1
Brake horse power		See attached sheet 4-1)
Top Clearance		1.35 to 1.65mm (0.05315 to 0.06496in)
Compression pressure		1.32MPa (192psi)
Fuel consumption		See attached sheet 4-2)
Lube. oil consumption		Max.0.67g/kWh (0.5g/HPh) at rated load
Lube. oil pressure		at idling speed: more than 69kPa (more than 9.95psi)
		at rated speed: 196 to 441kPa (28.44 to 63.99psi)
Noise level		See attached sheet 4-3)
Combustion air requirements		See attached sheet (Refer to 25deg.C and 1000hPa) 4-4)
Cooling air requirements		
Combustion and cooling air requirements		
Exhaust gas volume		See attached sheet (Refer to 25deg.C and 1000hPa) 4-5)
Cold starting limits		-15deg.C (5deg.F)
Heat rejection		See attached sheet 4-6)
Angles of tilt	Front or Rear down	30° (Less than 10min. continuous operation)
		20° (Continuous operation)
	Left or Right side down	30° (Less than 10min. continuous operation)
		20° (Continuous operation)
Valve timing		[Inlet valve] Open: TDC -20° Close: BDT +45°
		[Exhaust valve] Open: BDC -50° Close: TDC +15°
Cooling fan data		See attached sheet 4-7)
Center of gravity		See attached sheet 4-8)
Unbalanced forces of engines		See attached sheet 4-9)
Mass elastic system		See attached sheet 4-10)
Thermostat specifications		Opening temperature: 71±1.5deg.C (159.8±2.7deg.F)
		Fully opened temperature: 85deg.C (185deg.F) [at Thermostat lift:8mm (0.31in)]

4-1) BRAKE HORSE POWER

SAE J1349

Engine speed	rpm	2000	2400	2800	3200	3600
Net intermittent	kW	12.6	15.4	17.4	18.9	19.5
	HP	16.9	20.6	23.3	25.3	26.1
	PS	17.1	20.9	23.7	25.7	26.5
Net continuous	kW	10.1	12.3	13.9	15.1	15.6
	HP	13.5	16.5	18.7	20.3	20.9
	PS	13.7	16.8	18.9	20.6	21.2

Note

- Conversion rates
 $1\text{kW}=1.35962\text{PS}=1.34048\text{HP}$
 $1\text{PS}=0.7355\text{kW}=0.985925\text{HP}$
 $1\text{HP}=0.7457\text{kW}=1.01428\text{PS}$
- Fuel detail
 Japanese standard gas
 higher calorific value : 11000kcal/m^3 (1236BTU/ft^3)
 supply pressure : $0.98 - 2.45\text{kPa}$ ($7.35 - 18.38\text{mmHg}$)

4-2) FUEL CONSUMPTION

Specific at net intermittent (SAE J1349)

Engine speed	rpm	2000	2400	2800	3200	3600
Brake horse power	kW	12.6	15.4	17.4	18.9	19.5
	HP	16.9	20.6	23.3	25.3	26.1
	PS	17.1	20.9	23.7	25.7	26.5
Fuel consumption	g/kWh	269	264	269	273	273
	g/HPh	200	197	200	204	204
	g/PSh	198	194	198	201	201
	lb/HPh	0.442	0.434	0.442	0.449	0.449

Note

- Conversion rates
 $1\text{kW}=1.35962\text{PS}=1.34048\text{HP}$ $1\text{kg}=2.20462\text{lb}$ ($1\text{g}=0.00220462\text{lb}$)
 $1\text{PS}=0.7355\text{kW}=0.985925\text{HP}$ $1\text{lb}=0.45359\text{kg}$
 $1\text{HP}=0.7457\text{kW}=1.01428\text{PS}$
- Fuel detail
 Japanese standard gas
 higher calorific value : 11000kcal/m^3 (1236BTU/ft^3)
 supply pressure : $0.98 - 2.45\text{kPa}$ ($7.35 - 18.38\text{mmHg}$)

4-3) NOISE LEVEL

Load × rpm	Unit	Sound pressure at 1m(3.3ft)
0/4 × 3850	dB(A)	90.0
4/4 × 3850 15.6kW (20.9HP)	dB(A)	92.0
0/4 × 1500	dB(A)	72.0

These data show the average noise level at four points.

Note

- Measurement conditions : With radiator, cooling fan, air cleaner and muffler.

4-4) AIR REQUIREMENTS

1. Combustion air requirements (Refer to 25deg.C and 1000hPa)

rpm	2000	2400	2800	3200	3600
L/sec	12.35	14.81	17.28	19.75	22.22
m ³ /h	44.44	53.33	62.22	71.11	80.00
in ³ /sec	753	904	1055	1205	1356
ft ³ /min	26.13	31.35	36.58	41.80	47.03

Combustion air requirements calculating formula

$$Q_1 = Vh \cdot N \cdot C \cdot \eta \cdot 10^{-3}$$

Q₁: Amount of intake air (m³/min)

η: Intake efficiency

Vh: Total displacement (L)

Natural Gas: 0.77

N: Engine speed (rpm)

C: Coefficient=0.5

2. Cooling air requirements (Refer to 25deg.C and 1000hPa)

rpm	2000	2400	2800	3200	3600
L/sec	571.2	737.2	824.7	833.9	764.7
m ³ /h	2056	2654	2969	3002	2753
in ³ /sec	34859	44984	50327	50888	46667
ft ³ /min	1210.2	1561.8	1747.3	1766.7	1620.2

Above data is decided by following conditions.

1. Using the standard radiator.
2. Engine is run as open unit.

3. Combustion and cooling air requirements (Refer to 25deg.C and 1000hPa)

rpm	2000	2400	2800	3200	3600
L/sec	583.5	752.0	842.0	853.7	786.9
m ³ /h	2100.4	2707.3	3031.2	3073.1	2833.0
in ³ /sec	35612	45888	51382	52093	48023
ft ³ /min	1236.3	1593.2	1783.9	1808.5	1667.2

Note

1. Cooling fan and fan pulley specifications(Cooling fan Part No. 15881-74112)

Item	
Fan diameter	300mm (11.81in)
No. of blade and type of shape	4, S type
Diameter of fan driving pulley	100mm (3.94in)
Diameter of fan pulley	84mm (3.31in)

2. Conversion rates

$$1L = 61.0237 \text{ in}^3 = 0.035315 \text{ ft}^3$$

$$1 \text{ ft}^3 = 28.3168 \text{ L}$$

$$1L/\text{sec} = 3.6 \text{ m}^3/\text{h} = 2.1189 \text{ ft}^3/\text{min}$$

4-5) EXHAUST GAS VOLUME

Refer to 25deg.C and 1000hPa

rpm	2000	2400	2800	3200	3600
L/sec	35.46	42.55	49.65	56.74	63.83
m ³ /h	127.67	153.19	178.73	204.26	229.80
in ³ /sec	2164	2597	3030	3462	3895
ft ³ /min	75.05	90.06	105.07	120.08	135.09

Note

- Conversion rates
 - 1L=61.0237in³=0.035315ft³
 - 1ft³=28.3168L
 - 1L/sec=3.6m³/h=127.133ft³/hr

4-6) HEAT REJECTION TO COOLING WATER

1. Specific at net intermittent (SAE J1349)

Engine speed	rpm	2000	2400	2800	3200	3600
Brake horse power	kW	12.6	15.4	17.4	18.9	19.5
	HP	16.9	20.6	23.3	25.3	26.1
	PS	17.1	20.9	23.7	25.7	26.5
Fuel consumption	g/kWh	269	264	269	273	273
	g/HPh	200	197	200	204	204
	g/PSh	198	194	198	201	201
	lb/HPh	0.442	0.434	0.442	0.449	0.449
Heat rejection to cooling water	MJ/h	29.05	31.52	38.79	45.13	51.82
	kcal/h	6940	7529	9267	10781	12379
	BTU/h	12491	13551	16679	19404	22281

Note

Heat rejection to cooling water calculating formula

$$Ho=Hu \cdot Ne \cdot be \cdot i$$

Ho: Heat rejection to cooling water

Hu: Fuel low calorific value

Japanese standard gas; 49.4MJ/kg, 11800kcal/h, 212391BTU/lb

Ne: Brake horse power

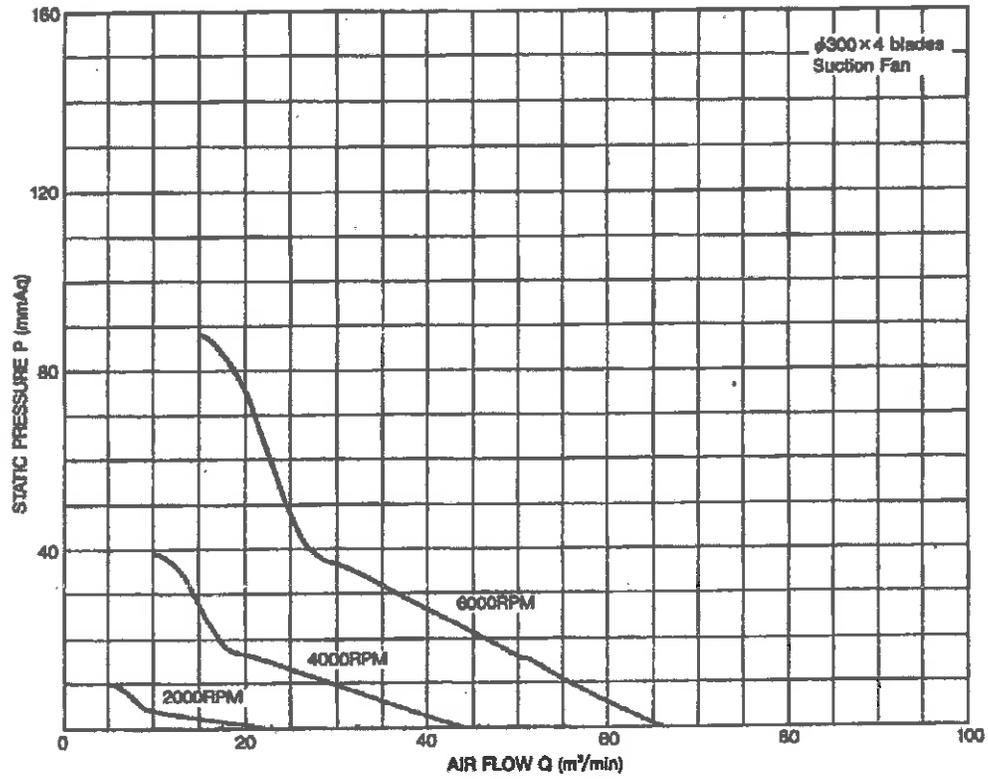
Be: Specific fuel consumption

i: Dispersion ratio to cooling water

4-7) COOLING FAN DATA

1. Performance curves <P-Q>

- Part No. 15881-74110 (Applicable for DG972)



4-8) CENTER OF GRAVITY

1. With standard flywheel and rear-end plate

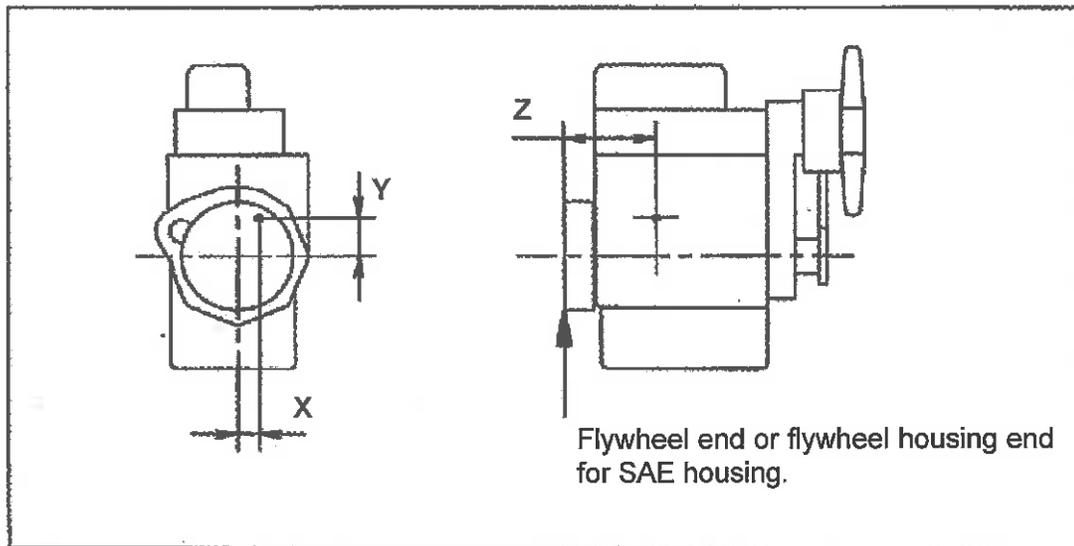
Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
WG/DF972	72.0 (159)	-25.5 (-1.00)	73.3 (2.89)	179.5 (7.07)

2. With SAE flywheel and flywheel housing

Model	Dry weight kg (lb)	Center of gravity		
		X mm (in)	Y mm (in)	Z mm (in)
DG972 -SAEH-S1	95.4 (210)	-10.0 (0.39)	28.0 (1.10)	207.0 (8.15)

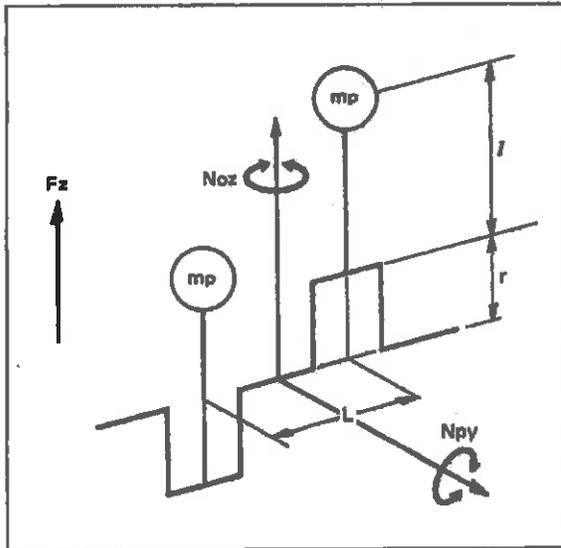
Note

Cooling water and lubricating oil weight is not included in above engine weight.



4-9) UNBALANCED FORCES OF ENGINES

1. Base data



F_z : Unbalanced inertia force
 N_{py} , N_{oz} : Unbalanced inertia couple
 m_p : Reciprocating mass
 r : Crank radius
 l : Center distance of connecting rod
 L : Cylinder distance
 ω : Angular velocity

$$\omega = 2\pi n / 60 \quad n: \text{Engine speed (rpm)}$$

$l=0.098\text{m}$	Cylinder bore (mm)	m_p (kg)
$r=0.0368\text{m}$	74.5	0.37/9.80665
$L=0.080\text{m}$		

2. Unbalanced inertia force and couple

($\times \omega^2$)

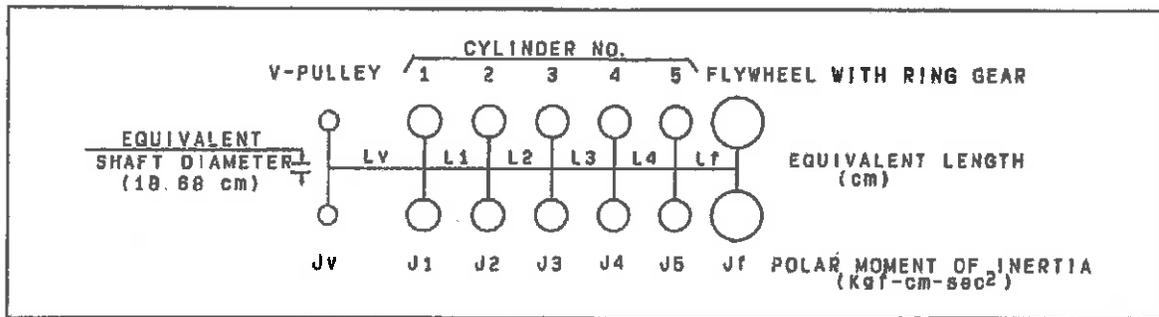
Model	No. of Cylinder	Cylinder Bore	Order	F_z	N_{py}	N_{oz}
WG/DF/DG 972	3	74.5mm	1	0	0.000096	0.000096
			2	0	0.000072	0

▼An example of calculation

Calculation condition	ω^2	F_z, N_{py}, N_{oz}		
		Order	Calculation	
Engine model DG972 Engine speed 3600(rpm)	$[2 \times \pi \times 3600/60]^2$ $=142122$	F_z	1	0
			2	0
		N_{py}	1	$0.000096 \times 142122 = 13.6\text{kg}$
			2	$0.000072 \times 142122 = 10.2\text{kg}$
		N_{oz}	1	$0.000096 \times 142122 = 13.6\text{kg}$
			2	0

4-10) MASS ELASTIC SYSTEM

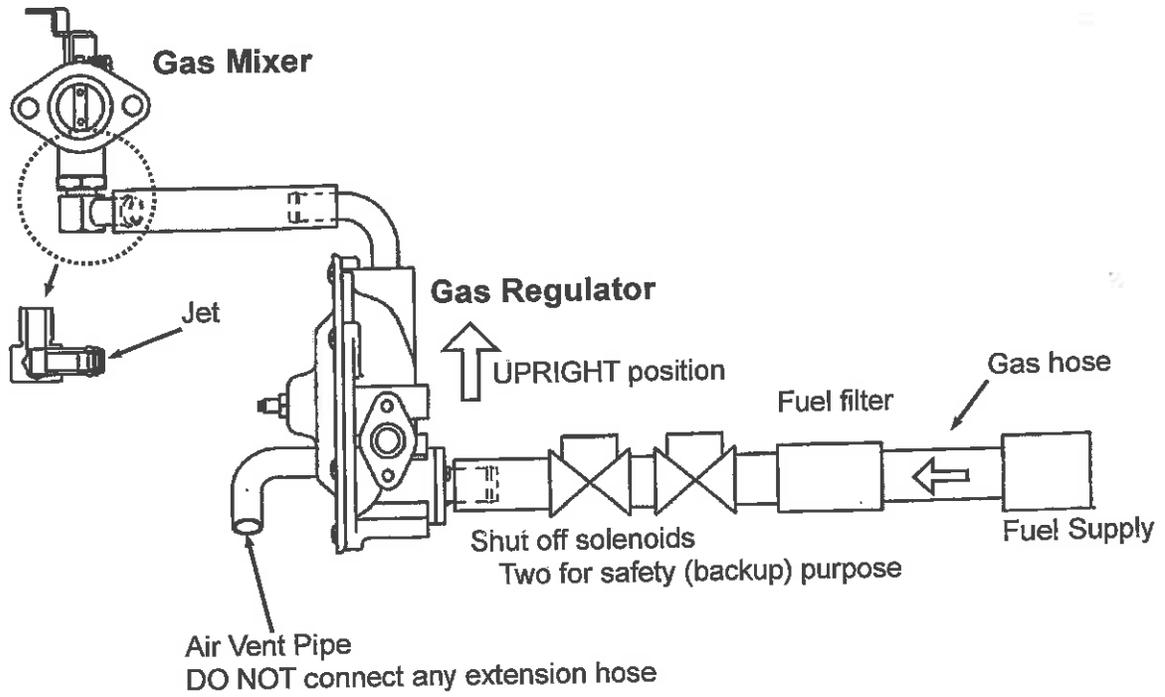
Equivalent torsional vibration data



MODEL	EQUIVALENT LENGTH (cm)				POLAR MOMENT OF INERTIA (kgf-cm-sec ²)				
	LV	L1	L2	Lf	JV	J1	J2	J3	Jf
DG972 -SAEH-S1	35082	4528	4528	2824	0.013	0.026	0.026	0.026	1.281

Note: Flywheel E8052-25110, V-Pulley 16861-74280

5. Fuel diagram



NATURAL GAS ENGINE

KUBOTA DG SERIES (3-cylinder)

DG972-E2



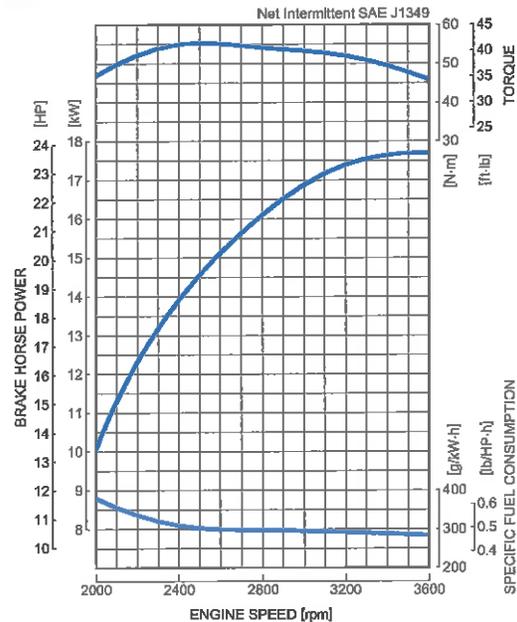
RATED POWER

17.6kW@3600rpm



Photograph may show non-standard equipment.

PERFORMANCE CURVE



FEATURES and BENEFITS

New Engine Series

- The Kubota DG Series offers a new solution to the increasing needs for natural gas engine. The diesel engine based Kubota DG Series gives users the same foot-print, reliability and durability of D902, WG972, and DF972 acknowledged as the world's top quality small industrial engines.
- Kubota offers SAE Flywheel Housing and Rear End Plate specifications for the DG972 engine. These options offer users flexible Power Take Off (PTO) choices.
- The Kubota DG Series is designed to endure use outdoors under severe environment. This series is equipped with a bypass breather tube to avoid freezing below zero.

Emission

- Kubota DG Series complies with EPA Tier 2 Emissions Regulations. EPA regulation is one of the most stringent emissions regulations in the world.

Best Fuel System

- Specialized for Natural Gas use, the DG972 engine eliminated the carburetor, regulator and a fuel filter parts, which are only necessary for Gasoline or LPG use. Also, Kubota adopts the best jet set and the ignition timing that provides the best engine performance in severe conditions.

Ease maintenance cost and time

- Mechanical governor system will contribute to lower maintenance cost and prevents users from having to deal with complicated electric maintenance. Moreover, water resistant spark plug caps are adopted for outdoor use.

GENERAL SPECIFICATION

Model		DG972-E2
Emission Regulation		Tier 2
Type		Vertical 4-cycle Liquid Cooled Natural Gas
Number of Cylinders		3
Bore	mm (in)	74.5 (2.93)
Stroke	mm (in)	73.6 (2.9)
Displacement	L (cu.in)	0.962 (58.70)
Fuel		Natural Gas
Intake System		Naturally Aspirated
Maximum Speed	rpm	3600
Output: Net Intermittent	kW	17.6
	hp	23.6
	ps	23.9
Direction of Rotation		Counterclockwise Viewed on Flywheel
Oil Pan Capacity	L (gal)	3.7 (0.98)
Starter Capacity	V-kW	12-1.0
Alternator Capacity	V-A	12-40
Length	mm (in)	525.5 (20.69)*1 / 452.5 (17.81)*2
Width	mm (in)	415.4 (16.35)
Height (1)	mm (in)	502.5 (19.78)
Height (2)	mm (in)	159.0 (6.26)
Dry Weight	kg (lb)	72.0 (158.7)*1 / 95.4 (210.3)*2

*Specification is subject to change without notice.

*Output: Net Intermittent SAE J1349

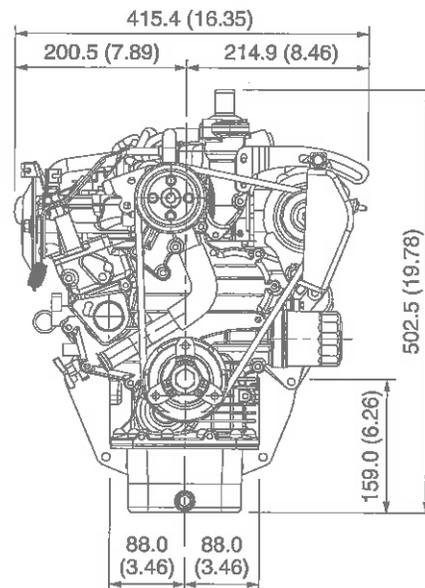
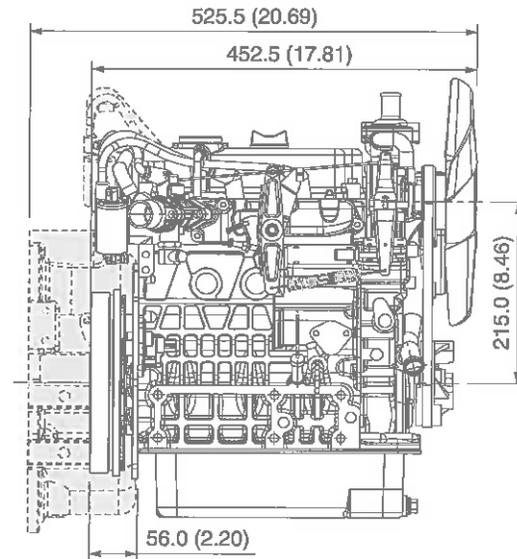
*Dry weight is according to Kubota's standard specification.

*When specification varies, the weight will vary accordingly.

*1 with SAE Flywheel and Housing

*2 with Rear End Plate

DIMENSIONS



Your Driving Force
KUBOTA ENGINE

KUBOTA Corporation

2-47, Shikitsuhigashi 1-chome, Naniwa-ku, Osaka, 556-8601 Japan
Fax: 06-6648-3521

<http://www.engine.kubota.co.jp>

GUIDE TO
**ENVIRONMENTAL
ANALYTICAL
METHODS**
5th Edition

Edited by
Roy-Keith Smith, PhD
Apichemical Consultants



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INTRODUCTION TO 5th EDITION

The fifth edition of the *Guide to Environmental Analytical Methods* covers the massive changes that have continued to take place to EPA methods, affecting organic and inorganic determinative methods along with preparative and sampling procedures.

Since the last edition of "*The Guide*," EPA SW846 has been updated with many new methods; existing methods have been revised; and more methods removed. For instance the large number of individual flame AA and graphite furnace AA methods for metals have been collapsed into general Methods 7000B and 7010, respectively. Update IV to SW-846 has been out in distribution for several years however the legal status of the update is uncertain in many States as the Office of Solid Waste has not promulgated the update, choosing instead to hold fast to the idea of SW-846 as guidance rather than regulation. I have chosen to update this book to Update IV of the Third Edition of SW-846 as many laboratories are already using it. Previous editions of this book present appropriate information about earlier SW-846 versions. The changes from SW846 Final Update III are so expansive that the Method Status Table in Appendix D of this fifth edition has been revised, listing current promulgated methods and available more recently revised versions.

The CLP data are extensively revised to reflect the newest Statements of Work: inorganics ILM05.2, December, 2001, and organics OLM04.2, May, 1999 and OLC03.2, December, 2000. Further, tabular data on the CLP organics have been expanded to include the low concentration method in a side-by-side comparison with the multi-media, multi-concentration Statement of Work. The inorganic SOW is noteworthy as no FLAA nor GFAA techniques are included in it and the dreaded GFAA decision flowchart has been dropped.

An important addition to the fifth edition is tabular comparison of multi-anion analysis by ion chromatography and capillary electrophoresis. These analytical techniques are becoming more visible within the industry and the regulatory framework. The increased number of practitioners of these methods justifies their inclusion.

The discussion and data relating to the analysis of PCB congeners in SW-846 Method 8082A has been deleted, as it is an inadequate method for the stated objective. The Office of Water is working on Method 1668, which is a high resolution mass spectrometer technique capable of identifying and quantitating most of the 209 PCB congeners including the individual planar (toxic) PCB.

All EPA 200 series, 500 series, 600 series, and methods found in the 20th Edition of *Standard Methods for the Examination of Water and Wastewater* contained in the book have been reviewed for changes and revised where necessary.

It must be kept in the forefront that despite the wishes and practices of many in the laboratory community, EPA still maintains a strict separation between program areas. Thus EPA Method 8270 (regardless of version) is not a permissible replacement for EPA Method 625 for the analysis of semivolatile organics in wastewater. Let the reader be aware that even though they may think Method 8270 is the better method, Clean Water Act regulations still require the use of Method 625. And Method 625 has easily recognizable differences from Method 8270.

Roy-Keith Smith, PhD
Apichemical Consultants

HISTORY and ACKNOWLEDGMENTS

The *Guide to Environmental Analytical Methods* was originally developed from a method comparison document called *Variability in Protocols (VIP)* published by the EPA Risk Reduction Engineering Laboratory in Cincinnati, Ohio. VIP provided a useful tool for understanding similarities and differences among commonly used environmental test methods. This concept was greatly expanded by Northeast Analytical's staff with the first publication of the *Guide to Environmental Analytical Methods* in 1992. Now in its fifth edition, and under new editorship, *The Guide* has become a popular reference tool for all who work in the environmental field.

Dr. Roy-Keith Smith retired in June, 2000 from his former position as Quality Assurance Manager and Analytical Methods Manager with a prominent commercial environmental laboratory in the Southeast. His retirement has actually provided more time for him to delve into the intricacies of the environmental industry, unhampered by the day-to-day distractions of the laboratory. Besides writing, Dr. Smith has been busy serving as an expert witness for environmental lawsuits, where his specialty of foundation destruction has been widely appreciated, and for teaching, presenting seminars, and laboratory consultations. He can be reached through Genium Publishing, www.genium.com.

Analytical Methods - Organic Constituents

The numerous analytical methods for organic constituent testing have been organized into five major categories:

- Herbicides (chlorinated) identified by gas chromatography
- Pesticides (organochlorine) and PCBs identified by gas chromatography
- Semivolatile organic compounds identified by gas chromatography/mass spectroscopy
- Volatile organic compounds identified by gas chromatography/mass spectroscopy
- Volatile organic compounds (aromatic and halogenated) identified by gas chromatography

Within each category there is a section called *Method Comparison* that summarizes the key method requirements and components for each testing method. The methods are compared on a side-by-side basis, which allows the user to quickly compare key aspects of the test methods. Where appropriate the user is referred to a table in Appendix A that provides details about an aspect of the test method. The tables in Appendix A are taken directly from the regulations.

For determining if a specific analyte is analyzed by a test method, each category has an *Analyte Listing* of all compounds addressed by the test methods within the category. This is also presented on a side-by-side basis so that the user can quickly see which method(s) cover the specific compound in question.

If you want to find a test method for a specific analyte but don't know what category(ies) it belongs to, refer to Appendix B. Appendix B is an alphabetical listing of all organic analytes specified in the method comparison sections. Use this appendix to identify the category to turn to for additional information.

SW-846 Method 8000B

Unlike most Methods published by EPA and the various Standards organizations, the complete intent and guidance of SW-846, the EPA Office of Solid Waste Methods Manual, is not present in an individual Method such as Method 8270D, Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry. Instead SW-846 is broken down into sampling guidance, sample preparation guidance, and sample analysis guidance, followed by specific Methods that implement the guidance. Thus to say that Method 8270D was performed on a sample actually means that a host of Methods in SW-846 were used, specifically Chapter 1 and Chapter 2, the quality control and Method selection chapters, followed by Methods 3500B (Sample preparation guidance) and a specific sample preparation technique such as Method 3520C (continuous liquid-liquid extraction). Next the general directions for use of analytical instruments in organic analysis, Method 8000B, was consulted prior to the use of the specific determinative Method, 8270D.

Method 8000B is essential to successful use of any chromatographic Methods in SW-846. Method 8000B has the following contents:

- Section 1. Introduction and Applicability
- Section 2. Summary
- Section 3. Interferences/Chromatographic Performance
- Section 4. Apparatus and Materials (GC Inlet Systems, flow control, columns, detectors, HPLC inlet systems, pumps, columns, ovens, detectors, and data systems)
- Section 5. Reagents
- Section 6. Sample Collection, Preservation, and Handling
- Section 7. Procedure (Extraction, cleanup and separation, initial calibration, calibration linearity, retention time windows, calibration verification, chromatographic analysis, compound identification, calculations, and system maintenance.)
- Section 8. Quality Control (chromatographic performance, required instrument quality control, initial demonstration of proficiency, matrix spike and laboratory control samples, surrogate recoveries, generating performance criteria for quality control measures.)
- Section 9. Method Performance (MDL definition and procedure for determination.)
- Section 10. References

All of Method 8000B is important, however if any sections can be said to be critical they are Sections 7 and 8. All of the chromatographic Methods in SW-846 describe a calibration procedure, however they are very scant on description of options. Method 8000B exhaustively describes the options for the cases where linear calibration is not achievable. One particular item of concern is the number of concentration standards needed in a non-linear calibration. Five standards are required for a linear calibration, six for a second order (quadratic equation) calibration, and seven for a third order equation.

Method Comparison

Determination of Chlorinated Herbicides by GC

Method ⇒ Parameter ↓	SW-846 Method 8151A	EPA 500 Series Method 515.4 ⁱ	EPA 500 Series Method 515.2	Standard Methods Method 6640 ^a
Applicability	Groundwater, soils, sludges, and non-water miscible wastes	Groundwater, and drinking water	Groundwater and drinking water	Groundwater, surface, and drinking water
Number of Analytes (3)	19 total	17 total	14 total	9 total
Method Validation (4)	Extract and analyze 4 replicates of a QC check sample. Compare accuracy and precision results to Table 4 (see page A-126). Note: accuracy and precision limits not listed for PFB derivatives of herbicides.	Extract and analyze a minimum of 4 to 7 replicates of QC check sample, Concentration 5 ug/L. Analyte recovery must be within ±20% of fortified concentration. RSD of measurements must be ≤20%. Perform MDL study	Extract and analyze a minimum of 4 replicates of a QC check sample. Concentration 10-20 times the MDL or at a mid point in the calibration Results must be within 40% of fortified concentration. RSD must be <30%	Extract and analyze 4 replicates of QC check standards. Results must be within ±30% of values specified in Table 6640: VI. (see page A-112) Determine MDL (6)
QC Check Standards/Samples	Analyze one laboratory control sample per 20 samples or each batch of samples whichever is more frequent. Compare results to laboratory established limits. Laboratory can use 70-130% as interim limits until in house limits are developed.	Analyze one QC check sample at least once a quarter; Concentration should be 10 times the EDL or a conc. which is near the mid point of the calibration. Compare %R to laboratory established limits, if available. If laboratory limits not available analyte recovery must be ± 20% of fortified value. Laboratory established limits must not exceed ±20%.	Analyze one QC check sample (Laboratory Fortified Blank) per 20 samples or one per sample set (all samples extracted within a 24 hr period), whichever is more frequent. Concentration should be 10 times the EDL or a conc. which is near the mid point of the calibration. Compare %R to laboratory established limits, if available. If laboratory limits not available analyte recovery must be ±40% of fortified value. Laboratory established limits must not exceed ±40%.	Analyze one QC check sample (Laboratory Fortified Blank) per 20 samples or one per sample set (all samples extracted within a 24 hr period), whichever is more frequent. Concentration should be within 2 times the concentration listed in Table 6640: VI (see page A-112). Compare %R to laboratory established limits, if available, or Table 6640: VI and VII (see pages A-104)
Method Detection Limit	MDLs listed in Table 1 (see page A-125) for diazomethane derivatives of herbicides. MDLs for PFB derivatives are not listed in the method.	MDLs and EDLs listed in Table 3. Extract and analyze a minimum of 7 laboratory fortified blanks. Use Table 3 concentrations as guide. Calculate MDL.	MDLs listed in Table 2 (see page A-38). Extract and analyze a minimum of 7 laboratory fortified blanks. Use Table 2 concentrations as guide. Calculate MDL.	MDLs listed in Table 6640: I (see page A-111). EQLs measured at approximately 5-10 times the MDL.

Notes:

- (1) EPA Method 515.4, Revision 1.0, April, 2000
- (2) 20th Edition Standard methods for the Examination of Water and Wastewater 1998; the method does not include a base-catalyzed hydrolysis step and is thus not approved for use by EPA.
- (3) Analyte lists may vary among methods; a smaller list in one method is not necessarily a subset of a larger list in another method.
- (4) Initial, one-time, demonstration of ability to generate acceptable accuracy and precision. Procedure may need to be repeated if changes in instrumentation or methodology occur.

Method Comparison

Determination of Chlorinated Herbicides by GC (Continued)

Method ⇒ Parameter ↓	SW-846 Method 8151A	EPA 500 Series Method 515.4	EPA 500 Series Method 515.2	Standard Methods Method 6640
Standard Solution Expiration (5)	Stock standards: Not specified. Working Standard solution: Prepare daily. Calibration standards: Prepare daily	Stock standards: Not specified. Calibration standards: Prepare daily.	Stock standards: Not specified. Calibration standards: Prepare daily.	Stock standards: Not specified. Calibration standards: Prepare daily.
Initial Calibration	<p>Minimum of 5 levels, lowest near but above MDL.</p> <p>Option 1: If CF or RF %RSD ≤20 or if mean %RSD of all analytes ≤20 then use avg. CF or RF. Alternatively use a cal. curve (see options below).</p> <p>Option 2: If CF or RF %RSD >20 or if %RSD of all analytes >20, then use cal. curve:</p> <p>a) linear cal. using least squares regression;</p> <p>b) linear cal. using weighted least squares regression.</p> <p>Requirements: $r \geq 0.99$, not forced through origin, do not use origin as a cal. point.</p> <p>Option 3: Where instrument response is non-linear over wide working range or above procedures fail acceptance criteria, non-linear cal. may be employed.</p> <p>Requirements: COD ≥ 0.99, not forced through origin, do not use origin as a cal. point, other requirements exist pending curve fitting model chosen.</p>	<p>Calibration is by extracting calibration standards from water. 5 levels of calibration are required. Pre-esterified standards may not be used. Lowest concentration calibration standard is at the minimum reporting level.</p>	<p>Calibration levels required:</p> <p>20x range: 3 calibration standards.</p> <p>50x range: 4 calibration standards.</p> <p>100x range: 5 calibration standards.</p> <p>Lowest level should be near but above MDL.</p> <p>If %RSD ≤30, linearity assumed and average RF used.</p> <p>Alternatively use a calibration curve.</p> <p>Calibration standards are to be extracted the same as samples.</p>	<p>Minimum of 3 levels (5 recommended), use calibration levels listed in Table 6640: IV (see page A-111). If %RSD ≤ 20, linearity assumed and average RF used. Alternatively use a calibration curve or a single point calibration. Single point calibration standard must produce response within 20% of unknowns.</p>

Notes:

(5) Indicates maximum usage time. If comparisons to QC check standards indicate a problem, more frequent preparation may be necessary.

Organic

Method Comparison

Determination of Chlorinated Herbicides by GC (Continued)

Method ⇒ Parameter ↓	SW-846 Method 8151A	EPA 500 Series Method 515.4	EPA 500 Series Method 515.2	Standard Methods Method 6640
Continuing Calibration	<p>A mid-level calibration check standard must be analyzed at the beginning of each 12 hour shift, or more frequently if warranted. If average response of all analytes is not within ±15% of predicted response, recalibrate. Samples which contain target compounds above the reportable limit must be bracketed by an acceptable calibration check standard.</p> <p>Standard RT must fall within daily RT window or system is out of control.</p> <p>Samples injected after criteria was exceeded must be reanalyzed.</p>	<p>A calibration check standard at the minimum reporting level for each analyte must be analyzed at the beginning of analysis day. If not within ±50% of predicted response, recalibrate. A mid- or high- level calibration check standard is then run after each 10 samples. These must be within 70-130% of true value</p> <p>Verify calibration standards at least quarterly using an independent source.</p>	<p>One or more calibration standards analyzed daily. If not within ± 30% of predicted response, recalibrate.</p> <p>Derivatized calibration standards can be used up to 14 days.</p> <p>Verify calibration standards at least quarterly using an independent source.</p>	<p>A calibration check standard must be analyzed at the beginning and end of analysis day. If not within ±20% of predicted response, recalibrate and reanalyze samples.</p>
Surrogate Standards	<p>One/two surrogates added to each sample (avoid use of deuterated analogs) 2,4-Dichlorophenylacetic acid (DCAA) at 0.5 mg/L in extract is recommended. Results must fall within laboratory established limits.</p>	<p>2,4-Dichlorophenylacetic acid (DCAA) at 25 ng/mL in sample. %R = 70-130.</p>	<p>2,4-Dichlorophenylacetic acid (DCAA) at 0.1 µg/ml in extract. %R = 60-140.</p>	<p>2,3,5,6-Tetrafluorobenzoic acid %R=70-130 compared to the average daily calibration standard.</p>
Internal Standards	<p>Optional. If used 4,4'-Dibromooctafluorobiphenyl (DBOB) or others if there is DBOB interference. (DBOB) at 0.25 µg/mL in extract.</p>	<p>4,4'-Dibromooctafluorobiphenyl (DBOB) at 0.25 µg/mL in extraction solvent. Sample IS response must be ±50% of calibration response</p>	<p>Optional. If used 4,4'-Dibromooctafluorobiphenyl (DBOB) at .020 µg/ml in extract. Sample IS response must be ±30% of daily standard response.</p>	<p>Optional. If used, 1,2,3-Trichloropropane. Sample IS response must be ±30% of daily standard response.</p>

Organic

Method Comparison

Determination of Chlorinated Herbicides by GC (Continued)

Method ⇒ Parameter ↓	SW-846 Method 8151A	EPA 500 Series Method 515.4	EPA 500 Series Method 515.2	Standard Methods Method 6640
Accuracy/ Precision	One MS/MSD per 20 samples or each batch of samples, whichever is more frequent. Compare results to laboratory established limits. (See also: QC Check Standards/Samples.) Laboratory can use 70-130% as interim limits until in-house limits are developed.	One MS (Laboratory Fortified Sample Matrix) per 10 samples or each sample set, whichever is more frequent. Compare %R to laboratory established limits. Recovery should be 70-130%. Duplicates analyzed at a rate of 1 per batch. Analyze a QC sample from an external source at least quarterly. (See also: QC Check Standards/Samples.)	One MS (Laboratory Fortified Sample Matrix) per 10 samples or each sample set, whichever is more frequent. Compare %R to laboratory established limits. Analyze a QC sample from an external source at least quarterly. (See also: QC Check Standards/Samples.)	One MS (Matrix with known additions) per 10 samples or at least one per month. Compare %R to laboratory established limits. Analyze a QC sample from an external source at least quarterly. (See also: QC Check Standards/Samples.)
Blanks	One method blank per extraction batch (up to 20 samples) or when there is a change in reagents, whichever is more frequent.	One method blank with each batch of samples extracted.	One method blank with each batch of samples extracted or when new reagents are used.	One method blank with each batch of samples extracted or when new reagents are used.
Preservation/ Storage Conditions	If residual chlorine present, add sodium thiosulfate. Store at 4 °C. Protect from light.	Sodium sulfite added to sample container.. Store at less than 6 °C in the dark. Store extracts at less than 0°C in the dark.	Adjust pH to <2 by adding HCL at sampling site. Sodium thiosulfate if residual chlorine present (aqueous). Protect from light. Store at 4 °C.	Store at 4 °C. Protect from light. Sodium thiosulfate if residual chlorine present. Adjust pH to <2 at sampling site.
Holding Time (6)	Extraction: 7 days (aqueous). 14 days (solids). Analysis: 40 days after extraction.	Extraction: 14 days. Analysis: 21 days after extraction.	Extraction: 14 days. Analysis: 14 days after extraction.	Extraction: 14 days. Analysis: 14 days after extraction.
Field Sample Amount (7)	1 liter (aqueous). 4 oz. (solid) glass container. Teflon lined top.	40 mL glass container Teflon lined top.	250 mL amber glass container. Teflon lined top.	40 mL glass container Teflon lined top. Collect samples in quadruplicate.
Amount for Extraction	1 liter (aqueous). 30 grams (low level solid). 2 grams (medium level solid).	40 mL	250 mL	30 mL

Notes:

- (6) Unless otherwise indicated, holding times are from the date of sample collection.
- (7) Approximate volumes to be gathered for analysis. Additional volumes are required for the generation of QC data.

Method Comparison

Determination of Chlorinated Herbicides by GC (Continued)

Method ⇒ Parameter ↓	SW-846 Method 8151A	EPA 500 Series Method 515.4	EPA 500 Series Method 515.2	Standard Methods Method 6640
Other Criteria (Method Specific)	When doubt exists in compound identification, second column or GC/MS confirmation should be used.	Laboratory Performance Check Sample analyzed daily to monitor instrument sensitivity, column performance, and chromatographic performance. Compound identification, verified by second column confirmation	Instrument Performance Check Sample analyzed daily to monitor instrument sensitivity, column performance, and chromatographic performance. Compare results to Table 11 (see page A-38). When doubt exists in compound identification, second column confirmation or additional qualitative technique must be used.	Use at least two columns for identification and quantification. Laboratory Performance Check Sample analyzed daily to monitor instrument sensitivity, column performance, and chromatographic performance. Compare results to Table 6640: VIII (see page A-113).

Organic

Notes:

- (8) MDL determination for Standard Methods 6000 Series: Analyze a minimum of seven check samples (concentration = 0.2 times MCL or 10 times estimated MDL.). Average percent recovery should be 80% to 120% of true value with %RSD ≤ 35%. Use results to determine MDLs. Broader acceptance ranges exist for some compounds with lower extraction efficiency and are indicated in the specific method.
- (9) For SW-846 Method 8151A, either diazomethane or pentafluorobenzyl bromide may be used for esterification.

Analyte Cross-Reference

Determination of Chlorinated Herbicides by GC

Chemical Name	CAS Number	SW-846 Method 8151A	EPA 500 Series Method 515.4	EPA 500 Series Method 515.2	Std. Methods Method 6640
Acifluorfen	50594-66-6	•	•	•	
Bentazon	25057-89-0	•	•	•	•
Chloramben	133-90-4	•	•		
2,4-D	94-75-7	•	•	•	•
Dalapon	75-99-0	•	•		•
2,4'-DB	94-82-6	•	•	•	
Dacthal	1861-32-1			•	
DCPA acid metabolites	N/A	•	•		
Dicamba	1918-00-9	•	•	•	•
3,5-Dichlorobenzoic acid	51-36-5	•	•	•	
Dichloroprop	120-36-5	•	•	•	
Dinoseb	88-85-7	•	•	•	•
5-Hydroxydicamba	7600-50-2	•		•	
MCPA	94-74-6	•			
MCPP	93-65-2	•			
4-Nitrophenol	100-02-7	•			
Pentachlorophenol	87-86-5	•	•	•	•
Picloram	1918-02-1	•	•	•	•
2,4,5-T	93-76-5	•	•	•	•
2,4,5-TP(Silvex)	93-72-1	•	•	•	•
Quinclorac	84087-01-4		•		

Organic

Analytical Methods - Inorganic Constituents

The numerous analytical methods for inorganic constituent testing have been organized into six major categories:

- Cyanide (total and amenable)
- Organic carbon (total)
- Mercury identified by cold vapor atomic absorption
- Trace metals identified by flame and graphite furnace atomic absorption spectroscopy
- Trace metals identified by inductively coupled plasma technique
- Trace metals identified by inductively coupled plasma/mass spectroscopy

Within each category there is a section called *Method Comparison* that summarizes the key method requirements and components for each testing method. The methods are compared on a side-by-side basis, which allows the user to quickly compare key aspects of the test methods. Where appropriate the user is referred to a table in Appendix A that provides details about an aspect of the test method. The tables in Appendix A are taken directly from the regulations.

For determining if a specific inorganic analyte is analyzed by a test method, each category that identifies more than one specific analyte has an *Analyte Listing* of all analytes addressed by the test methods within the category. This is also presented on a side-by-side basis so that the user can quickly see which method(s) cover the specific inorganic analyte in question.

If you want to find a test method for a specific inorganic analyte but don't know what category(ies) it belongs to, refer to Appendix C. Appendix C is an alphabetical listing of all inorganic analytes specified in the method comparison sections. Use this appendix to identify the category to turn to for additional information.

Method Comparison

Multi-Analyte Analysis of Anions

Method ⇒ Parameter ↓	EPA 300.1 ¹	SW-846 6500 ²	SW-846 9056A ³	SM 4110 ⁴	SM 4140 ⁵
Instrument	Ion Chromatograph	Capillary Electrophoresis	Ion Chromatograph	Ion Chromatograph	Capillary Electrophoresis
Number of Analytes	10 ⁶	7	7	6	11
Method Validation	Initial analysis of a Quality Control Sample and determination of MDL for all analytes followed by quarterly re-analysis of the Quality Control Sample and semi-annual MDL determination	None specified	None specified	Assessment of individual capability, performance evaluation samples (Method 4020)	Analyze 7 replicates of a certified performance evaluation sample, mean of each analyte must be within 95% confidence interval for the sample; semi-annual performance of performance evaluation samples
QC Check Standards/Samples	Analysis of a Laboratory Fortified Blank with every batch of samples	One laboratory control sample with each batch of samples	One Laboratory Control sample with each batch of samples; recoveries between 80-120%	Laboratory control samples (Method 4020)	Laboratory control samples (Method 4020)
Method Detection Limit	Determined by 40 CFR 136, Appendix B; MDL range from 0.5 µg/L to 20 µg/L depending on analyte	Depends on injected sample size and sensitivity of detector; nominally <0.1 mg/L	Depends on injected sample size and sensitivity of detector; nominally <0.02 mg/L	Depends on injected sample size and sensitivity of detector; nominally <0.1 mg/L	Depends on injected sample size; nominally <0.1 mg/L
Standard Solution Expiration	Chlorite 2 weeks; nitrite and phosphate 1 month; all others 6 mos; fresh working standards prepared daily	One month for nitrite; others not specified	One month when stored at 4C; fresh working standards prepared weekly	At least one month; prepare working standards fresh daily	At least three months; prepare working standards fresh daily

¹ Revision 1.0, with errata sheet, April, 1999

² Update IVA, January, 1998

³ Update IVB, November, 2000

⁴ 20th Edition, 1998

⁵ 20th Edition, 1998

⁶ Combined analytes of Methods 300.0 Part A and 300.0 Part B



Sampling Procedures and Preparation

This section provides a tabulation of environmental sample parameters including method references, sample amounts required for analysis, container specifications, sample preservation requirements, and extraction and analysis hold times. This information is useful in maintaining sample integrity as well as compliance with correct sampling procedures as specified in EPA regulation.

Also provided in this section is a summary of sample extraction and sample cleanup methods approved for various sample matrix types for each of the analytical methods listed. The user should note that for EPA SW-846 the extraction and clean-up methods are cited with their own method numbers.

Sampling Procedures and Preparation

Sample Extraction and Clean-up Methods for Municipal and Industrial Discharge

EPA Method Name	Method #	Preparation and Extraction				Cleanup Methods			
		Purge-and-Trap	Liquid/Liquid Extraction	Base Wash	Derivatization	Florisil Cmn Clean-up	Alumi-na Cmn Clean-up	Silica Gel Cmn Clean-up	Sulfur Clean-up (Hg)
Purgeable Halocarbons	601	*							
Purgeable Aromatics	602	*							
Acrolein and Acrylonitrile	603	*							
Phenols	604		*		*			*	
Hexachlorophene and Dichlorophen	604.1*		*	*					
Benzidines	605		*						
Phthalate Esters	606		*			*	*		
Nitrosamines	607		*			*	*		
Organochlorine Pesticides and PCBs	608		*			*			*
Organochlorine Pesticides	608.1		*			*			
Organochlorine Pesticides	608.2		*			*		*	
Nitroaromatics and Isophorone	609		*			*			
Polynuclear Aromatic Hydrocarbons	610		*					*	
Haloethers	611		*			*			
Chlorinated Hydrocarbons	612		*			*			
2,3,7,8-Tetrachlorodibenzo-p-dioxin	613		*	*			*	*	
Organophosphorus Pesticides	614*		*			*			*
Organophosphorus Pesticides	614.1*		*					*	
Chlorinated Herbicides	615*		*		*				
Carbon, Hydrogen, and Oxygen containing pesticides	616*		*					*	
Organohalide pesticides and PCBs	617*		*			*			*
Volatile Pesticides	618*		*						
Triazine Pesticides	619*		*			*			
Diphenylamine	620*		*					*	
Organophosphorus Pesticides	622*		*						
Purgeables	624	*							
Base Neutrals and Acids	625		*						
Dinitroaniline Pesticides	627*		*						
Cyanazine	629*		*						
Dithiocarbamate Pesticides	630*(1)								
Dithiocarbamate Pesticides	630.1*(1)								

Sampling

APPENDIX A

This is a compilation of some of the tables, exhibits, etc., found in the methods. If the method comparison refers to a specific table, that table will be found in this appendix. Only tables and exhibits referred to in the method comparison are found in this appendix.

Listing of Tables and Exhibits from the Methods included in this Appendix

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Appendix B

All organic analytes mentioned in any of the test methods covered in the method comparison sections in this reference are listed in alphabetical order followed by their CAS number. If the analyte is included in one of the listed test methods it is marked with a “•” or one of the following letters in the appropriate column. “S” for Surrogate compounds, “I” for Internal Standard compounds, or “B” if the compound is both a Surrogate and an Internal Standard.

Organic Analyte Cross-Reference to Methods

Key:

S = Surrogate

I = Internal Standard

B = Both Surrogate and Internal Standard

Analyte	CAS Number	Herbicides				Pesticides & PCBs				Semivolatile Organic								
		SW846 - 8151A	EPA 500 - 515.4	EPA 500 - 515.2	Std. Methods 6640	SW846 - 8081B	SW846 - 8082A	EPA500 - 508	EPA600 - 608	Std. Methods 6630	CLP-PEST - MC	SW846 - 8270D	EPA500 - 525.2	EPA600 - 625	Std. Methods 6410	CLP - SVOA - MC	CLP - SVOA - LC	CLP - PEST - LC
Acenaphthene	83-32-9																	
Acenaphthene d10	15067-26-2																	
Acenaphthylene	208-96-8																	
Acetone	67-64-1																	
Acetonitrile	75-05-8																	
Acetophenone	98-86-2																	
2-Acetylaminofluorene	53-96-3																	
1-Acetyl-2-thiourea	591-08-2																	
Acifluorfen	50594-66-6	•	•	•														
Acrolein	107-02-8																	
Acrylonitrile	107-13-1																	
Alachlor	15972-60-8					•												
Aldrin	309-00-2					•	•	•	•	•	•	•	•	•	•	•	•	•
Allyl alcohol	107-18-6																	
Allyl chloride	107-05-1																	
Ametryn	834-12-8												•					
2-Aminoanthraquinone	117-79-3											•						
Aminoazobenzene	60-09-3											•						
4-Aminobiphenyl	92-67-1											•						
3-Amino-9-ethylcarbazole	132-32-1											•						
Anilazine	101-05-3											•						
Aniline	62-53-3											•	•					
Aniline d5	4165-61-1												B	B				
o-Anisidine	90-04-0											•						
Anthracene	120-12-7											•	•	•	•	•	•	•
Anthracene d10	1719-06-8												B	B				
Aramite	140-57-8											•						
Aroclor-1016	12674-11-2						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1221	11104-28-2						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1232	11141-16-5						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1242	53469-21-9						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1248	12672-29-6						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1254	11097-69-1						•	•	•	•	•	•	•	•	•	•	•	•
Aroclor-1260	11096-82-5						•	•	•	•	•	•	•	•	•	•	•	•
Atraton	1610-17-9											•						
Atrazine	1912-24-9											•			•	•		
Azabenzene	110-86-1																	
Azinphos methyl	86-50-0											•						
Barban	101-27-9											•						

Organic Analyte Cross-Reference to Methods

Volatile Organic by GC/MS		Volatile Organic by GC		Analyte
SW846 - 8260B	EPA500 - 524.2	EPA600 - 624	Std. Methods 6210B	
				Acenaphthene
				Acenaphthene d10
				Acenaphthylene
•	•			Acetone
•				Acetonitrile
				Acetophenone
				2-Acetylaminofluorene
				1-Acetyl-2-thiourea
				Acifluorfen
•				Acrolein
•	•			Acrylonitrile
				Alachlor
				Aldrin
•				Allyl alcohol
•	•			Allyl chloride
				Ametryn
				2-Aminoanthraquinone
				Aminoazobenzene
				4-Aminobiphenyl
				3-Amino-9-ethylcarbazole
				Anilazine
				Aniline
				Aniline d5
				o-Anisidine
				Anthracene
				Anthracene d10
				Aramite
				Aroclor-1016
				Aroclor-1221
				Aroclor-1232
				Aroclor-1242
				Aroclor-1248
				Aroclor-1254
				Aroclor-1260
				Atraton
				Atrazine
				Azabenzene
				Azinphos methyl
				Barban

Inorganic Analyte Cross-Reference to Methods

APPENDIX C

Inorganic analytes mentioned in the categories of Trace Metals identified by Flame and Graphite Furnace Atomic Absorption Spectroscopy, Trace Metals identified by Inductively Coupled Plasma (ICP), and Trace Metals identified by Inductively Coupled Plasma/Mass Spectroscopy are listed in alphabetical order. If the analyte is included in one of the listed test methods it is noted with a "*" in the appropriate column.

Determination of Total Trace Metals Cross-Reference

Metal	Symbol	CAS	Flame and Graphite Furnace AA Spect. (p. 74)				ICP (p. 80)				ICP-MS (p. 86)	
			SW-846 7000 Series	EPA 200 Series	Std Methods 3000 Series	CLP Inorgan Method	SW-846 6010C	EPA 200.7	Std. Methods 3120	CLP Inorgan Method	SW-846 6020A	EPA 200.8
Aluminum	Al	7429-90-5	*	*	*		*	*	*	*	*	*
Antimony	Sb	7440-36-0	*	*	*	*	*	*	*	*	*	*
Arsenic	As	7440-38-2	*	*	*	*	*	*	*	*	*	*
Barium	Ba	7440-39-3	*	*	*		*	*	*	*	*	*
Beryllium	Be	7440-41-7	*	*	*	*	*	*	*	*	*	*
Bismuth	Bi	7440-69-9			*							
Boron	B	7440-42-8					*	*	*			
Cadmium	Cd	7440-43-9	*	*	*	*	*	*	*	*	*	*
Calcium	Ca	7440-70-2	*	*	*	*	*	*	*	*	*	*
Cerium	Ce	7440-45-1						*				
Cesium	Cs	7440-46-2			*							
Chromium	Cr	7440-47-3	*	*	*	*	*	*	*	*	*	*
Cobalt	Co	7440-48-4	*	*	*		*	*	*	*	*	*
Copper	Cu	7440-50-8	*	*	*		*	*	*	*	*	*
Gold	Au	7440-57-5		*	*							
Iridium	Ir	7439-88-5		*	*							
Iron	Fe	7439-89-6	*	*	*		*	*	*	*	*	*
Lead	Pb	7439-92-1	*	*	*	*	*	*	*	*	*	*
Lithium	Li	7439-93-2	*		*		*	*	*			
Magnesium	Mg	7439-95-4	*	*	*	*	*	*	*	*	*	*
Manganese	Mn	7439-96-5	*	*	*		*	*	*	*	*	*
Mercury (a)	Hg	7439-97-6	*	*	*	*	*	*		*	*	*
Molybdenum	Mo	7439-98-7	*	*	*		*	*	*			*
Nickel	Ni	7440-02-0	*	*	*		*	*	*	*	*	*
Osmium	Os	7440-04-2	*	*	*							
Palladium	Pd	7440-05-3		*	*							
Phosphorus	P	7723-14-0					*	*				
Platinum	Pt	7440-06-4		*	*							
Potassium	K	7440-09-7	*	*	*	*	*	*	*	*	*	*
Rhenium	Re	7440-15-5		*	*							

APPENDIX D

STATUS TABLES FOR SW-846, THIRD EDITION AND DRAFT UPDATES IVA AND IVB REVISED NOVEMBER 2000

This document provides historical status information on EPA-published draft, proposed, and final SW-846 methods and chapters. It contains two status tables, namely; the "SW-846 Method Status Table," which is a listing of SW-846 methods; and the "Status Table for SW-846 Chapter Text and Other Documents", which lists all other documents in SW-846.

Use the "SW-846 Method Status Table" as a reference guide to identify the historical and current status of published SW-846 methods. It also identifies the current location of the method in the manual. Methods in this status table are listed sequentially by method number. This order is different from that in the hard copy manual, where the methods are grouped by purpose and included as part of one of the chapters.

Use the "Status Table for SW-846 Chapter Text and Other Documents" as a reference guide to identify the historical and current status of published chapters and other SW-846 document (e.g., the Disclaimer).

APPENDIX E

Contained in this section are definitions and explanations of terms and abbreviations used in this book or commonly in use in this field.

AA. Atomic Absorption.

Absorb. To soak up. The incorporation of a liquid into a solid substance, as by capillary, osmotic, solvent, or chemical action.

Absorbance. A measure of the decrease in incident light passing through a sample into the detector. It is defined mathematically as:

$$A = \frac{I(\text{solvent})}{I(\text{solution})} = \log \frac{I_0}{I}$$

Where, I = radiation intensity

Absorption. To absorb. The process of incorporating a substance (liquid or gas) into the body of another substance (solid).

Accuracy. Accuracy means the nearness of a result or the mean (\bar{x}) of a set of results to the true value. Accuracy is assessed by means of reference samples and percent recoveries.

Acid. An inorganic or organic compound that 1) reacts with metals to yield hydrogen; 2) reacts with a base to form a salt; 3) dissociates in water to yield hydrogen ions; 4) has a pH of less than 7.0; and 5) neutralizes bases or alkalies. All acids contain hydrogen and turn litmus paper red. They are corrosive to human tissue and are to be handled with care. See Base; pH.

Action Levels. Typically action levels are considered regulatory levels set by federal government agencies such as the EPA, the Food and Drug Administration (FDA), and the U.S. Department of Agriculture. The presence of a contaminant in high enough concentration to warrant action or a response under regulatory guidelines.

Adsorb. To attract and retain gas, liquid, or dissolved substances on the surface of another material.

Adsorption. To adsorb. Adhesion of molecules of gas, liquid, or dissolved solids to a surface. Adsorption is a surface phenomenon.

Aliquot. A measured portion of a sample taken for analysis.

Alkali. Any compound having highly basic properties; i.e., one that readily ionizes in aqueous solution to yield OH anions, with a pH above 7, and turns litmus paper blue. Examples are oxides and hydroxides of certain metals belonging to group IA of the periodic table (Li, Na, K, Rb, Cs, Fr). Ammonia and amines may also be alkaline. Alkalies are caustic and dissolve human tissue. Treat alkali burns by quickly washing the affected area with large amounts of water for at least 15 min. Common commercial alkalies are sodium carbonate (soda ash), caustic soda and caustic potash, lime, lye, waterglass, regular mortar, Portland cement, and bicarbonate of soda. See Acid; Base; pH.

Alpha Particle. A particle emitted from radioactive decay. The particle is a helium nucleus consisting of two neutrons and two protons.

Ambient. Usual or surrounding conditions of temperatures, humidity, etc.

Analysis Date/Time. The date and military time (24 hour clock) of the introduction of the sample, standard, or blank into the analysis system.

Analyte. The element or ion compound an analyst seeks to determine; the element of interest.

Analytical Batch. The basic unit for analytical quality control is the analytical batch. The analytical batch is defined as samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each batch should be of similar composition (e.g. groundwater, sludge, ash, etc.)

APPENDIX F

Source information used to compile this manual is the latest promulgated versions of methods commonly available to analytical testing laboratories and environmental engineering companies. In some cases newer proposed versions of methods exist. These are not included in this reference because their use is not universally accepted. The latest versions of the inorganic and organic Statements of Work for the Contract Laboratory Program were used, though some laboratories may still have contracts using an older Statement of Work version. SW-846 third edition, methods, including promulgated updates to December 1996, are included in this reference. Appendix D is a detailed explanation of SW-846 third edition and its updates.

REFERENCES

U.S. Environmental Protection Agency

National Primary Drinking Water Regulations – 40 CFR Part 141; July 1, 1988.

Contract Laboratory Program – User's Guide to the Contract Laboratory Program. EPA/540/P-91/002, January 1991, Office of Emergency and Remedial Response. Washington, DC

Contract Laboratory Program – Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration. Document OLM3.2, 1996; OLM04.2, May 1999; Low Concentration OLC03.2, December, 2000

Contract Laboratory Program - Statement of Work for Inorganic Analysis – Multi-Media Multi-Concentration. Document ILMO4.0, 1995; ILM05.2, December, 2001

EPA100-400 Series – Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Revised March 1983.

EPA100-400 Series – Methods for the Determination of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993.

EPA 200 Series – Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91-010, June 1991.

EPA 200 Series – Methods for the Determination of Metals in Environmental Samples. Supplement I, EPA/600/R-94-111, May 1994.

EPA Method 300 – Revision 1.0, with errata sheet, April, 1999, available at www.epa.gov

EPA 500 Series – Methods for the Determination of Organic Compounds in Drinking Water, EPA/600/4-88/039, December 1988.

EPA 500 Series – Methods for the Determination of Organic Compounds in Drinking Water, Supplement I, EPA/600/4-90/020, 1990.

EPA 500 Series – Methods for the Determination of Organic Compounds in Drinking Water, Supplement II, EPA/600/R-92/129, August 1992.

EPA 500 Series – Methods for the Determination of Organic Compounds in Drinking Water, Supplement III, EPA/600/R-95/131, August 1995.

EPA Method 515.4 – Revision 1.0, April, 2000, available at www.epa.gov

EPA 600 Series – 40 CFR, Part 136, Revised as of July 1, 1995. Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater.

EPA 600 Series – Methods for the Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater - Volume I - EPA-821-R-93-010-A August 1993, Revision 1.

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WEST VIRGINIA
 DEPARTMENT OF ENVIRONMENTAL PROTECTION
 DIVISION OF AIR QUALITY
 601 57th Street, SE
 Charleston, WV 25304
 Phone: (304) 926-0475 • www.dep.wv.gov/daq

APPLICATION FOR GENERAL PERMIT REGISTRATION
CONSTRUCT, MODIFY, RELOCATE OR ADMINISTRATIVELY UPDATE
A STATIONARY SOURCE OF AIR POLLUTANTS

- CONSTRUCTION MODIFICATION RELOCATION CLASS I ADMINISTRATIVE UPDATE
 CLASS II ADMINISTRATIVE UPDATE

CHECK WHICH TYPE OF GENERAL PERMIT REGISTRATION YOU ARE APPLYING FOR:

- | | |
|---|---|
| <input type="checkbox"/> G10-D – Coal Preparation and Handling | <input type="checkbox"/> G40-C – Nonmetallic Minerals Processing |
| <input type="checkbox"/> G20-B – Hot Mix Asphalt | <input type="checkbox"/> G50-B – Concrete Batch |
| <input type="checkbox"/> G30-D – Natural Gas Compressor Stations | <input type="checkbox"/> G60-C – Class II Emergency Generator |
| <input type="checkbox"/> G33-A – Spark Ignition Internal Combustion Engines | <input type="checkbox"/> G65-C – Class I Emergency Generator |
| <input type="checkbox"/> G35-A – Natural Gas Compressor Stations (Flare/Glycol Dehydration Unit) | <input checked="" type="checkbox"/> G70-A – Class II Oil and Natural Gas Production Facility |

SECTION I. GENERAL INFORMATION

1. Name of applicant (as registered with the WV Secretary of State's Office): Antero Resources Corporation		2. Federal Employer ID No. (FEIN): 80-0162034	
3. Applicant's mailing address: 1615 Wynkoop St. Denver, CO, 80202		4. Applicant's physical address: 1615 Wynkoop St. Denver, CO, 80202	
5. If applicant is a subsidiary corporation, please provide the name of parent corporation:			
6. WV BUSINESS REGISTRATION. Is the applicant a resident of the State of West Virginia? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO IF YES, provide a copy of the Certificate of Incorporation/ Organization / Limited Partnership (one page) including any name change amendments or other Business Registration Certificate as Attachment A. IF NO, provide a copy of the Certificate of Authority / Authority of LLC / Registration (one page) including any name change amendments or other Business Certificate as Attachment A.			

SECTION II. FACILITY INFORMATION

7. Type of plant or facility (stationary source) to be constructed, modified, relocated or administratively updated (e.g., coal preparation plant, primary crusher, etc.): Natural Gas and Oil Production facility	8a. Standard Industrial Classification Classification (SIC) code: 1311	AND	8b. North American Industry System (NAICS) code: 211111
9. DAQ Plant ID No. (for existing facilities only): _____	10. List all current 45CSR13 and other General Permit numbers associated with this process (for existing facilities only): N/A _____ _____		

A: PRIMARY OPERATING SITE INFORMATION

11A. Facility name of primary operating site: _____ Zinn Well Pad _____		12A. Address of primary operating site: Mailing: _____ N/A _____ Physical: From the intersection of WV-74 N/Mountain Dr and Marsh Run, head north on WV-74 N and go 3.5 mi to reach destination on the right.	
13A. Does the applicant own, lease, have an option to buy, or otherwise have control of the proposed site? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO - IF YES, please explain: _____ Antero is leasing the mineral rights for this site _____ _____ - IF NO, YOU ARE NOT ELIGIBLE FOR A PERMIT FOR THIS SOURCE.			
14A. - For Modifications or Administrative Updates at an existing facility, please provide directions to the present location of the facility from the nearest state road; - For Construction or Relocation permits, please provide directions to the proposed new site location from the nearest state road. Include a MAP as Attachment F . From the intersection of WV-74 N/Mountain Dr and Marsh Run, head north on WV-74 N and go 3.5 mi to reach destination on the right.			
15A. Nearest city or town: Pennsboro		16A. County: Ritchie	
		17A. UTM Coordinates: Northing (KM): 4352.317 Easting (KM): 505.3265 Zone: 17 N	
18A. Briefly describe the proposed new operation or change (s) to the facility: Construction of a new natural gas and oil production facility		19A. Latitude & Longitude Coordinates (NAD83, Decimal Degrees to 5 digits): Latitude: 39.320242 Longitude: -80.938208	

B: 1ST ALTERNATE OPERATING SITE INFORMATION (only available for G20, G40, & G50 General Permits)

11B. Name of 1 st alternate operating site: _____ _____		12B. Address of 1 st alternate operating site: Mailing: _____ Physical: _____ _____	
13B. Does the applicant own, lease, have an option to buy, or otherwise have control of the proposed site? <input type="checkbox"/> YES <input type="checkbox"/> NO - IF YES, please explain: _____ _____ - IF NO, YOU ARE NOT ELIGIBLE FOR A PERMIT FOR THIS SOURCE.			
14B. - For Modifications or Administrative Updates at an existing facility, please provide directions to the present location of the facility from the nearest state road; - For Construction or Relocation permits, please provide directions to the proposed new site location from the nearest state road. Include a MAP as Attachment F . _____ _____			

15B. Nearest city or town:	16B. County:	17B. UTM Coordinates: Northing (KM): _____ Easting (KM): _____ Zone: _____
18B. Briefly describe the proposed new operation or change (s) to the facility:		19B. Latitude & Longitude Coordinates (NAD83, Decimal Degrees to 5 digits): Latitude: _____ Longitude: _____

C: 2ND ALTERNATE OPERATING SITE INFORMATION (only available for G20, G40, & G50 General Permits):

11C. Name of 2 nd alternate operating site:	12C. Address of 2 nd alternate operating site: Mailing: _____ Physical: _____
--	---

13C. Does the applicant own, lease, have an option to buy, or otherwise have control of the proposed site? YES NO

— IF YES, please explain: _____

— IF NO, YOU ARE NOT ELIGIBLE FOR A PERMIT FOR THIS SOURCE.

14C. — For **Modifications or Administrative Updates** at an existing facility, please provide directions to the present location of the facility from the nearest state road;

— For **Construction or Relocation permits**, please provide directions to the proposed new site location from the nearest state road. Include a **MAP as Attachment F**.

15C. Nearest city or town:	16C. County:	17C. UTM Coordinates: Northing (KM): _____ Easting (KM): _____ Zone: _____
18C. Briefly describe the proposed new operation or change (s) to the facility:		19C. Latitude & Longitude Coordinates (NAD83, Decimal Degrees to 5 digits): Latitude: _____ Longitude: _____

20. Provide the date of anticipated installation or change: <u>8/20/2015</u> <input type="checkbox"/> If this is an After-The-Fact permit application, provide the date upon which the proposed change did happen: : ____/____/____	21. Date of anticipated Start-up if registration is granted: <u>9/20/2015</u>
---	--

22. Provide maximum projected **Operating Schedule** of activity/activities outlined in this application if other than 8760 hours/year. (Note: anything other than 24/7/52 may result in a restriction to the facility's operation).

Hours per day _____ Days per week _____ Weeks per year _____ Percentage of operation _____

SECTION III. ATTACHMENTS AND SUPPORTING DOCUMENTS

23. Include a check payable to WVDEP -- Division of Air Quality with the appropriate **application fee** (per 45CSR22 and 45CSR13).

24. Include a **Table of Contents** as the first page of your application package.

All of the required forms and additional information can be found under the Permitting Section (General Permits) of DAQ's website, or requested by phone.

25. Please check all attachments included with this permit application. Please refer to the appropriate reference document for an explanation of the attachments listed below.

- ATTACHMENT A : CURRENT BUSINESS CERTIFICATE
- ATTACHMENT B: PROCESS DESCRIPTION
- ATTACHMENT C: DESCRIPTION OF FUGITIVE EMISSIONS
- ATTACHMENT D: PROCESS FLOW DIAGRAM
- ATTACHMENT E: PLOT PLAN
- ATTACHMENT F: AREA MAP
- ATTACHMENT G: EQUIPMENT DATA SHEETS AND REGISTRATION SECTION APPLICABILITY FORM
- ATTACHMENT H: AIR POLLUTION CONTROL DEVICE SHEETS
- ATTACHMENT I: EMISSIONS CALCULATIONS
- ATTACHMENT J: CLASS I LEGAL ADVERTISEMENT
- ATTACHMENT K: ELECTRONIC SUBMITTAL
- ATTACHMENT L: GENERAL PERMIT REGISTRATION APPLICATION FEE
- ATTACHMENT M: SITING CRITERIA WAIVER
- ATTACHMENT N: MATERIAL SAFETY DATA SHEETS (MSDS)
- ATTACHMENT O: EMISSIONS SUMMARY SHEETS
- OTHER SUPPORTING DOCUMENTATION NOT DESCRIBED ABOVE (Equipment Drawings, Aggregation Discussion, etc.)

Please mail an original and two copies of the complete General Permit Registration Application with the signature(s) to the DAQ Permitting Section, at the address shown on the front page of this application. Please **DO NOT** fax permit applications. For questions regarding applications or West Virginia Air Pollution Rules and Regulations, please refer to the website shown on the front page of the application or call the phone number also provided on the front page of the application.

SECTION IV. CERTIFICATION OF INFORMATION

This General Permit Registration Application shall be signed below by a Responsible Official. A Responsible Official is a President, Vice President, Secretary, Treasurer, General Partner, General Manager, a member of a Board of Directors, or Owner, depending on business structure. A business may certify an Authorized Representative who shall have authority to bind the Corporation, Partnership, Limited Liability Company, Association, Joint Venture or Sole Proprietorship. Required records of daily throughput, hours of operation and maintenance, general correspondence, Emission Inventory, Certified Emission Statement, compliance certifications and all required notifications must be signed by a Responsible Official or an Authorized Representative. If a business wishes to certify an Authorized Representative, the official agreement below shall be checked off and the appropriate names and signatures entered. Any administratively incomplete or improperly signed or unsigned Registration Application will be returned to the applicant.

FOR A CORPORATION (domestic or foreign)

I certify that I am a President, Vice President, Secretary, Treasurer or in charge of a principal business function of the corporation

FOR A PARTNERSHIP

I certify that I am a General Partner

FOR A LIMITED LIABILITY COMPANY

I certify that I am a General Partner or General Manager

FOR AN ASSOCIATION

I certify that I am the President or a member of the Board of Directors

FOR A JOINT VENTURE

I certify that I am the President, General Partner or General Manager

FOR A SOLE PROPRIETORSHIP

I certify that I am the Owner and Proprietor

I hereby certify that (please print or type) _____ is an Authorized Representative and in that capacity shall represent the interest of the business (e.g., Corporation, Partnership, Limited Liability Company, Association Joint Venture or Sole Proprietorship) and may obligate and legally bind the business. If the business changes its Authorized Representative, a Responsible Official shall notify the Director of the Office of Air Quality immediately, and/or,

I hereby certify that all information contained in this General Permit Registration Application and any supporting documents appended hereto is, to the best of my knowledge, true, accurate and complete, and that all reasonable efforts have been made to provide the most comprehensive information possible

Signature _____
(please use blue ink) Responsible Official Date

Name & Title Donald Gray, Environmental and Regulatory Manager
(please print or type)

Signature  _____ 12-12-2014
(please use blue ink) Authorized Representative (if applicable) Date

Applicant's Name Antero Resources Corporation

Phone & Fax _____
Phone 303-357-6730 Fax 303-357-7315

Email dgray@anteroresources.com

**Attachment R
AUTHORITY OF CORPORATION
OR OTHER BUSINESS ENTITY (DOMESTIC OR FOREIGN)**

TO: The West Virginia Department of Environmental Protection,
Division of Air Quality

DATE: 6/14/13: 14 JUN. 2013

ATTN.: Director

Corporation's / other business entity's Federal Employer I.D. Number 80-0162034

The undersigned hereby files with the West Virginia Department of Environmental Protection, Division of Air Quality, a permit application and hereby certifies that the said name is a trade name which is used in the conduct of an incorporated business or other business entity.

Further, the corporation or the business entity certifies as follows:

(1) DONALD C. GRAY (is/are) the authorized representative(s) and in that capacity may represent the interest of the corporation or the business entity and may obligate and legally bind the corporation or the business entity.

(2) The corporation or the business entity is authorized to do business in the State of West Virginia.

(3) If the corporation or the business entity changes its authorized representative(s), the corporation or the business entity shall notify the Director of the West Virginia Department of Environmental Protection, Division of Air Quality, immediately upon such change.

Kevin J. Kilstrom KEVIN J. KILSTROM - VICE PRESIDENT
President or Other Authorized Officer
(Vice President, Secretary, Treasurer or other
official in charge of a principal business function
of the corporation or the business entity)

(If not the President, then the corporation or the business entity must submit certified minutes or bylaws stating legal authority of other authorized officer to bind the corporation or the business entity).

Secretary

Name of Corporation or business entity

Attachment A

Current Business Certificate

State of West Virginia



Certificate

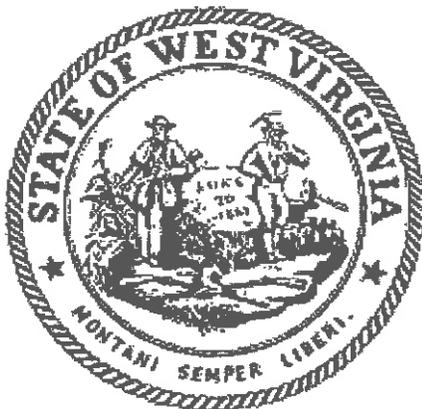
*I, Natalie E. Tennant, Secretary of State of the
State of West Virginia, hereby certify that*

ANTERO RESOURCES CORPORATION

a corporation formed under the laws of Delaware, which is authorized to transact business in West Virginia by a Certificate of Authority has filed in my office as required by the provisions of the West Virginia Code, a copy of an amendment to its Articles of Incorporation authenticated by the proper office of the state or country of its incorporation and was found to conform to law.

Therefore, I issue this

CERTIFICATE OF AMENDMENT TO CERTIFICATE OF AUTHORITY



*Given under my hand and the
Great Seal of the State of
West Virginia on this day of
June 10, 2013*

Natalie E. Tennant

Secretary of State

FILED

JUN 10 2013

Natalie E. Tennant
Secretary of State
1900 Kanawha Blvd E
Bldg 1, Suite 157-K
Charleston, WV 25305



Penney Barker, Manager
Corporations Division
Tel: (304)558-8000
Fax: (304)558-8381
Website: www.wvsos.com
E-mail: business@wvsos.com

**APPLICATION FOR
AMENDED CERTIFICATE
OF AUTHORITY**

Office Hours: Monday - Friday
8:30 a.m. - 5:00 p.m. ET

FILE ONE ORIGINAL
(Two if you want a filed
stamped copy returned to you)
FEE: \$25.00

**** In accordance with the provisions of the West Virginia Code, the undersigned corporation hereby ****
applies for an Amended Certificate of Authority and submits the following statement:

- Name under which the corporation was authorized to transact business in WV: Antero Resources Appalachian Corporation
- Date Certificate of Authority was issued in West Virginia: 6/26/2008
- Corporate name has been changed to:
(Attach one Certified Copy of Name Change
as filed in home State of incorporation.) Antero Resources Corporation
- Name the corporation elects to use in WV:
(due to home state name not being available) Antero Resources Corporation
- Other amendments:
(attach additional pages if necessary) _____
- Name and phone number of contact person. (This is optional; however, if there is a problem with the filing, listing a contact person and phone number may avoid having to return or reject the document.)
Alvyn A. Schopp (303) 367-7310
Contact Name Phone Number
- Signature information (See below *Important Legal Notice Regarding Signature*):
Print Name of Signer: Alvyn A. Schopp Title/Capacity: Authorized Person
Signature: [Handwritten Signature] Date: June 10, 2013

***Important Legal Notice Regarding Signature:** Per West Virginia Code §31D-1-122, Penalty for signing false document. Any person who signs a document he or she knows is false in any material respect and knows that the document is to be delivered to the secretary of state for filing is guilty of a misdemeanor and, upon conviction thereof, shall be fined not more than one thousand dollars or confined in the county or regional jail not more than one year, or both.

Delaware

PAGE 1

The First State

I, JEFFREY W. BULLOCK, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY THE ATTACHED IS A TRUE AND CORRECT COPY OF THE CERTIFICATE OF AMENDMENT OF "ANTERO RESOURCES APPALACHIAN CORPORATION", CHANGING ITS NAME FROM "ANTERO RESOURCES APPALACHIAN CORPORATION" TO "ANTERO RESOURCES CORPORATION", FILED IN THIS OFFICE ON THE TENTH DAY OF JUNE, A.D. 2013, AT 9:37 O'CLOCK A.M.

A FILED COPY OF THIS CERTIFICATE HAS BEEN FORWARDED TO THE NEW CASTLE COUNTY RECORDER OF DEEDS.

4520810 8100

130754186

You may verify this certificate online
at corp.delaware.gov/authver.shtml




Jeffrey W. Bullock, Secretary of State
AUTHENTICATION: 0496546

DATE: 06-10-13

**AMENDMENT TO THE
AMENDED AND RESTATED
CERTIFICATE OF INCORPORATION
OF
ANTERO RESOURCES APPALACHIAN CORPORATION**

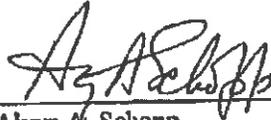
Antero Resources Appalachian Corporation (the "Corporation"), a corporation organized and existing under the laws of the State of Delaware, hereby certifies as follows:

1. The original Certificate of Incorporation of the Corporation was filed under the name Antero Resources Barnett Corporation with the filing of the original Certificate of Incorporation of the Corporation with the Secretary of State of the State of Delaware on March 18, 2008.
2. This Amendment to the Amended and Restated Certificate of Incorporation has been duly adopted and approved in accordance with Sections 242 of the General Corporation Law of the State of Delaware.
3. Article FIRST of the Amended and Restated Certificate of Incorporation is hereby amended to read in its entirety as follows:

FIRST. The name of the Corporation is Antero Resources Corporation.

IN WITNESS WHEREOF, the Corporation has caused this Certificate of Amendment to be executed by its duly authorized officer on the 10th day of June, 2013.

ANTERO RESOURCES APPALACHIAN CORPORATION

By: 
Name: Alvyn A. Schopp
Title: Vice President of Accounting &
Administration / Treasurer

Attachment B

Process Description

Attachment B**Process Description****Zinn Well Pad****Antero Resources Corporation****Ritchie County, West Virginia**

A mixture of condensate and entrained gas from the wells enters the Facility through a number of low pressure separators where the gas phase is separated from the liquid phase. Gas Processing Units (GPU) heaters (H001-H012) are used in conjunction with the separators to help separate the gas from the liquid phases. These heaters are fueled by a slip stream of the separated gas. The separated gas from the low pressure separators is sent to a compressor (ENG001). The compressed gas is then metered and sent to the sales gas pipeline. The separated condensate and water from the separators flow to their respective storage tanks (TANKCOND001-010 and TANKPW001-002).

The Facility has ten (10) tanks (TANKCOND001-010) on site to store condensate and two (2) tanks (TANKPW001-002) to store produced water prior to removal from the site. Flashing, working, and breathing losses from the tanks are routed to the flare (FL001) to control the emissions. The flare that will be used to control emissions is designed to achieve a VOC destruction efficiency of 98 percent.

Condensate and produced water are transported off site on an as needed basis via tanker truck. Truck loading connections are in place to pump condensate (L001) and produced water (L002) from the storage tanks into tanker trucks. Emissions from the loading operations are vented to the atmosphere.

Emissions from the Facility's emission sources were calculated using the gas and extended analysis of the condensate from Prunty No. 1H, one of the wells in the Lockhart Heirs Pad. This extended analysis is considered representative of the materials from Zinn Well Pad, being in the same Marcellus rock formation.

Zinn Well Pad calculation of potential to emit included all of the emission sources that belong to the same industrial grouping, are located on contiguous or adjacent properties, and are under the control of the same person. The nearest emission source that belongs to the same industrial grouping and under the control of the same person but not located on contiguous or adjacent property is the Annie Horizontal Pad. This operates independently and is approximately 0.25 miles from the Facility.

Attachment C

Description of Fugitive Emissions

Attachment C

Description of Fugitive Emissions Zinn Well Pad Antero Resources Corporation Ritchie County, West Virginia

Sources of fugitive emissions include loading operations, haul road emissions, equipment leaks, and pneumatic control valves. Fugitive emissions were calculated using AP-42 factors. Routine equipment leaks are assumed to be occurring continuously throughout the year. Loading operations and haul road emissions only occur when tanker trucks are onsite. The fugitives emissions summary is also located in Attachment O.

Equipment Leaks

Equipment include valves, flanges, and connectors installed in various process equipment such as gas production unit heaters, compressor, pipelines, and separators. Emissions are assumed to be occurring throughout the year. Detailed calculations are shown on Table 4.

Pneumatic Control Valves

Pneumatic control valves are part of the gas production unit heaters. These are intermittent low bleed valves and their emissions are assumed to be occurring throughout the year. Detailed calculations are shown on Table 5.

Loading Operations

Loading emissions occur when condensate and produced water are transferred out of the well site via tanker trucks. Fugitive emissions were estimated using AP-42 loading loss formula, $L = 12.46 * SPM/T$, and Bryan & Engineering (BR&E) software known as Promax. Detailed calculations are shown in Table 8.

Haul Road Emissions

Haul road emissions are emitted when tanker trucks or service vehicles enter the Facility. The Facility is flat and unpaved. Detailed calculations are shown on Table 12.

Attachment C/O: G70-A Emissions Summary Sheet
Fugitive Emissions Data Summary Sheet

FUGITIVE EMISSIONS SUMMARY	All Regulated Pollutants Chemical Name/CAS 1	Maximum Potential Uncontrolled Emissions 2		Maximum Potential Controlled Emissions 3		Est. Method Used 4
		lb/hr	ton/yr	lb/hr	ton/yr	
Haul Road/Road Dust Emissions	n/a					
Paved Haul Roads	PM ₁₀ , PM _{2.5}	4.8968	13.7260	2.4484	6.8630	MB
Unpaved Haul Roads	VOCs	9.5318	3.4861	9.5318	3.4861	MB
Loading/Unloading Operations	toluene (108883)	0.0018	0.0006	0.0018	0.0006	
	ethyl benzene (100414)	0.0009	0.0003	0.0009	0.0003	
	hexane (110543)	0.0274	0.0100	0.0274	0.0100	
	o,m,p-xylenes (95476,108383,106423)	0.0026	0.0009	0.0026	0.0009	
	CO2 Equivalent	9.2290	7.2054	9.2290	7.2054	
	CO2 (124389), CH4	0.0009	0.0003	0.0009	0.0003	
	benzene (71432)	0.0009	0.0003	0.0009	0.0003	
	TAPs (benzene)	0.0009	0.0003	0.0009	0.0003	
	Benzene (71432)		0.0343		0.0343	MB
	Toluene (108883)		0.1063		0.1063	
	Ethyl benzene (100414)		0.0840		0.0840	
	Hexane (110543)		1.4393		1.4393	
Equipment Leaks (Components)	o,m,p-xylenes (95476,108383,106423)	Does not apply	0.2585	Does not apply	0.2585	
	CO2 Equivalent		424.2884		424.2884	
	CO2 (124389), CH4		19.9875		19.9875	
	VOCs		0.0343		0.0343	
	TAPs (benzene)		0.00E+00		0.00E+00	MB
	toluene (108883)		0.00E+00		0.00E+00	
	ethyl benzene (100414)		0.00E+00		0.00E+00	
	hexane (110543)		0.0163		0.0163	
	o,m,p-xylenes (95476,108383,106423)		0.00E+00		0.00E+00	
	CO2 Equivalent		10.8393		10.8393	
	CO2 (124389), CH4		0.1374		0.1374	
	VOCs		0.00E+00		0.00E+00	
TAPs (benzene)		0.00E+00		0.00E+00		

¹ List all regulated air pollutants. Speciate VOCs, including all HAPs. Follow chemical name with Chemical Abstracts Service (CAS) number. LIST Acids, CO, CS₂, VOCs, H₂S, Inorganics, Lead, Organics, O₃, NO, NO₂, SO₂, SO₃, all applicable Greenhouse Gases (including CO₂ and methane), etc. DO NOT LIST H₂, H₂O, N₂, O₂, and Noble Gases.

² Give rate with no control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

³ Give rate with proposed control equipment operating. If emissions occur for less than 1 hr, then record emissions per batch in minutes (e.g. 5 lb VOC/20 minute batch).

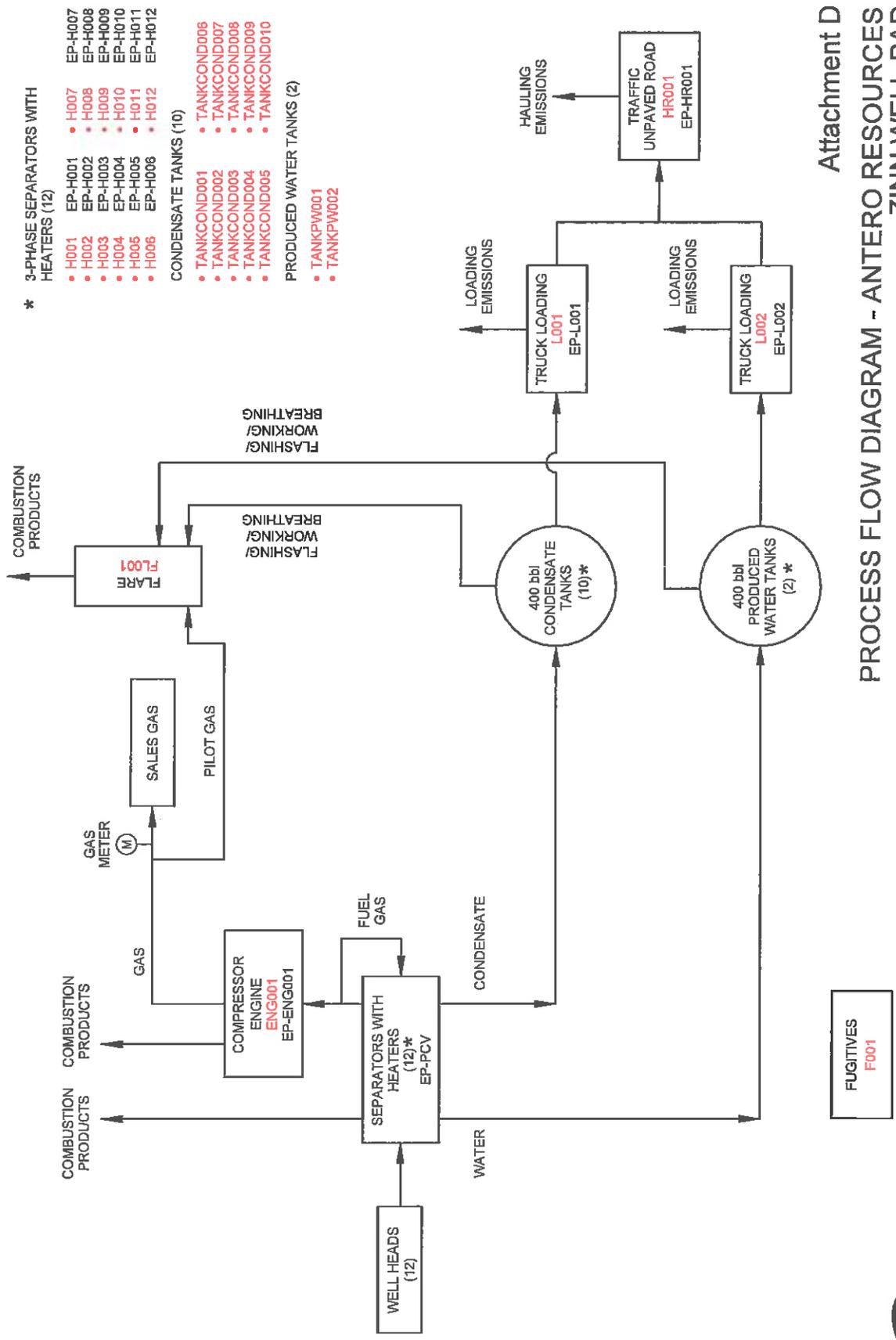
⁴ Indicate method used to determine emission rate as follows: MB = material balance; ST = stack test (give date of test); EE = engineering estimate; O = other (specify).

Attachment C: Leak Source Data Sheet

Source Category	Pollutant	Number of Source Components (1)	Number of Components Monitored by Frequency2	Average Time to Repair (days) (3)	Estimated Annual Emission Rate (lb/yr) (4)
Pumps (5)	light liquid VOC ^(6,7)				
	heavy liquid VOC ⁸				
	Non-VOC ⁹				
Valves (10)	Gas VOC	600		First attempt within 5 days of detection and final repair within 15 days	9,936.91
	Light Liquid VOC	624		First attempt within 5 days of detection and final repair within 15 days	29,293.10
	Heavy Liquid VOC	--			--
	Non-VOC	--			--
Safety Relief Valves (11)	Gas VOC	See Valves		First attempt within 5 days of detection and final repair within 15 days	see Valves
	Non VOC	See Valves		First attempt within 5 days of detection and final repair within 15 days	see Valves
Open-ended Lines (12)	VOC				
	Non-VOC				
Sampling Connections (13)	VOC				
	Non-VOC				
Compressors	VOC				
	Non-VOC				
Flanges	VOC	156		First attempt within 5 days of detection and final repair within 15 days	223.91
	Non-VOC			First attempt within 5 days of detection and final repair within 15 days	948.60
Other	VOC	708		First attempt within 5 days of detection and final repair within 15 days	521.14
	Non-VOC				2,207.78

Attachment D

Process Flow Diagram



* 3-PHASE SEPARATORS WITH HEATERS (12)

- H001 EP-H001
- H002 EP-H002
- H003 EP-H003
- H004 EP-H004
- H005 EP-H005
- H006 EP-H006
- H007 EP-H007
- H008 EP-H008
- H009 EP-H009
- H010 EP-H010
- H011 EP-H011
- H012 EP-H012

CONDENSATE TANKS (10)

- TANKCOND001
- TANKCOND002
- TANKCOND003
- TANKCOND004
- TANKCOND005
- TANKCOND006
- TANKCOND007
- TANKCOND008
- TANKCOND009
- TANKCOND010

PRODUCED WATER TANKS (2)

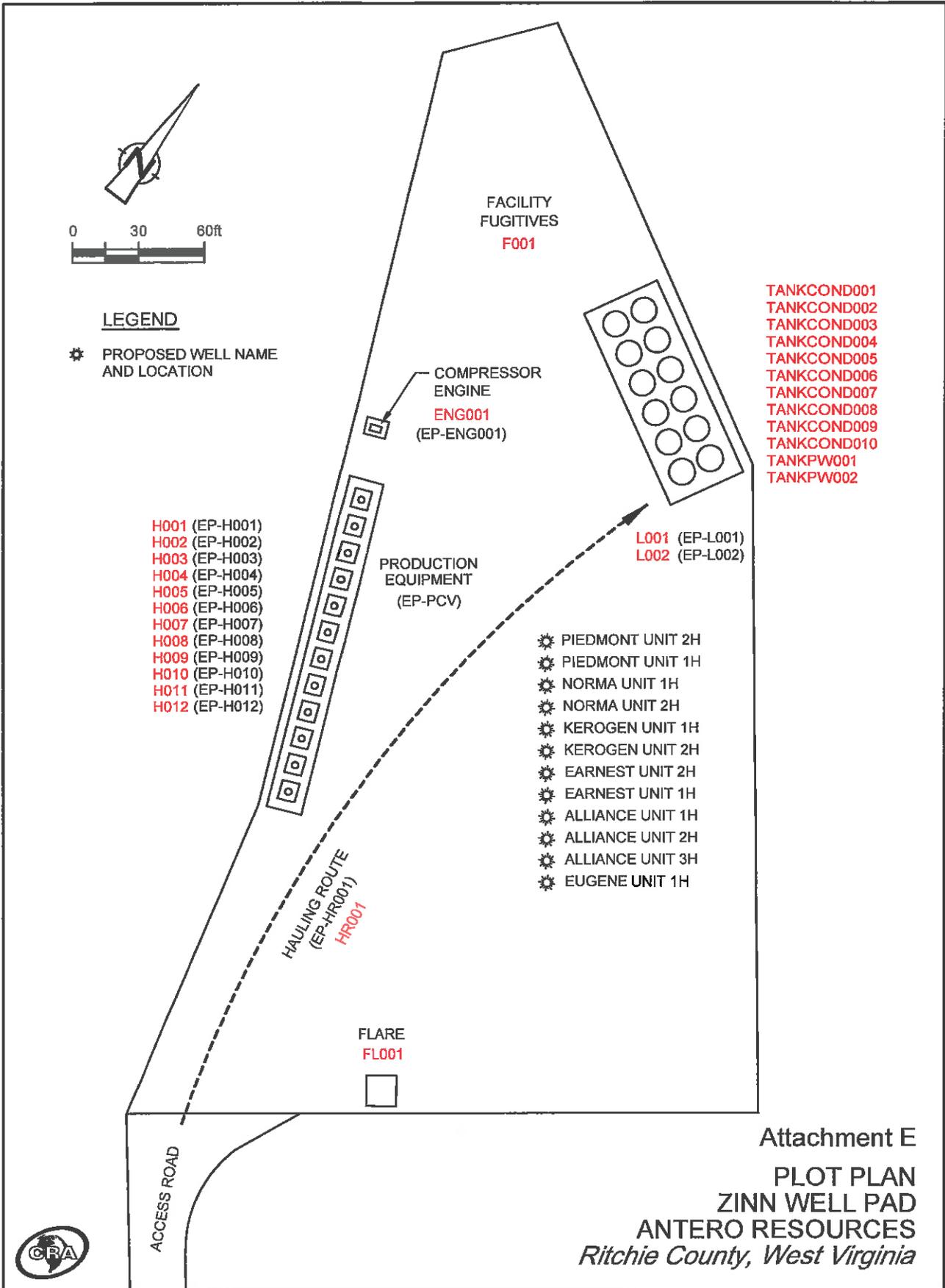
- TANKPW001
- TANKPW002

Attachment D
 PROCESS FLOW DIAGRAM - ANTERO RESOURCES
 ZINN WELL PAD
 Ritchie County, West Virginia



Attachment E

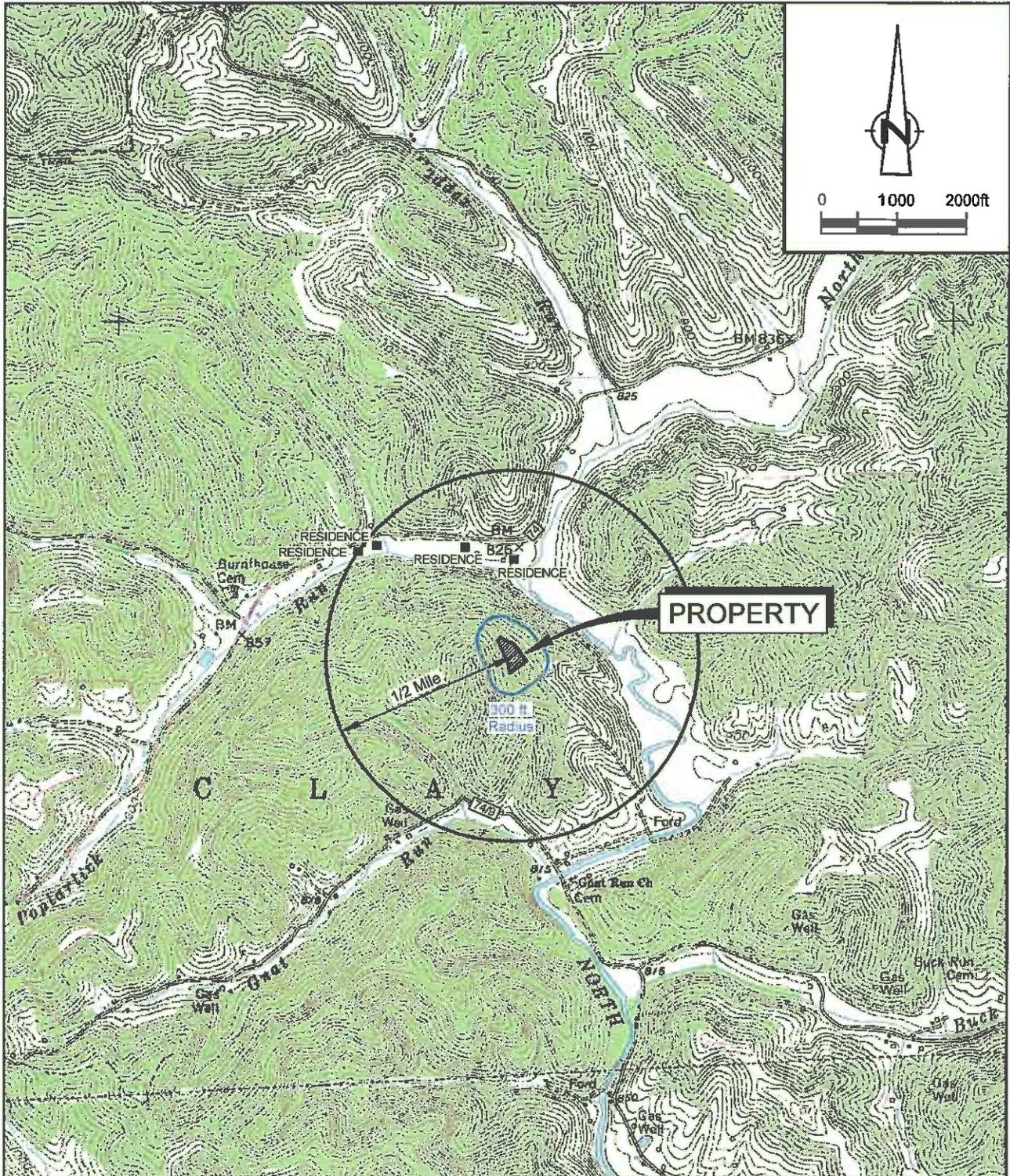
Plot Plan



Attachment E
PLOT PLAN
ZINN WELL PAD
ANTERO RESOURCES
Ritchie County, West Virginia

Attachment F

Area Map



SOURCE: USGS QUADRANGLE MAP;
PENNSBORO, WEST VIRGINIA

SITE COORDINATES: LAT. 39.320242, LONG. -80.938208
SITE ELEVATION: 1119 ft AMSL



Attachment F
AREA MAP
ZINN WELL PAD
ANTERO RESOURCES
Ritchie County, West Virginia

Attachment G

Emission Unit Data Sheets/G70-A Section Applicability Form

**General Permit G70-A Registration
Section Applicability Form**

General Permit G70-A was developed to allow qualified applicants to seek registration for a variety of sources. These sources include natural gas well affected facilities, storage tanks, natural gas-fired compressor engines (RICE), natural gas producing units, natural gas-fired in-line heaters, pneumatic controllers, heater treaters, tank truck loading, glycol dehydration units, completion combustion devices, flares, enclosed combustion devices, and vapor recovery systems. All registered facilities will be subject to Sections 1.0, 2.0, 3.0, and 4.0.

General Permit G70-A allows the registrant to choose which sections of the permit they are seeking registration under. Therefore, please mark which additional sections that you are applying for registration under. If the applicant is seeking registration under multiple sections, please select all that apply. Please keep in mind, that if this registration is approved, the issued registration will state which sections will apply to your affected facility.

Section 5	Natural Gas Well Affected Facility	<input checked="" type="checkbox"/>
Section 6	Storage Vessels*	<input checked="" type="checkbox"/>
Section 7	Gas Producing Units, In-Line Heaters, Heater Treaters, and Glycol Dehydration Reboilers	<input checked="" type="checkbox"/>
Section 8	Pneumatic Controllers Affected Facility (NSPS, Subpart OOOO)	<input type="checkbox"/>
Section 9	<i>Reserved</i>	<input type="checkbox"/>
Section 10	Natural gas-fired Compressor Engine(s) (RICE) **	<input checked="" type="checkbox"/>
Section 11	Tank Truck Loading Facility ***	<input checked="" type="checkbox"/>
Section 12	Standards of Performance for Storage Vessel Affected Facilities (NSPS, Subpart OOOO)	<input type="checkbox"/>
Section 13	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (NSPS, Subpart JJJJ)	<input checked="" type="checkbox"/>
Section 14	Control Devices not subject to NSPS, Subpart OOOO	<input checked="" type="checkbox"/>
Section 15	National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (40CFR63, Subpart ZZZZ)	<input checked="" type="checkbox"/>
Section 16	Glycol Dehydration Units	<input type="checkbox"/>
Section 17	Dehydration Units With Exemption from NESHAP Standard, Subpart HH § 63.764(d) (40CFR63, Subpart HH)	<input type="checkbox"/>
Section 18	Dehydration Units Subject to NESHAP Standard, Subpart HH and Not Located Within an UA/UC (40CFR63, Subpart HH)	<input type="checkbox"/>
Section 19	Dehydration Units Subject to NESHAP Standard, Subpart HH and Located Within an UA/UC (40CFR63, Subpart HH)	<input type="checkbox"/>

* Applicants that are subject to Section 6 may also be subject to Section 12 if the applicant is subject to the NSPS, Subpart OOOO control requirements or the applicable control device requirements of Section 14.

** Applicants that are subject to Section 10 may also be subject to the applicable RICE requirements of Section 13 and/or Section 15.

*** Applicants that are subject to Section 11 may also be subject to control device requirements of Section 14.

NATURAL GAS WELL AFFECTED FACILITY DATA SHEET

Complete this data sheet if you are the owner or operator of a gas well affected facility for which construction, modification, or reconstruction commenced after August 23, 2011. This form must be completed for natural gas well affected facilities regardless of when flowback operations occur (or have occurred).

Please provide the API number(s) for each NG well at this facility:	
47-085-10169-00	
47-085-10170-00	
47-085-10171-00	
9 wells not permitted	

Note: This is the same API well number(s) provided in the well completion notification and as provided to the WVDEP, Office of Oil and Gas for the well permit. The API number may be provided on the application without the state code (047).

Every oil and gas well permitted in West Virginia since 1929 has been issued an API (American Petroleum Institute) number. This API is used by agencies to identify and track oil and gas wells.

The API number has the following format: 047-001-00001

Where,

047 = State code. The state code for WV is 047.

001 = County Code. County codes are odd numbers, beginning with 001 (Barbour) and continuing to 109 (Wyoming).

00001 = Well number. Each well will have a unique well number.

Attachment G: Storage Vessel Emission Unit Data Sheet (Condensate)

Provide the following information for each new or modified bulk liquid storage tank.

I. GENERAL INFORMATION (required)

1. Bulk Storage Area Name COND TANK	2. Tank Name TANKCOND001-010
3. Emission Unit ID number TANKCOND001-010	4. Emission Point ID number FL001
5. Date Installed or Modified (for existing tanks): New	
6. Type of change: NA	
7A. Description of Tank Modification (if applicable) NA	
7B. Will more than one material be stored in this tank? If so, a separate form must be completed for each material. No	
7C. Provide any limitations on source operation affecting emissions. (production variation, etc.)	

II. TANK INFORMATION (required)

8. Design Capacity (specify barrels or gallons). Use the internal cross-sectional area multiplied by internal height. 400bbbls	
9A. Tank Internal Diameter (ft.) 12	9B. Tank Internal Height (ft.) 20
10A. Maximum Liquid Height (ft.) 18	10B. Average Liquid Height (ft.) 10
11A. Maximum Vapor Space Height (ft.) 18	11B. Average Vapor Space Height (ft.) 10
12. Nominal Capacity (specify barrels or gallons). This is also known as "working volume." 400bbbls	
13A. Maximum annual throughput (gal/yr) 7,358,400	13B. Maximum daily throughput (gal/day) 20,160
14. Number of tank turnovers per year 44	15. Maximum tank fill rate (gal/min) 168
16. Tank fill method: Splash Fill	
17. Is the tank system a variable vapor space system? No If yes, (A) What is the volume expansion capacity of the system (gal)? (B) What are the number of transfers into the system per year?	
18. Type of tank (check all that apply): <input checked="" type="checkbox"/> Fixed Roof <input checked="" type="checkbox"/> vertical horizontal <input checked="" type="checkbox"/> flat roof cone roof dome roof other (describe) External Floating Roof pontoon roof double deck roof Domed External (or Covered) Floating Roof Internal Floating Roof vertical column support self-supporting Variable Vapor Space lifter roof diaphragm Pressurized spherical cylindrical Underground Other (describe)	

III. TANK CONSTRUCTION AND OPERATION INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets

Refer to the responses to items 19 – 26 in section VII

IV. SITE INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets

Refer to the responses to items 27 – 33 in section VII

V. LIQUID INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets

Refer to the responses to items 34 – 39 in section VII

Attachment G: Storage Vessel Emission Unit Data Sheet (Condensate)

Provide the following information for each new or modified bulk liquid storage tank.

SITE INFORMATION:			
27. Provide the city and state on which the data in this section are based: Charleston, WV			
28. Daily Avg. Ambient Temperature (°F): 55.3		29. Annual Avg. Maximum Temperature (°F): 75.94	
30. Annual Avg. Minimum Temperature (°F): 65.9		31. Avg. Wind Speed (mph): 5.9	
32. Annual Avg. Solar Insulation Factor (BTU/ft ² -day): 1030.235999		33. Atmospheric Pressure (psia): 14.8	
LIQUID INFORMATION:			
34. Avg. daily temperature range of bulk liquid (°F): 51.7	34A. Minimum (°F): 39.5	34B. Maximum (°F): 63.8	
35. Avg. operating pressure range of tank (psig): 0	35A. Minimum (psig): 0	35B. Maximum (psig): 0	
36A. Minimum liquid surface temperature (°F): 39.5		36B. Corresponding vapor pressure (psia): 1.0758	
37A. Avg. liquid surface temperature (°F): 51.7		37B. Corresponding vapor pressure (psia): 1.4176	
38A. Maximum liquid surface temperature (°F): 63.8		38B. Corresponding vapor pressure (psia): 1.8401	
39. Provide the following for each liquid or gas to be stored in the tank. Add additional pages if necessary.			
39A. Material name and composition:	Condensate		
39B. CAS number:	mix of HC		
39C. Liquid density (lb/gal):	5.93		
39D. Liquid molecular weight (lb/lb-mole):	108.7		
39E. Vapor molecular weight (lb/lb-mole):	43.09		
39F. Maximum true vapor pressure (psia):	2.1856		
39G. Max Reid vapor pressure (psi):	3.41000		
39H. Months Storage per year. From:	year round		
To:			

Attachment G: Storage Vessel Emission Unit Data Sheet (Produced Water)

Provide the following information for each new or modified bulk liquid storage tank.

I. GENERAL INFORMATION (required)

1. Bulk Storage Area Name PWTANK	2. Tank Name TANKPW001-002
3. Emission Unit ID number TANKPW001-002	4. Emission Point ID number FL001
5. Date Installed or Modified (for existing tanks): New	6. Type of change: NA
7A. Description of Tank Modification (if applicable) NA	
7B. Will more than one material be stored in this tank? If so, a separate form must be completed for each material. No	
7C. Provide any limitations on source operation affecting emissions. (production variation, etc.)	

II. TANK INFORMATION (required)

8. Design Capacity (specify barrels or gallons). Use the internal cross-sectional area multiplied by internal height.
400bbbls

9A. Tank Internal Diameter (ft.) 12	9B. Tank Internal Height (ft.) 20
10A. Maximum Liquid Height (ft.) 18	10B. Average Liquid Height (ft.) 10
11A. Maximum Vapor Space Height (ft.) 18	11B. Average Vapor Space Height (ft.) 10
12. Nominal Capacity (specify barrels or gallons). This is also known as "working volume." 400bbbls	
13A. Maximum annual throughput (gal/yr) 88,300,800	13B. Maximum daily throughput (gal/day) 241,920
14. Number of tank turnovers per year 2628	15. Maximum tank fill rate (gal/min) 168
16. Tank fill method Splash Fill	
17. Is the tank system a variable vapor space system? No If yes, (A) What is the volume expansion capacity of the system (gal)? (B) What are the number of transfers into the system per year?	
18. Type of tank (check all that apply): <input checked="" type="checkbox"/> Fixed Roof <input checked="" type="checkbox"/> vertical horizontal <input checked="" type="checkbox"/> flat roof cone roof dome roof other (describe) External Floating Roof pontoon roof double deck roof Domed External (or Covered) Floating Roof Internal Floating Roof vertical column support self-supporting Variable Vapor Space lifter roof diaphragm Pressurized spherical cylindrical Underground Other (describe)	

III. TANK CONSTRUCTION AND OPERATION INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets
 Refer to the responses to items 19 – 26 in section VII

IV. SITE INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets
 Refer to the responses to items 27 – 33 in section VII

V. LIQUID INFORMATION (check which one applies)

Refer to enclosed TANKS Summary Sheets
 Refer to the responses to items 34 – 39 in section VII

Attachment G: Storage Vessel Emission Unit Data Sheet (Produced Water)

Provide the following information for each new or modified bulk liquid storage tank.

VI. EMISSIONS AND CONTROL DEVICE DATA (required)

40. Emission Control Devices (check as many as apply):
 Does Not Apply Rupture Disc (psig)
 Carbon Adsorption¹ Inert Gas Blanket of _____
 Vent to Vapor Combustion Device¹ (vapor combustors, flares, thermal oxidizers) Condenser¹
 Conservation Vent (psig)
 Other¹ (describe) _____ Vacuum Setting _____ Pressure Setting _____ Emergency Relief Valve (psig) _____
¹ Complete appropriate Air Pollution Control Device Sheet

41. Expected Emission Rate (submit Test Data or Calculations here or elsewhere in the application).

Material Name and CAS No.	Flashing Loss		Breathing Loss		Working Loss		Total Emissions Loss	
	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
<i>Please see Tables 6 and 7</i>								

¹ EPA = EPA Emission Factor, MB = Material Balance, SS = Similar Source, ST = Similar Source Test, Throughput Data, O = Other (specify)
 Remember to attach emissions calculations, including TANKS Summary Sheets and other modeling summary sheets if applicable.

SECTION VII (required if did not provide TANKS Summary Sheets)

TANK CONSTRUCTION AND OPERATION INFORMATION

19. Tank Shell Construction: Steel

20A. Shell Color: Green 20B. Roof Color: Green 20C. Year Last Painted: New

21. Shell Condition (if metal and unlined): No Rust

22A. Is the tank heated? No 22B. If yes, operating temperature: 22C. If yes, how is heat provided to tank?

23. Operating Pressure Range (psig): 0

24. Is the tank a Vertical Fixed Roof Tank? Yes 24A. If yes, for dome roof provide radius (ft): 24B. If yes, for cone roof, provide slop (ft/ft):

25. Complete item 25 for Floating Roof Tanks Does not apply

25A. Year Internal Floaters Installed:

25B. Primary Seal Type (check one): Metallic (mechanical) shoe seal Liquid mounted resilient seal

25C. Is the Floating Roof equipped with a secondary seal? Yes No

25D. If yes, how is the secondary seal mounted? (check one) Shoe Rim Other (describe):

25E. Is the floating roof equipped with a weather shield? Yes No

25F. Describe deck fittings:

26. Complete the following section for Internal Floating Roof Tanks Does not apply

26A. Deck Type: Bolted Welded 26B. For bolted decks, provide deck construction:

26C. Deck seam. Continuous sheet construction:

26D. Deck seam length (ft.): 26E. Area of deck (ft²): 26F. For column supported 26G. For column supported

Attachment G: Storage Vessel Emission Unit Data Sheet (Produced Water)

Provide the following information for each new or modified bulk liquid storage tank.

SITE INFORMATION:			
27. Provide the city and state on which the data in this section are based: Charleston, WV			
28. Daily Avg. Ambient Temperature (°F): 55.3		29. Annual Avg. Maximum Temperature (°F): 75.94	
30. Annual Avg. Minimum Temperature (°F): 65.9		31. Avg. Wind Speed (mph): 5.9	
32. Annual Avg. Solar Insulation Factor (BTU/ft ² -day): 1030.235999		33. Atmospheric Pressure (psia): 14.8	
LIQUID INFORMATION:			
34. Avg. daily temperature range of bulk liquid (°F): 51.7		34A. Minimum (°F): 39.5	34B. Maximum (°F): 63.8
35. Avg. operating pressure range of tank (psig): 0		35A. Minimum (psig): 0	35B. Maximum (psig): 0
36A. Minimum liquid surface temperature (°F): 39.5		36B. Corresponding vapor pressure (psia):	0.1839
37A. Avg. liquid surface temperature (°F): 51.7		37B. Corresponding vapor pressure (psia):	0.2599
38A. Maximum liquid surface temperature (°F): 63.8		38B. Corresponding vapor pressure (psia):	0.3604
39. Provide the following for each liquid or gas to be stored in the tank. Add additional pages if necessary.			
39A. Material name and composition:	Produced Water		
39B. CAS number:	mix of HC and water		
39C. Liquid density (lb/gal):	8.33		
39D. Liquid molecular weight (lb/lb-mole):	18.0157		
39E. Vapor molecular weight (lb/lb-mole):	18.4343		
39F. Maximum true vapor pressure (psia):	0.4472		
39G. Max Reid vapor pressure (psi):	1.02408		
39H. Months Storage per year. From:	year round		
To:			

**Attachment G: Tank Truck Loading
Emissions Unit Data Sheet**

Furnish the following information for each new or modified bulk liquid transfer area or loading rack at the natural gas production pad. This form is to be used for bulk liquid transfer operations to tank trucks.

1. Emission Unit ID: L001, L002		2. Emission Point ID: EP-L001, EP-L002		3. Year Installed/Modified: New	
4. Emission Unit Description: CONDENSATE AND PRODUCED WATER					
5. Loading Area Data					
5A. Number of pumps: 2		5B. Number of liquids loaded: 2		5C. Maximum number of tank trucks loading at one time: 2	
6. Describe cleaning location, compounds and procedure for tank trucks: For hire tank trucks are used and are cleaned at the operator's dispatch terminal. These trucks are in dedicated service and cleaned only prior to repair or leak tests. Cleaning materials include water, steam, detergent, and solvents which are applied using hand held pressurized spray nozzles.					
7. Are tank trucks pressure tested for leaks at this or any other location? X Yes No If YES, describe: Tank trucks are pressure tested for leaks at the location of the leak testing company. Trucks are tested using EPA Method 27-internal vapor valve test and issued certification that DOT requirements are met.					
8. Projected Maximum Operating Schedule (for rack or transfer point as a whole):					
Maximum	Jan. - Mar.	Apr. - June	July - Sept.	Oct. - Dec.	
hours/day	13	13	13	13	
days/week	7	7	7	7	
9. Bulk Liquid Data (add pages as necessary)					
Liquid Name		Condensate	Produced Water		
Max. daily throughput (1000 gal/day)		20.16	241.92		
Max. annual throughput (1000 gal/yr)		7,358.40	88,300.80		
Loading Method ¹		BF	BF		
Max. Fill Rate (gal/min)		168	168		
Average Fill Time (min/loading)		50	50		
Max. Bulk Liquid Temperature (°F)		72.1	72.1		
True Vapor Pressure ²		2.19	0.45		
Cargo Vessel Condition ³		U	U		
Control Equipment or Method ⁴		None	None		
Minimum collection efficiency (%)		0	0		
Minimum control efficiency (%)		0	0		
Maximum	Loading (lb/hr)	13.35	1.17		
Emission Rate	Annual (ton/yr)	4.87	5.12		
Estimation Method ⁵		Promax	Promax		
Notes:					
1 BF = Bottom Fill SP = Splash Fill SUB = Submerged Fill					
2 At maximum bulk liquid temperature					
3 B = Ballasted Vessel, C = Cleaned, U = Uncleaned (dedicated service), O = other (describe)					
4 List as many as apply (complete and submit appropriate Air Pollution Control Device Sheets as Attachment "H"): CA = Carbon Adsorption VB = Dedicated Vapor Balance (closed system) ECD = Enclosed Combustion Device F = Flare TO = Thermal Oxidation or Incineration					
5 EPA = EPA Emission Factor as stated in AP-42					
10. Proposed Monitoring, Recordkeeping, Reporting, and Testing					
MONITORING		RECORDKEEPING			
1) Visual inspection to ensure that loading connections from storage tanks to trucks are leak-free.		1) Maintain records of condensate transferred from storage tanks. 2) Maintain records of produced water transferred from storage tanks.			
REPORTING		TESTING			
N/A		N/A			
11. Describe all operating ranges and maintenance procedures required by Manufacturer to maintain warranty: N/A					

Attachment H

Air Pollution Control Device Data Sheet

Attachment H: Air Pollution Control Device Vapor Combustion Control Device Sheet

Complete this vapor combustion control device sheet for each enclosed combustion device, flare, thermal oxidizer, or completion combustion device that is located at the natural gas production pad for the purpose of thermally destructing waste gas to control emissions of regulated pollutants to the atmosphere.

IMPORTANT: READ THE INSTRUCTIONS ACCOMPANYING THIS FORM BEFORE COMPLETING.			
General Information			
1. Control Device ID#: FL001		2. Installation Date: New	
3. Maximum Rated Total Flow Capacity: scfh 200,000 scfd		4. Maximum Design Heat Input: 18.4 MMBtu/hr	5. Design Heat Content: 2208 BTU/scf
Control Device Information			
6. Select the type of vapor combustion control device being used: Elevated Flare			
7. Manufacturer: Model No. Abutech-200		8. Hours of operation per year: 8760	
9. List the emission units whose emissions are controlled by this vapor combustion control device: (Emission Point ID#):			
10. Emission Unit ID#	Emission Source Description:	Emission Unit ID#	Emission Source Description:
TANKCOND001-010	Condensate Tank		
TANKPW001-002	PW Tanks		
If this vapor combustor controls emissions from more than six emission units, please attach additional pages.			
11. Assist Type		12. Flare Height (ft)	13. Tip Diameter (ft)
Steam - Air - Pressure - <input checked="" type="checkbox"/> Non -		20	3.92
14. Was the design per \$60.18? Yes			
Waste Gas Information			
15. Maximum waste gas flow rate (scfm):	16. Heat value of waste gas stream (BTU/ft3)	17. Temperature of the emissions stream (°F)	18. Exit Velocity of the emissions stream (ft/s)
73.54	1,949.35	900	1.02E-01
19. Provide an attachment with the characteristics of the waste gas stream to be burned.			
Pilot Information			
20. Type/Grade of pilot fuel:	21. Number of pilot lights:	22. Fuel flow rate to pilot flame per pilot (scf/hr):	23. Heat input per pilot (BTU/hr):
Natural Gas	1	12.6	12800
24. Will automatic re-ignition be used? Yes			
25. If automatic re-ignition will be used, describe the method: Based on a monitoring system			
26. Describe the method of controlling flame: Flame Rectification, a thermocouple equivalent			
27. Is pilot flame equipped with a monitor to detect the presence of the flame? Yes		28. If yes, what type? Thermocouple	
29. Pollutant(s) Controlled		30. % Capture Efficiency	31. Manufacturer's Guaranteed Control Efficiency (%)
F/W/B Emissions from TANKCOND		98	98
F/W/B Emissions from TANKPW		98	98

Attachment H: Air Pollution Control Device Vapor Combustion Control Device Sheet

Complete this vapor combustion control device sheet for each enclosed combustion device, flare, thermal oxidizer, or completion combustion device that is located at the natural gas production pad for the purpose of thermally destructing waste gas to control emissions of regulated pollutants to the atmosphere.

32. Has the control device been tested by the manufacturer and certified? Yes, see spec sheet.

33. Describe all operating ranges and maintenance procedures required by the manufacturer to maintain warranty: See spec sheet for operating ranges.

MONITORING

- 1) Report any period when visible emissions exceeded 5 minutes during any two-hour period.
- 2) Monitor the presence of pilot flame at all times with the Flame rectification system, a thermocouple equivalent.
- 3) Monitor visible emissions from the vapor combustor.
- 4) Monitor throughput to the vapor combustor.

RECORDKEEPING

- 1) Record the times and duration of periods when the pilot flame was not present.
- 2) Records of throughput to the vapor combustor.
- 3) Records of vapor combustor malfunction or shutdown which resulted in excess emissions.
- 4) Records of vapor combustor inspection and maintenance activities conducted.

REPORTING

- 1) Report any period when visible emissions exceeded 5 minutes during any two-hour period.

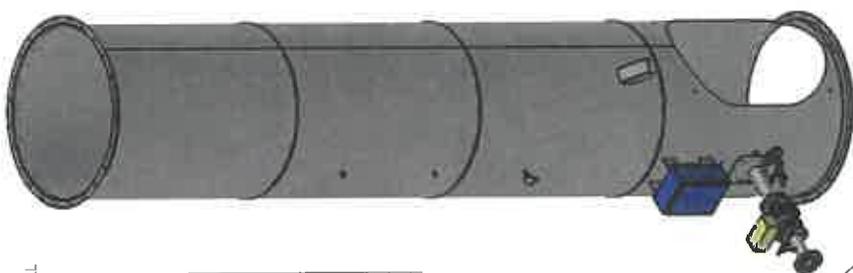
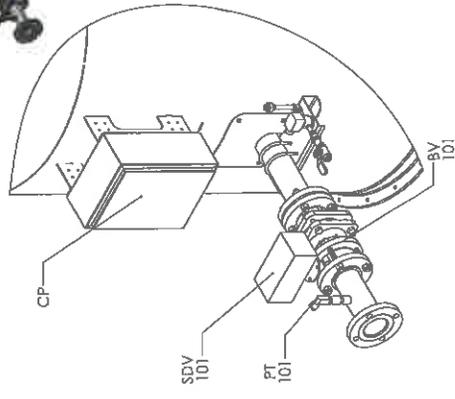
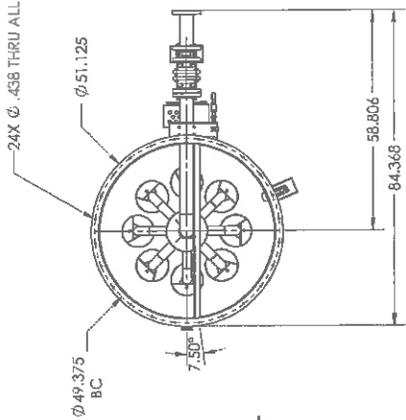
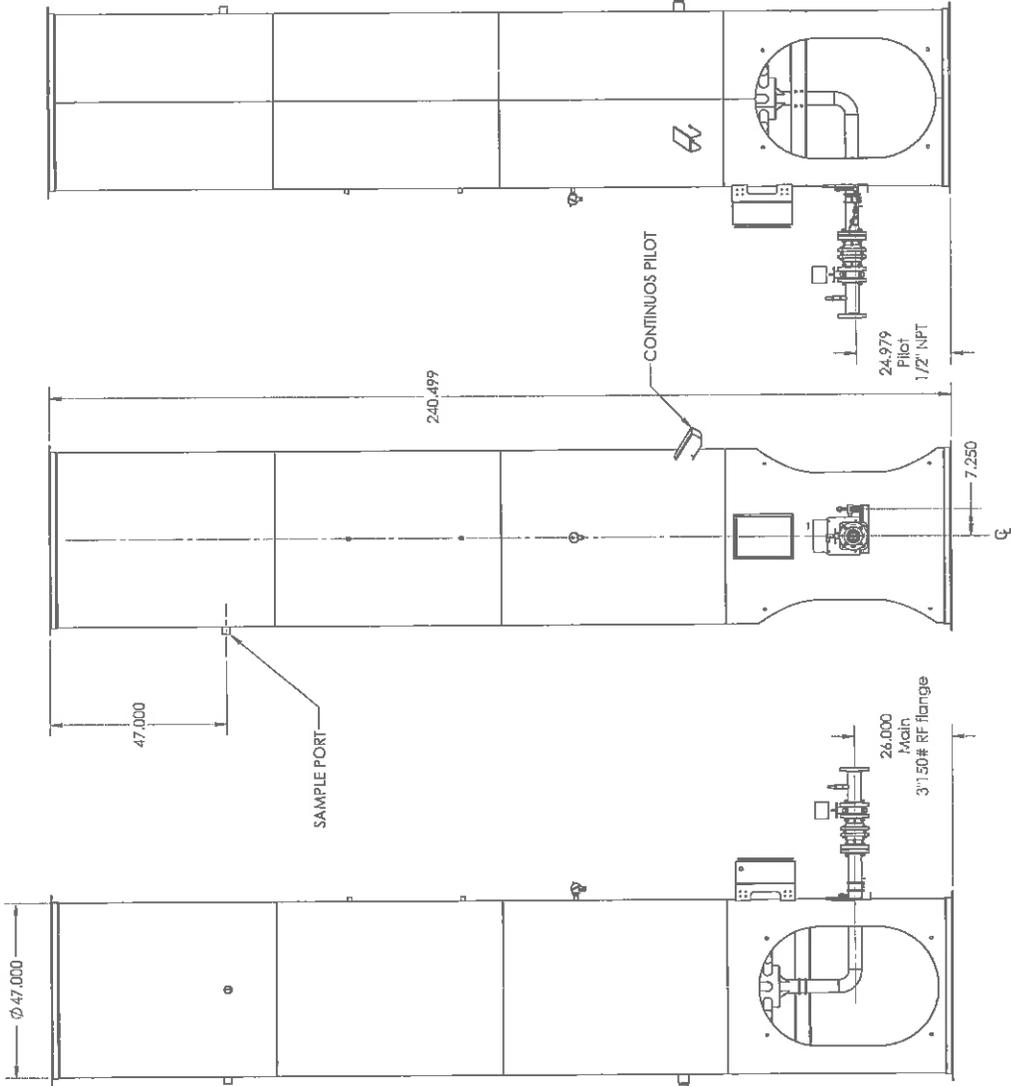
34. Additional Information Attached? **YES**

*Please attach a copy of manufacturer's data sheet. Please attach a copy of manufacturer's drawing.
Please attach a copy of the manufacturer's performance testing.*

If any of the requested information is not available, please contact the manufacturer.

General Arrangement Drawing

NOTE: This drawing is intended for your review and approval of the general arrangement for project ABUTEK 200. Some dimensions are subject to change during the final engineering phase of this project. "As Built" drawings will be provided at engineering completion.



ABUTEK™ Advanced Purifier Technology	
ABUTEK-200	
TITLE	SIZE DWG. NO.
MATERIAL UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS: ±0.005 DECIMALS: ±0.001 TWO PLACE DECIMAL: ±0.01 THREE PLACE DECIMAL: ±0.001	DRAWN: J. PHILLIPS CHECKED: ESCAN DATE: 1/24 WEIGHT: 1690.48
REV	SHEET 1 OF 1

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Attachment I

Emission Calculations

Table 1

**Facility Information
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Oil and Gas Site General Information

Administrative Information	
Company Name	Antero Resources Corporation
Facility/Well Name	Zinn Well Pad
Nearest City/Town	Pennsboro
API Number/SIC Code	1311
Latitude/Longitude	39.320242, -80.938208
County	Ritchie County

Technical Information	
Max Condensate Site Throughput (bbl/day):	480
Max Produced Water Site Throughput (bbl/day):	5,760
Are there any sour gas streams at this site?	No
Is this site currently operational/producing?	No

Equipment/Processes at Site	
Equipment/Process Types	How many for this site?
Fugitives	12
IC Engines	1
Turbines	0
Diesel Engines	0
Gas Production Unit Heaters	12
Condensate Tanks	10
Produced Water Tanks	2
Miscellaneous Tanks	0
Loading Jobs	2
Glycol Units	0
Amine Units	0
Flares-Vapor Combustors	1

Table Z

Uncontrolled/Controlled Emissions Summary
 Zimm Well Pad
 Ritchie County, West Virginia
 Antero Resources Corporation

Emission Source	VOC		NO _x		CO		SO ₂		PM ₁₀		PM _{2.5}		Pb		Total HAPs		Benzene		Xylenes		Formaldehyde					
	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)	(lb/yr)	(ton/yr)				
UNCONTROLLED (Fugitives, Storage Tanks, Gas Production Unit Heaters)																										
Fugitive Emissions (Component Count, PCV and Hauling) ¹	4,7007	20,5889			107,709	471.76					2,285	6,1767			0,4552	1,9940	0,0078	0,0543	5,90E-02	2,59E-01						
Flaring, Working and Breathing (F/W/B) Losses ²	399.12	1,353.9			1,460.0	6,394.9									14,518	63,588	0,5690	2,4920	0,3390	1,4715						
Engine Emissions ³	0,0071	0,0311	0,3158	1,3831	27,78	121.66	5,6445	24,7228	0,0001	0,0004	0,0024	0,0104	0,0023	0,0100	0,0055	0,0241	0,0004	0,0017	0,0000	0,0002	0,0002	0,0009	0,0215	0,0047		
Gas Production Unit Heater Emissions ⁴	0,0794	0,3477	1,4434	6,3721	1,742,37	7,631,57	1,2125	5,3105	0,0087	0,0379	0,1097	0,4805	0,1097	0,4805	2,72E-02	1,19E-01	3,09E-05	1,39E-04					0,0011	0,0047		
TOTALS:	513,6090	1,974,8952	1,7652	7,7652	30,97,8656	126,519,4512	6,8599	28,059,931	0,0088	0,0386	0,1121	0,4609	0,1121	0,4609	13,0057	55,7248	0,5772	2,5261	0,8950	1,7902	0,0060	0,0269	0,0060	0,0269		
UNCONTROLLED (Truck Loading Emissions)																										
Truck Loading Emissions ⁵	9,532	3,486			9,229	7,205									0,0336	0,0123	9,01E-04	3,40E-04	0,0026	0,0009						
CONTROLLED EMISSIONS																										
Flare Emissions (from F/W/B losses) ⁶	6,1824	27,0788	0,4425	1,9381	1506,7069	6399,3498	0,3717	1,6280	7,58E-06	3,31E-05	0,0252	0,1105	0,0395	0,1473	0,2904	1,2719	1,14E-02	4,38E-02	0,0067	0,0294			9,49E-07	4,14E-06		
Controlled Fugitive Emissions from Hauling	6,1824	27,0788	0,4425	1,9381	1506,7069	6399,3498	0,3717	1,6280	7,58E-06	3,31E-05	0,0252	0,1105	0,0395	0,1473	0,2904	1,2719	1,14E-02	4,38E-02	0,0067	0,0294			9,49E-07	4,14E-06		
TOTALS:	109,699	51,5630	2,2077	9,6439	30,97,8656	126,519,4512	7,2296	31,681,4	0,0088	0,0386	0,1121	0,4609	0,1121	0,4609	13,0057	55,7248	0,5772	2,5261	0,8950	1,7902	0,0060	0,0269	0,0060	0,0269		

1 - See Tables 4 and 5 for fugitive emission calculations; Table 12 for PM emissions from hauling.
 2 - See Tables 6 and 7 for tank emission calculations.
 3 - See Table 13 for engine emissions.
 4 - See Table 9 for gas production unit heater emission calculations.
 5 - The maximum emission was calculated based on tank truck capacity of 200 barrels and actual fill rate of 50 minutes per tank truck. At a production rate of 480 barrels per day, VOC emissions would be 9,5318 pounds per hour when there is truck loading activity. Average hourly VOC emissions from truck loading per year is 0,7959 pound per hour.
 6 - See Table 10 and 11 for flare emission calculations.
 7 - The hourly potential to emit is the sum of emissions from gas production unit heaters, engine, storage tanks, fugitives and flares. Does not include emissions from loading (see footnote 5). The total TPE PTE is the sum of all emissions.
 PM₁₀ TPE is the sum of uncontrolled hauling and other PM₁₀ sources.

Table 3

**Permit Summary
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Pollutant		Emissions			Threshold Exceeded?	
		Uncontrolled	Controlled	Threshold	Uncontrolled	Controlled
VOC	lbs/hr	313.9030	10.9696	6	Yes	Yes
	tons/yr	1378.3813	51.5330	10	Yes	Yes
NO _x	lbs/hr	1.7592	2.2017	6		
	tons/yr	7.7052	9.6433	10		
CO	lbs/hr	6.8569	7.2286	6	Yes	Yes
	tons/yr	30.0333	31.6614	10	Yes	Yes
SO ₂	lbs/hr	0.0088	0.0088	6		
	tons/yr	0.0386	0.0386	10		
PM _{2.5}	lbs/hr	1.12E-01	1.37E-01	6		
	tons/yr	4.91E-01	6.01E-01	10		
PM ₁₀	lbs/hr	2.3155	1.2474	6		
	tons/yr	6.6671	3.7261	10		
Lead	lbs/hr	7.22E-06	9.43E-06	6		
	tons/yr	3.16E-05	4.13E-05	10		
Total HAPs	lbs/hr	15.0057	0.7783	2	Yes	
	tons/yr	65.7371	3.4212	5	Yes	
Total TAPs	lbs/hr	0.5832	0.0256	1.14		
n-Hexane	lbs/hr	13.3619	0.6577			
	tons/yr	58.4148	2.7704			
Toluene	lbs/hr	0.5383	0.0365			
	tons/yr	2.3508	0.1526			
Ethylbenzene	lbs/hr	0.1573	0.0228			
	tons/yr	0.6854	0.0963			
Xylenes	lbs/hr	0.3976	0.0684			
	tons/yr	1.7311	0.2891			
Benzene	lbs/hr	0.5781	0.0205			
	tons/yr	2.5284	0.0863			

Enter any notes here:	<p>1. Emissions are based on 98% Flare DRE operating 100% of the time.</p> <p>2. Please see Attachment C/O- Fugitive Emissions Data Summary Sheet and Attachment O – Emission Points Data Summary Sheet for sitewide sources and breakdown of emission quantities.</p>
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Table 4

Fugitive Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation

VOC Type:	Condensate VOC
Emission Type:	Steady State (continuous)

Gas Weight Fraction From Analysis:	VOC frac	0.191
	Benzene frac	0.000
	Toluene	0.000
	Ethylbenzene	0.000
	Xylenes	0.000
	n-Hexane	0.023
	Methane	0.603

Gas					
Number	Component	Pollutant	Emission Factor (kg/hr of THC per component)	kg/hr	lb/yr
600	Valves	Gas VOC	0.004500	0.52	9,936.91
		Non VOC	0.004500	2.18	42,097.49
708	Connectors	VOC	0.000200	0.03	521.14
		Non-VOC	0.000200	0.11	2,207.78
156	Flanges	VOC	0.000390	0.01	223.91
		Non-VOC	0.000390	0.05	948.60
Total VOCs:				0.55	10,681.96
Total THC:				2.90	55,935.82

Light Liquid Weight Fraction From Analysis:	VOC frac	0.974
	Benzene frac	0.002
	Toluene	0.007
	Ethylbenzene	0.006
	Xylenes	0.017
	n-hexane	0.053
	Methane	0.008

Light Liquid					
Number	Component	Pollutant	Emission Factor (kg/hr of THC per component)	kg/hr	lb/yr
624	Valves	Light Liquid VOC	0.002500	1.52	29,293.10
		Light Liquid Non-VOC		0.04	771.22
Total VOC:				1.52	29,293.10
Total THC:				1.56	30,064.32

Fugitive Total Emissions			
	Annual Emissions (lb/yr)	Annual Emissions (lb/hr)	Annual Emissions (tpy)
VOC	39,975.05	4.56	19.99
Ethylbenzene		0.02	0.08
Toluene		0.02	0.11
Xylenes		0.06	0.26
n-Hexane		0.33	1.44
TAPs (Benzene)		0.01	0.03
HAPs		0.44	1.92
CO _{2e}	848,576.86	96.87	424.29

Enter Notes Here:	Fugitive emissions based on an estimated component count
	Global Warming Potentials from EPA site
	Reference to Emission factors used:
	1. Emission factors are for oil and gas production facilities (not refineries) come from the EPA's "Protocol for Equipment Leak Emission Estimates" November 1995, EPA 4531, R-95-017, Table 2-4.
	2. Percent of speciated VOCs used in fugitive calculations are based on the total hydrocarbons, not of the total sample.

Table 5

**Pneumatic Control Valve Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Number of PCVs	48
Bleed Rate (scf/day/PCV)	6.6
Total Bleed Rate (scf/day)	316.8

Component	Mol%	Molecular Weight (lb/lb-mole)	Component Flow (scf/day)	Component Moles (lb-moles)	Component Emissions		
					(lbs/day)	(lbs/hr)	(tons/year)
H2S	0	34.08	0	0.00	0.00	0.00	0.00
Nitrogen	0.4946	14.01	1.5668928	0.00	0.06	0.00	0.01
Carbon Dioxide	0.1467	44.01	0.4647456	0.00	0.05	0.00	0.01
Methane	77.6927	16.04	246.1304736	0.65	10.40	0.43	1.90
Ethane	14.1987	30.07	44.9814816	0.12	3.56	0.15	0.65
Propane	4.4938	44.1	14.2363584	0.04	1.65	0.07	0.30
Isobutane	0.5666	58.12	1.7949888	0.00	0.27	0.01	0.05
n-Butane	1.1838	58.12	3.7502784	0.01	0.57	0.02	0.10
Isopentane	0.3749	72.15	1.1876832	0.00	0.23	0.01	0.04
n-Pentane	0.2914	72.15	0.9231552	0.00	0.18	0.01	0.03
2-Methylpentane	0	86.18	0	0.00	0.00	0.00	0.00
3-Methylpentane	0	86.18	0	0.00	0.00	0.00	0.00
n-Hexane	0.5451	86.18	1.7268768	0.00	0.39	0.02	0.07
Methylcyclopentane	0	84.16	0	0.00	0.00	0.00	0.00
Benzene	0	78.11	0	0.00	0.00	0.00	0.00
2-Methylhexane	0	100.2	0	0.00	0.00	0.00	0.00
3-Methylhexane	0	100.2	0	0.00	0.00	0.00	0.00
Heptane	0	100.21	0	0.00	0.00	0.00	0.00
Methylcyclohexane	0	98.186	0	0.00	0.00	0.00	0.00
Toluene	0	92.14	0	0.00	0.00	0.00	0.00
Octane	0	114.23	0	0.00	0.00	0.00	0.00
Ethylbenzene	0	106.17	0	0.00	0.00	0.00	0.00
m & p-Xylene	0	106.16	0	0.00	0.00	0.00	0.00
o-Xylene	0	106.16	0	0.00	0.00	0.00	0.00
Nonane	0	128.2	0	0.00	0.00	0.00	0.00
C10+	0	174.28	0	0.00	0.00	0.00	0.00

	lb/hr	tpy
VOC Emissions	0.1374	0.6017
Benzene Emissions	0.0000	0.0000
Toluene Emissions	0.0000	0.0000
Ethylbenzene Emissions	0.0000	0.0000
Xylene Emissions	0.0000	0.0000
n-Hexane Emissions	0.0163	0.0716
HAPs Emissions	0.0163	0.0716
TAPs Emissions	0.0000	0.0000
CO _{2e} emissions	10.8393	47.4760

Enter any notes here:	1. PCV bleed rate obtained from the user manual for PCV http://issuu.com/rmcprocesscontrols/docs/mizer-pilot-operation-parts-installation-manual 2. Emissions per hour= Mol % x no. of PCV x bleed rate x MW / 379.48 / 24
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Table 7

Uncontrolled Working and Breathing Losses
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation

Condensate Tank Information		Condensate Tank W/B Losses										
Number of Tanks	Vapor Mass Fraction wt%	Working Losses		Breathing Losses		Max W/B Losses		tpy	lbs/hr	tpy	lbs/hr	tpy
		lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy					
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7.1068	0.0028	0.0002	0.0009	0.0001	0.0001	0.0006	0.0003	0.0005	0.0003	0.0015	0.0003	0.0015
5.3281	0.2395	0.0170	0.0745	0.0128	0.0128	0.0559	0.0298	0.0559	0.0298	0.1304	0.0298	0.1304
	2.4701	0.1755	0.7689	0.1316	0.1316	0.5765	0.3072	0.5765	0.3072	1.3454	0.3072	1.3454
	25.8780	1.8391	8.0552	1.3788	1.3788	6.0392	3.2179	6.0392	3.2179	14.0944	3.2179	14.0944
	28.1244	1.9987	8.7544	1.4985	1.4985	6.5635	3.4972	6.5635	3.4972	15.3179	3.4972	15.3179
	7.4176	0.5272	2.3089	0.3952	0.3952	1.7311	0.9224	1.7311	0.9224	4.0400	0.9224	4.0400
	16.8945	1.2006	5.2588	0.9002	0.9002	3.9427	2.1008	3.9427	2.1008	9.2016	2.1008	9.2016
	6.3916	0.4542	1.9895	0.3406	0.3406	1.4916	0.7948	1.4916	0.7948	3.4812	0.7948	3.4812
	6.6143	0.4701	2.0589	0.3524	0.3524	1.5436	0.8225	1.5436	0.8225	3.6024	0.8225	3.6024
	1.7384	0.1235	0.5411	0.0926	0.0926	0.4057	0.2162	0.4057	0.2162	0.9468	0.2162	0.9468
	1.0187	0.0724	0.3171	0.0543	0.0543	0.2377	0.1267	0.2377	0.1267	0.5548	0.1267	0.5548
	0.2057	0.0146	0.0640	0.0110	0.0110	0.0480	0.0256	0.0480	0.0256	0.1120	0.0256	0.1120
	0.4053	0.0288	0.1262	0.0216	0.0216	0.0946	0.0504	0.0946	0.0504	0.2208	0.0504	0.2208
	0.0067	0.0005	0.0021	0.0004	0.0004	0.0016	0.0008	0.0016	0.0008	0.0037	0.0008	0.0037
	0.0388	0.0028	0.0121	0.0021	0.0021	0.0090	0.0048	0.0090	0.0048	0.0211	0.0048	0.0211
	0.4385	0.0312	0.1365	0.1023	0.1023	0.4466	0.0545	0.4466	0.0545	1.2020	0.0545	1.2020
	0.8199	0.0583	0.2552	0.0437	0.0437	0.1914	0.1020	0.1914	0.1020	0.4466	0.1020	0.4466
	0.5808	0.0413	0.1608	0.0309	0.0309	0.1356	0.0722	0.1356	0.0722	0.3163	0.0722	0.3163
	0.0131	0.0009	0.0041	0.0007	0.0007	0.0031	0.0016	0.0031	0.0016	0.0072	0.0016	0.0072
	0.5643	0.0401	0.1756	0.0301	0.0301	0.1317	0.0702	0.1317	0.0702	0.3073	0.0702	0.3073
	0.0066	0.0005	0.0020	0.0003	0.0003	0.0015	0.0008	0.0015	0.0008	0.0036	0.0008	0.0036
	0.0108	0.0008	0.0034	0.0006	0.0006	0.0025	0.0013	0.0025	0.0013	0.0059	0.0013	0.0059
	0.0085	0.0006	0.0027	0.0005	0.0005	0.0020	0.0011	0.0020	0.0011	0.0046	0.0011	0.0046
	0.1099	0.0078	0.0342	0.0059	0.0059	0.0256	0.0137	0.0256	0.0137	0.0599	0.0137	0.0599
	0.0012	0.0001	0.0004	0.0001	0.0001	0.0003	0.0002	0.0003	0.0002	0.0007	0.0002	0.0007
	71.410	5.0749	22.228	3.8048	3.8048	16.6650	8.8757	16.6650	8.8757	38.893	8.8757	38.893
		4.4057	19.2969	3.3031	3.3031	14.4674	7.7087	14.4674	7.7087	33.764	7.7087	33.764
		0.0005	0.0021	0.0004	0.0004	0.0016	0.0008	0.0016	0.0008	0.0037	0.0008	0.0037
		0.0009	0.0041	0.0007	0.0007	0.0031	0.0016	0.0031	0.0016	0.0072	0.0016	0.0072
		0.0005	0.0020	0.0003	0.0003	0.0015	0.0008	0.0015	0.0008	0.0036	0.0008	0.0036
		0.0014	0.0060	0.0010	0.0010	0.0045	0.0024	0.0045	0.0024	0.0105	0.0024	0.0105
		0.0146	0.0640	0.0110	0.0110	0.0480	0.0256	0.0480	0.0256	0.1120	0.0256	0.1120
		0.0179	0.0783	0.0134	0.0134	0.0587	0.0313	0.0587	0.0313	0.1369	0.0313	0.1369
	100.00	7.1068	31.1276	5.3281	5.3281	23.3373	12.4349	23.3373	12.4349	54.465	12.4349	54.465

Table 7

Uncontrolled Working and Breathing Losses
 Zinn Well Pad
 Ritchie County, West Virginia
 Antero Resources Corporation

Produced Water Tank Information	
Number of Tanks	2
Maximum Working Losses (lbs/hr)	0.2552
Maximum Breathing Losses (lbs/hr)	0.0083

	Vapor Mass Fraction		Produced Water Tank W/B Losses				Breathing Losses		Max W/B Losses	
	wt%		lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy
H2S	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0095		0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Carbon Dioxide	3.5725		0.0091	0.0399	0.0003	0.0013	0.0003	0.0013	0.0094	0.0412
Methane	3.1292		0.0080	0.0350	0.0003	0.0011	0.0003	0.0011	0.0082	0.0361
Ethane	1.1366		0.0029	0.0127	0.0001	0.0004	0.0001	0.0004	0.0030	0.0131
Propane	0.1404		0.0004	0.0016	0.0000	0.0001	0.0000	0.0001	0.0004	0.0016
Isobutane	0.0010		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0060		0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Isopentane	0.0003		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0002		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2-Methylpentane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3-Methylpentane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methylcyclopentane	0.0001		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Benzene	0.0002		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2-Methylhexane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3-Methylhexane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Heptane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methylcyclohexane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Toluene	0.0001		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Octane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethylbenzene	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
m & p-Xylene	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
o-Xylene	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nonane	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
C10+	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total VOCs	0.1485		0.0004	0.0017	0.0000	0.0001	0.0000	0.0001	0.0004	0.0017
Total CO ₂			0.2088	0.9144	0.0068	0.0297	0.0068	0.0297	0.2155	0.9441
Total TAPs (Benzene)			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Toluene			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethylbenzene			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Xylenes			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total HAPs			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	100.00		0.2552	1.1178	0.0083	0.0363	0.0083	0.0363	0.2635	1.1541

Enter any notes here: Vapor mass fractions, working losses and breathing losses from Promax output

Table 8

**Loading Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Annual Loading	Oil Truck Loading	Water Truck Loading
RVP	3.41	1.0241
Annual Average Temp (F)	72.1	72.1
S (saturation factor)	0.6	0.6
P (true vapor pressure)	2.19	0.45
M (MW of vapor)	43.09	18.43
Collection Efficiency (%)	0	0
Loading Loss (lb/10 ³ gal)*	1.32	0.12
Maximum Throughput (gallons/hr)	10,080	10,080
Average Throughput (gallons/yr)	7,358,400	88,300,800
Loading Emissions (lbs/hr)	13.35	1.17
Loading Emissions (tpy)	4.87	5.12

	Condensate Tank Loading Losses			Produced Water Tank Loading Losses		
	Vapor Mass Fraction wt%	Loading Losses lbs/hr	tpy	Vapor Mass Fraction wt%	Loading Losses lbs/hr	tpy
H2S	0.0000	0.00	0.00	0.0000	0.00E+00	0.00E+00
Nitrogen	0.0028	0.00	0.00	0.0095	1.11E-04	4.98E-04
Carbon Dioxide	0.2395	0.03	0.01	3.5725	4.17E-02	1.83E-01
Methane	2.4701	0.33	0.12	3.1292	3.66E-02	1.60E-01
Ethane	25.8780	3.45	1.26	1.1366	1.33E-02	5.82E-02
Propane	28.1244	3.75	1.37	0.1404	1.64E-03	7.19E-03
Isobutane	7.4176	0.99	0.36	0.0010	1.14E-05	5.00E-05
n-Butane	16.8945	2.25	0.82	0.0060	7.05E-05	3.09E-04
Isopentane	6.3916	0.85	0.31	0.0003	3.79E-06	1.66E-05
n-Pentane	6.6143	0.88	0.32	0.0002	2.65E-06	1.16E-05
2-Methylpentane	1.7384	0.23	0.08	0.0000	5.73E-08	2.51E-07
3-Methylpentane	1.0187	0.14	0.05	0.0000	2.18E-07	9.55E-07
n-Hexane	0.2057	0.03	0.01	0.0000	3.03E-09	1.33E-08
Methylcyclopentane	0.4053	0.05	0.02	0.0001	5.98E-07	2.62E-06
Benzene	0.0067	0.00	0.00	0.0002	2.77E-06	1.21E-05
2-Methylhexane	0.0388	0.01	0.00	0.0000	2.91E-10	1.28E-09
3-Methylhexane	0.4385	0.06	0.02	0.0000	3.42E-09	1.50E-08
Heptane	0.8199	0.11	0.04	0.0000	5.48E-09	2.40E-08
Methylcyclohexane	0.5808	0.08	0.03	0.0000	1.20E-07	5.23E-07
Toluene	0.0131	0.00	0.00	0.0001	1.10E-06	4.82E-06
Octane	0.5643	0.08	0.03	0.0000	4.26E-10	1.87E-09
Ethylbenzene	0.0066	0.00	0.00	0.0000	1.65E-07	7.21E-07
m & p-Xylene	0.0108	0.00	0.00	0.0000	2.30E-07	1.01E-06
o-Xylene	0.0085	0.00	0.00	0.0000	2.25E-07	9.87E-07
Nonane	0.1099	0.01	0.01	0.0000	6.67E-11	2.92E-10
C10+	0.0012	0.00	0.00	0.0000	3.10E-17	1.36E-16
Total VOCs	71.4096	9.530	3.478	0.1485	1.73E-03	7.60E-03
Total CO _{2e}		8.273	3.0198		0.9556	4.1856
Total TAPs (Benzene)		0.0009	0.0003		0.0000	0.0000
Toluene		0.0018	0.0006		0.0000	0.0000
Ethylbenzene		0.0009	0.0003		0.0000	0.0000
Xylenes		0.0026	0.0009		0.0000	0.0000
n-Hexane		0.0274	0.0100		0.0000	0.0000
Total HAPs		0.0336	0.0122		0.0000	0.0000
Total	100.0000	13.3457	4.8712	100.0000	1.1682	5.1166

Enter any notes here

Vapor mass fractions and loading losses from Promax output
 *Using equation $L_1 = 12.46 \cdot \text{SPM}/T$ from AP-42, Chapter 5, Section 5.2-4
 MW was obtained by Promax; RVP was taken from laboratory reports
 Annual Average Temp (F) obtained from Charleston, WV (preset in Promax)
 S (saturation factor) is based on submerged loading, dedicated service as it was most representative
 True vapor pressure (TVP) equation from AP-42, Chapter 7, Figure 7.1-13b
 Loading emissions are vented to the atmosphere.

Table 9

**Gas Production Unit Heater Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Number of Units	12
GPU Heater Rating (MMBtu/hr)	1.50
Operating hours/year	8760
Fuel Heat Value (Btu/scf)	1,247

Pollutant	Emission Factors (lb/MMscf)	lb/hr	tpy
NOx	100	1.443	6.322
CO	84	1.212	5.311
CO ₂	120,000	1732.074	7586.483
Lead	0.0005	7.22E-06	3.16E-05
N ₂ O	2.2	0.032	0.139
PM (Total)	7.6	0.110	0.480
SO ₂	0.6	0.009	0.038
TOC	11	0.159	0.695
Methane	2.3	0.033	0.145
VOC	5.5	0.079	0.348
HAPS			
2-Methylnaphthalene	2.40E-05	3.46E-07	1.52E-06
Benzene	2.10E-03	3.03E-05	1.33E-04
Dichlorobenzene	1.20E-03	1.73E-05	7.59E-05
Fluoranthene	3.00E-06	4.33E-08	1.90E-07
Fluorene	2.80E-06	4.04E-08	1.77E-07
Formaldehyde	7.50E-02	1.08E-03	4.74E-03
Hexane	1.80E+00	2.60E-02	1.14E-01
Naphthalene	6.10E-04	8.80E-06	3.86E-05
Phenanathrene	1.70E-05	2.45E-07	1.07E-06
Toluene	3.40E-03	4.91E-05	2.15E-04

	lb/hr	tpy
TOTAL Uncontrolled VOC	0.079	0.348
TOTAL Uncontrolled HAPs	0.027	0.119
TOTAL Uncontrolled TAPs (Benzene)	0.000	0.000
TOTAL Uncontrolled TAPs (Formaldehyde)	0.001	0.005
TOTAL CO _{2e} Emissions	1,742.37	7,631.57

Enter any notes here:
All Emission Factors based off AP-42 Sec 1.4 Natural Gas Combustion

Table 10

**Flare Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

General Information	
Unit Name:	FL001

Pollutant	Emission Factor (lb/MMscf)
NOx	100
CO	84
PM10	7.6
PM2.5	5.7
SO ₂	0.6
CO ₂	120,000
VOC	5.5
benzene	2.10E-03
Hexane	1.80E+00
Toluene	3.40E-03
Formaldehyde	7.50E-02
N ₂ O	2.20
Lead	5.00E-04

Constants	
Btu/MMBtu	1,000,000
scf/MMscf	1,000,000
lb/ton	2,000
H ₂ S molecular weight	34.08
SO ₂ molecular weight	64.06
seconds/hour	3,600
Inches/ft	12

Destruction Efficiency	
VOC percent destruction efficiency (%)	98
H ₂ S percent destruction efficiency (%)	98

Flare operating hours	8760
-----------------------	------

Stream Information							
	1	2	3	4	5	6	Total
Stream Sent to Flare/Vapor Combustor (Enter Name of Each Stream Here)	pilot(s)	added fuel stream(s)	Oil Tank Flash Emissions	Water Tank Flash Emissions	Oil Tank W/B Emissions	Water Tank W/B Emissions	-
Maximum Expected Hourly Volumetric Flow Rate of Stream (scf/hr)	12.6	--	3,664.01	633.41	109.52	5.42	4,424.97
Maximum Expected Annual Volumetric Flow Rate of Stream (scf/yr)	110,376.00	--	32,096,743.75	5,548,714.81	959,359.09	47,514.15	38,762,707.80
Heating Content (Btu/ft3)	1,247		2,101.12	1,091.34	2,101.12	1,091.34	1,949.35

Mass Flow Rates of the Vapors Sent to this Control Device, Hourly Basis (lb/hr)							
	1	2	3	4	5	6	Total
Stream Sent to Flare/Vapor Combustor	pilot(s)	added fuel stream(s)	Oil Tank Flash Emissions	Water Tank Flash Emissions	Oil Tank W/B Emissions	Water Tank W/B Emissions	-
H ₂ S	-	-	0.000	0.000	0.000	0.000	0.000
Total VOC	-	-	295.056	5.179	8.880	0.000	309.12
Benzene	-	-	0.512	0.057	0.001	0.000	0.569
Toluene	-	-	0.464	0.047	0.002	0.000	0.512
Ethylbenzene	-	-	0.124	0.012	0.001	0.000	0.137
Xylenes	-	-	0.303	0.030	0.002	0.000	0.336
n-Hexane	-	-	12.912	0.026	0.026	0.000	12.963
HAPs	-	-	14.315	0.171	0.031	0.000	14.518
Total Mass Flow	-	-	416.027	30.770	12.435	0.263	459.495

Mass Flow Rates of the Vapors Sent to this Control Device, Annual Basis (tpy)							
	1	2	3	4	5	6	Total
H ₂ S	-	-	0.000	0.000	0.000	0.000	0.000
Total VOC	-	-	1292.347	22.685	38.893	0.002	1353.927
Benzene	-	-	2.241	0.248	0.004	0.000	2.492
Toluene	-	-	2.032	0.204	0.007	0.000	2.243
Ethylbenzene	-	-	0.543	0.054	0.004	0.000	0.601
Xylenes	-	-	1.329	0.132	0.011	0.000	1.471
n-Hexane	-	-	56.556	0.112	0.112	0.000	56.780
HAP	-	-	62.701	0.750	0.137	0.000	63.588
Total Mass Flow	-	-	1822.200	134.771	54.465	1.154	2012.590

Table 10
Flare Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation

Controlled Emissions							
Hourly (lb/hr)							
	1	2	3	4	5	6	Total
Stream Sent to Flare/Vapor Combustor	pilot(s)	added fuel stream(s)	Oil Tank Flash Emissions	Water Tank Flash Emissions	Oil Tank W/B Emissions	Water Tank W/B Emissions	-
NO _x	0.001	-	0.366	0.063	0.011	0.001	0.44
CO	0.001	-	0.308	0.053	0.009	0.000	0.37
PM2.5	0.000	-	0.021	0.004	0.001	0.000	0.03
PM10	0.000	-	0.028	0.005	0.001	0.000	0.03
H ₂ S	0.000	-	0.000	0.000	0.000	0.000	0.00
SO ₂	0.000	-	0.000	0.000	0.000	0.000	0.00
CO ₂	1.512	-	-	-	-	-	1.51
Total VOC	0.000	-	5.901	0.104	0.178	0.000	6.18
Benzene	0.000	-	0.010	0.001	0.000	0.000	0.01
Toluene	0.000	-	0.009	0.001	0.000	0.000	0.01
Ethylbenzene	0.000	-	0.002	0.000	0.000	0.000	0.00
Xylenes	0.000	-	0.006	0.001	0.000	0.000	0.01
n-Hexane	0.000	-	0.258	0.001	0.001	0.000	0.26
HAP	0.000	-	0.286	0.003	0.001	0.000	0.29
N ₂ O	0.000	-	0.008	0.001	0.000	0.000	0.01
Lead	0.000	-	0.000	0.000	0.000	0.000	0.00
Formaldehyde	0.000	-	-	-	-	-	0.00
Annual (tpy)							
	1	2	3	4	5	6	Total
Stream Sent to Flare/Vapor Combustor	pilot(s)	added fuel stream(s)	Oil Tank Flash Emissions	Water Tank Flash Emissions	Oil Tank W/B Emissions	Water Tank W/B Emissions	-
NO _x	0.006	-	1.605	0.277	0.048	0.002	1.94
CO	0.005	-	1.348	0.233	0.040	0.002	1.63
PM2.5	0.000	-	0.091	0.016	0.003	0.000	0.11
PM10	0.000	-	0.122	0.021	0.004	0.000	0.15
H ₂ S	0.000	-	0.000	0.000	0.000	0.000	0.00
SO ₂	0.000	-	0.000	0.000	0.000	0.000	0.00
CO ₂	6.623	-	-	-	-	-	6.62
Total VOC	0.000	-	25.847	0.454	0.778	0.000	27.08
Benzene	0.000	-	0.045	0.005	0.000	0.000	0.05
Toluene	0.000	-	0.041	0.004	0.000	0.000	0.04
Ethylbenzene	0.000	-	0.011	0.001	0.000	0.000	0.01
Xylenes	0.000	-	0.027	0.003	0.000	0.000	0.03
n-Hexane	0.000	-	1.131	0.002	0.002	0.000	1.14
HAP	0.000	-	1.254	0.015	0.003	0.000	1.27
N ₂ O	0.000	-	0.035	0.006	0.001	0.000	0.04
Lead	0.000	-	0.000	0.000	0.000	0.000	0.00
Formaldehyde	0.000	-	-	-	-	-	0.00

Flare/Vapor Combustor Total Emissions		
	Hourly Emissions (lb/hr)	Annual Emissions (tpy)
Total VOC	6.18	27.08
NO _x	4.42E-01	1.94E+00
CO	3.72E-01	1.63E+00
PM2.5	2.52E-02	1.10E-01
PM10	3.36E-02	1.47E-01
H ₂ S	4.02E-06	1.76E-05
SO ₂	7.56E-06	3.31E-05
Benzene (TAPs)	1.14E-02	4.98E-02
Formaldehyde (TAPs)	9.45E-07	4.14E-06
HAPs	0.29	1.27
CO ₂ e	1506.70	6599.35
N ₂ O	9.73E-03	4.26E-02
Lead	2.21E-06	9.69E-06

Enter any notes here as needed
 1. Emission Factors from AP-42 Tables 1.4-1, 1.4-2, and 1.4.3

Table 11

Flare GHG Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation

Flare CO₂ and CH₄ Emissions

Components	Mole fraction of oil flash gas constituents ^a	Volume of oil flash gas sent to flare scf/year	Mole fraction of water flash gas constituents ^a	Volume of water flash gas sent to flare scf/year	Mole fraction of oil tank vapors constituents ^a	Volume of oil tank vapor sent to flare scf/year	Mole fraction of water tank vapors constituents ^a	Volume of water tank vapors sent to flare scf/year	Volume of water tank vapors sent to flare scf/year	Component volume of gas sent to flare scf/year	Number of carbon atoms	Combustion Efficiency	Combusted CO ₂ Volume ^b scf/year	Uncombusted CO ₂ and CH ₄ Volume ^b scf/year	Volume GHGs Emitted scf/year
CO ₂	0.002	32,096,744	0.0326	5,548,715	0.0023	959,359	0.015	47,514	47,514	237,846	1	0	--	237,846	106,109,659
Methane	0.242	32,096,744	1.8979	5,548,715	0.0664	959,359	0.036	47,514	18,363,473	18,363,473	1	0.98	17,996,204	367,269	367,269
Ethane	0.259	32,096,744	0.3985	5,548,715	0.3708	959,359	0.007	47,514	10,699,364	20,970,754	2	0.98	20,970,754	--	--
Propane	0.225	32,096,744	0.1378	5,548,715	0.2748	959,359	0.001	47,514	8,298,607	24,221,504	3	0.98	24,221,504	--	--
n-Butane	0.048	32,096,744	0.0058	5,548,715	0.0550	959,359	0.000	47,514	1,609,851	6,310,616	4	0.98	6,310,616	--	--
i-Butane	0.110	32,096,744	0.0238	5,548,715	0.1252	959,359	0.000	47,514	3,791,794	14,863,833	4	0.98	14,863,833	--	--
Pentane	0.072	32,096,744	0.0081	5,548,715	0.0777	959,359	0.000	47,514	2,452,003	11,916,814	5	0.98	11,916,814	--	--
Hexane	0.028	32,096,744	0.0015	5,548,715	0.0148	959,359	0.000	47,514	905,136	5,322,197	6	0.98	5,322,197	--	--
Benzene	0.001	32,096,744	0.0012	5,548,715	0.0000	959,359	0.000	47,514	27,174	159,781	6	0.98	159,781	--	--
Heptanes	0.010	32,096,744	0.0011	5,548,715	0.0077	959,359	0.000	47,514	341,882	2,345,308	7	0.98	2,345,308	--	--
Toluene	0.000	32,096,744	0.0009	5,548,715	0.0001	959,359	0.000	47,514	20,440	140,218	7	0.98	140,218	--	--
Octane	0.005	32,096,744	0.0007	5,548,715	0.0047	959,359	0.000	47,514	173,336	1,358,956	8	0.98	1,358,956	--	--
Ethyl benzene	0.000	32,096,744	0.0002	5,548,715	0.0000	959,359	0.000	47,514	4,749	37,251	8	0.98	37,251	--	--
Xylenes	0.000	32,096,744	0.0005	5,548,715	0.0001	959,359	0.000	47,514	11,609	91,017	8	0.98	91,017	--	--
Nonane	0.000	32,096,744	0.0000	5,548,715	0.0004	959,359	0.000	47,514	15,351	135,392	9	0.98	135,392	--	--
Decane plus	0.000	32,096,744	0.0000	5,548,715	0.0000	959,359	0.000	47,514	203	1,988	10	0.98	1,988	--	--
															Subtotal 105,871,813

Pollutant	Volume Emitted scf/year	Density of GHG ^c lb/scf	Conversion Factor lb/year	GWF	Emissions ^c	
					lb/hr	(tons/yr)
CO ₂	106,109,659	0.12	2000	1	1,404.66	6,152.40
CH ₄	367,269	0.09	2000	25	3.90	17.08
					CO₂e Emissions	6579.51

GHG Emissions Summary

Notes

- a Flashing/Working/Breathing Losses from ProMax output reports
- b 40 CFR 98.233 (n)(4); Eqns: W-19, W-20 and W-21
- c 40 CFR 98.233(v) Eqn W-36 - density at 60F and 14.7 psia

Table 12

Haul Road Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation

	PM	PM10
Particle Size Multiplier (k)	0.8	0.36
Silt Content of Road Surface Material (s) (%)	5.1	5.1
Days per Year with Precipitation > 0.01 in (p)	150	150
Control Efficiency for Watering ¹ (%)	50	50

Tanker Truck Trip Calculation	
Condensate Production (bbbl/day)	480
PW Production (bbbl/day)	5,760
Truck Capacity (bbbl)	200

Pick Up Truck Trip Calculation	
No of Trips Per day	2
Trips Per Year	730

	# of Wheels	Mean Vehicle Weight (W) (tons)	Mean Vehicle Speed (S) (mph)	Miles Per Trip (miles)	Maximum Trips per Hour	Maximum Trips per Year	Vehicle Miles Travelled (miles/yr)	PM (lbs/VMT)	PM10 (lbs/VMT)
Tanker Trucks Condensate	10	40	10	0.6300	1	876	0.6300	551.8800	3.8175
Tanker Trucks PW	10	40	10	0.6300	1	10512	0.6300	6622.5600	3.8175
Pick Up Truck	4	3	10	0.2500	1	730	0.2500	182.5000	0.3467

	Uncontrolled Emissions				Controlled Emissions			
	PM (lbs/hr)	PM (lbs/year)	PM10 (lbs/hr)	PM10 (lbs/year)	PM (lbs/hr)	PM (lbs/year)	PM10 (lbs/hr)	PM10 (lbs/year)
Tanker Trucks Condensate	2.4050	2106.8181	1.0534	948.0682	0.4740	1053.4091	0.5411	474.0341
Tanker Trucks PW	2.4050	25281.8174	12.6409	11376.8179	5.6884	12640.9087	6.3205	5688.4089
Pick Up Truck	0.0867	63.2690	0.0316	28.4711	0.0142	31.6345	0.0158	14.2355
Total Emissions	4.8968	27,451.9046	13.7260	12,353.3571	6.1767	13,725.9523	6.8630	6,176.6785

Enter any notes here.
¹ EPA, AP-42, Volume I, Section 13.2.2 Unpaved Roads (11/06), assume 2:1 moisture ratio Section 13.2.2 Unpaved Roads (11/06)
 Sources: Attachment L, Fugitive Emissions from Unpaved Haul Roads, Rev 03/2007, West Virginia Department of Environmental Protection

Table 13

**Engine Emissions
Zinn Well Pad
Ritchie County, West Virginia
Antero Resources Corporation**

Kubota DG972-E2

Power (hp)	24
Fuel consumption (lbs/BHP-hr) ¹	0.449
Heat Content of Fuel (Btu/scf)	1247.06
Density of NG (lb/scf)	0.056
Operating Hours/year	8760

Pollutant	Emission Factors		lb/hr	tpy
	(g/hp-hr)	(lb/MMBtu)		
NOx ¹	5.97		0.3158	1.3831
CO ²	106.7		5.6445	24.7228
CO ₂		110.000	26.3967	115.62
PM _{2.5}		9.910E-03	0.0024	0.0104
PM ₁₀		9.500E-03	0.0023	0.0100
PM (Total)		9.910E-03	0.0024	0.0104
SO ₂		5.880E-04	0.0001	0.0006
TOC		0.358	0.0859	0.3763
Methane		0.230	0.0552	0.2417
VOC ³		0.0296	0.0071	0.0311
HAPS				
Benzene		1.58E-03	3.79E-04	1.66E-03
Ethylbenzene		2.48E-05	5.95E-06	2.61E-05
Formaldehyde		2.05E-02	4.92E-03	2.15E-02
Naphthalene		9.71E-05	2.33E-05	1.02E-04
Toluene		5.58E-04	1.34E-04	5.86E-04
Xylene		1.95E-04	4.68E-05	2.05E-04

	lb/hr	tpy
TOTAL Uncontrolled VOC	0.007	0.031
TOTAL Uncontrolled NOx	0.316	1.383
TOTAL Uncontrolled HAPs	0.006	0.024
TOTAL Uncontrolled TAPs (Benzene)	0.000	0.002
TOTAL Uncontrolled TAPs (Formaldehyde)	0.005	0.022
TOTAL CO _{2e} Emissions	27.78	121.7

Enter Any Notes Here:

1. Emission factor used for the 24 HP engine's Nox is the 40 CFR 1054 standard indicated on the EPA's Certificate of Conformity. See Appendix P.
2. Emission factor for CO was the Certification CO level taken from EPA's Non-Road Small SI 2013 Certification issued by Office of Transportation and Air Quality, March 2014.
3. Emission factors for all other contaminants including VOCs were obtained from AP-42, Section 3.2 "Natural Gas-fired Reciprocating Engines", Table 3.2-3.



Bryan Research & Engineering, Inc.

Promax[®] 3.2

with
TSWEET[®] & PROSIM[®]

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Simulation Report

Client Name:	Antero Resources Corporation
Location:	West Virginia
Job:	Zinn Well Pad

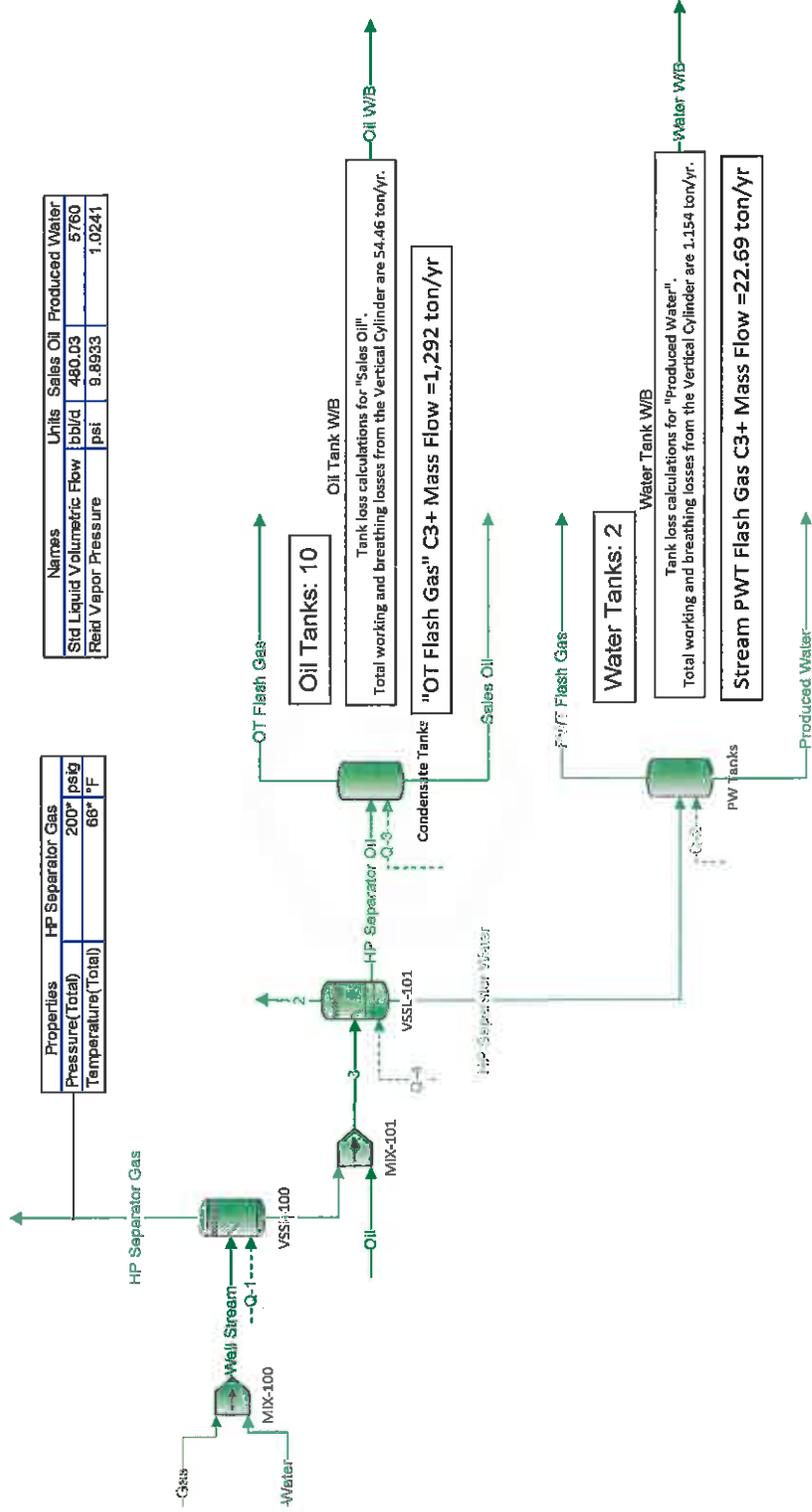
Project Name:	PROMAX SCENARIO 3
File Name:	ProMax@C:\ProMax\Antero\Scenario 3\PROMAX SCENARIO 3.PMX
ProMax Version:	3.2.13330.0

Report Created:	11/26/2014 12:41
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Stream HP Separator Gas C3+ Mass Flow = 2.012E+05 ton/yr

Properties		HP Separator Gas	
Pressure(Total)	200°	psig	
Temperature(Total)	66°	F	

Names		Units		Sales Oil		Produced Water	
Std Liquid Volumetric Flow	480.03	bbl/d				5760	
Reid Vapor Pressure	9.8933	psi				1,0241	



Oil Tanks: 10

Oil Tank W/B
 Tank loss calculations for "Sales Oil".
 Total working and breathing losses from the Vertical Cylinder are 54.46 ton/yr.

"OT Flash Gas" C3+ Mass Flow = 1,292 ton/yr

Water Tanks: 2

Water Tank W/B
 Tank loss calculations for "Produced Water".
 Total working and breathing losses from the Vertical Cylinder are 1.154 ton/yr.

Stream PWT Flash Gas C3+ Mass Flow = 22.69 ton/yr

Process Streams	Well Stream	HP Separator Gas	HP Separator Water	HP Separator Oil	DT Flash Gas	Sales Oil	Gas	Water	Oil	Produced Water	PVT Flash Gas	Oil WGR	Water WGR	1	2	3
Phase: Heavy Liquid	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched	Sched
Property	Units															
Temperature	°F															
Pressure	psig	66.0														
Mass Fraction Water	%	200														
Mass Fraction Light Liquid	%	0														
Mass Fraction Heavy Liquid	%	0														
Separator Height	ft	100														
Mass Fraction	wt-%	62.3														
Water Flow	lb/hr	0.0														
Mass Fraction	wt-%	0.0														
Water Volume Flow	MMBtu/hr	0.0														
Legal Volume Flow	MMBtu/hr	0.0														
Separator Volume Flow	MMBtu/hr	0.0														
Separator Volume Flow	MMBtu/hr	0.011														
Separator Volume Flow	MMBtu/hr	0.888														
Separator Volume Flow	MMBtu/hr	10.0														
Separator Volume Flow	MMBtu/hr	0.0														
Separator Volume Flow	MMBtu/hr	4829.7														
Separator Volume Flow	MMBtu/hr	1.0														
Separator Volume Flow	MMBtu/hr	1.26														
Separator Volume Flow	MMBtu/hr	1.0														
Separator Volume Flow	MMBtu/hr	0.1														
Separator Volume Flow	MMBtu/hr	0.3														
Separator Volume Flow	MMBtu/hr	0.005														
Separator Volume Flow	MMBtu/hr	0.4														
Separator Volume Flow	MMBtu/hr	-1064.1														
Separator Volume Flow	MMBtu/hr	50.7														
Separator Volume Flow	MMBtu/hr	9.1														

0.0059161
0.0002660
0.432697
0.0042681
0.133728
0.133286
0.167199
0.0142734
0.0331676

70.8791
200
0
0
100
18.0167
42.2596
4626.97
8493.2
1.36092
5.77295
42.4698
9.7811
0.0109167
0.938165
10.0435
473.758
4825.15
0.862977
1.22577
0.887182
0.869512
0.248859
0.0063174
0.500983
-181.13
50.7220
9.0

Attachment J

**Air Quality Permit Notice
Notice of Application
Zinn Well Pad
Antero Resources Corporation
Ritchie County, West Virginia**

Notice is given that Antero Resources Corporation has applied to the West Virginia Department of Environmental Protection, Division of Air Quality, for a General Permit Registration for an Oil and Natural Gas facility located near 3.5 miles north from the intersection of WV-74 N/Mountain Dr and Marsh Run in Ritchie County, West Virginia.

The latitude and longitude coordinates are: 39.320242 degrees N and -80.938208 degrees W

The applicant estimates the potential to discharge the following Regulated Air Pollutants will be:

Pollutants	TOTALS (tpy):
VOC	51.5330
NO _x	9.6433
CO _{2e}	14831.5000
CO	31.6614
SO ₂	0.0386
PM _{2.5}	0.6014
PM ₁₀	3.7261
Lead	4.13E-05
Total HAPs	3.4212
Benzene	0.0863
Formaldehyde	0.0263
Xylenes	0.2891

Startup of operation is planned to begin in August 2015. Written comments will be received by the West Virginia Department of Environmental Protection, Division of Air Quality, 601 57th Street, SE, Charleston, WV 25304, for at least 30 calendar days from the date of publication of this notice.

Any questions regarding this permit application should be directed to the DAQ at (304) 926-0499, extension 1227, during normal business hours.

Dated this the __ day of _____, 2014

By: Antero Resources Corporation
Donald Gray
Environmental and Regulatory Manager
1615 Wynkoop Street
Denver, CO 80202

Attachment K

Electronic Submittal

Attachment K

**Electronic Submittal
Zinn Well Pad
Antero Resources Corporation
Ritchie County, West Virginia**

No electronic submission was made.

Attachment L

General Permit Registration Application Fee

Attachment M

Siting Criteria Waiver

Attachment M

Siting Waiver

Zinn Well Pad

Antero Resources Corporation

Ritchie County, West Virginia

A Siting Waiver form is not required because there are no occupied dwelling structures within 300 feet of Zinn Well Pad.

Attachment N

Material Safety Data Sheet

Attachment N**Description of Material Safety Data Sheets (MSDS)****Zinn Well Pad****Antero Resources Corporation****Ritchie County, West Virginia**

Three generic Material Safety Data Sheets (MSDS), and analysis of the condensate and produced water of a similar well with the same formation are provided. Antero Resources Corporation has developed its own MSDS for these materials.

1. **Natural Gas:** The MSDS for natural gas reflects pipeline quality odorized gas. This is essentially the same as the material delivered to the metering and downstream gathering lines from the Antero well pad.
2. **Condensate:** Condensate is the hydrocarbon liquid that has been separated from raw natural gas through the well pad gas production unit. The liquid is often characterized as having a gasoline-like odor and consistency.
3. **Produced Water:** Produced water is primarily groundwater with residual trace hydrocarbons that has been withdrawn from the ground during the gas extraction process and then separated from the natural gas and condensate in the gas production units.

Material Name: Dry Field Natural Gas

US GHS

SYNONYMS: CNG, Natural Gas, Methane.

***** Section 1 – PRODUCT AND COMPANY IDENTIFICATION *****

PRODUCT NAME:	Dry Field Natural Gas	EMERGENCY PHONE:	(800) 878-1373
PRODUCT CODES:	CAS Reg. No. 68410-63-9	AFTER HOURS:	(800) 878-1373
PRODUCER:	Antero Resources		
ADDRESS:	1615 Wynkoop Street Denver, Colorado 80202	CHEMTREC PHONE:	(800) 424-9300

***** Section 2 – HAZARDS IDENTIFICATION *****

GHS Classification:

Flammable Gas – Category 1.

Gases Under Pressure – Gas.

Specific Target Organ Systemic Toxicity (STOT) – Single Exposure Category 2.

GHS LABEL ELEMENTS

Symbol(s)



Signal Word

Danger

Hazard Statements

Extremely flammable gas.

Contains gas under pressure, may explode if heated.

May cause damage to central nervous and respiratory systems.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking.

Do not breathe fume/gas/mist/vapors/spray.

Wash thoroughly after handling.

Do not eat, drink or smoke when using this product.

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

Response

Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.

If exposed to gas, or concerned about possible exposure: Call a POISON CENTER or doctor/physician.

Storage

Protect from sunlight. Store in a well-ventilated place.

Store in a secure area.

Disposal

Dispose of contents/containers in accordance with local/regional/national/international regulations.

*** Section 3 – COMPOSITION / INFORMATION ON INGREDIENTS ***

CAS #	Component	Percent
74-82-8	Methane	95.01
78-84-0	Ethane	3.99
74-98-6	Propane	0.32
106-97-8	Butanes	0.07
109-66-0	Pentanes	0.02
110-54-3	Hexanes	0.01
7727-37-9	Nitrogen	0.35
124-38-9	Carbon Dioxide	0.19
7782-44-7	Oxygen	0.03

Because natural gas is a natural product, composition can vary greatly.

*** Section 4 – FIRST AID MEASURES ***

First Aid: Eyes

In case of freeze burn, cover eyes to protect from light. Flush eyes with running water for at least fifteen (15) minutes. Following flushing, seek medical attention.

First Aid: Skin

Remove contaminated clothing. In case of blistering, frostbite or freeze burns, seek immediate medical attention.

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

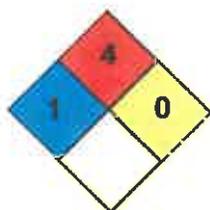
First Aid: Ingestion

Risk of ingestion is extremely low. However, if oral exposure occurs, seek immediate medical assistance.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

*** Section 5 – FIRE FIGHTING MEASURES ***



NFPA 704 Hazard Class

Health: 1 Flammability: 4 Instability: 0 (0-Minimal, 1-Slight, 2-Moderate, 3-Serious, 4-Severe)

General Fire Hazards

See Section 9 for Flammability Properties.

Forms a flammable mixture with air. If released, the resulting vapors will disperse with the prevailing wind. If a source of ignition is present where the vapor exists at a 5 – 15% concentration in air, the vapor will burn along the flame front toward the source of the fuel.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

Any extinguisher suitable for Class B fires, dry chemical, fire fighting foam, CO₂, and other gaseous agents. However, fire should not be extinguished unless flow of gas can be immediately stopped.

Unsuitable Extinguishing Media

None.

Fire Fighting Equipment / Instructions

Gas fires should not be extinguished unless flow of gas can be immediately stopped. Shut off gas source and allow gas to burn out. If spill or leak has not ignited, determine

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

*** Section 7 – HANDLING AND STORAGE ***

Handling Procedures

Keep away from flame, sparks and excessive temperatures. Bond and ground containers. Use only in well ventilated areas.

Storage Procedures

Natural gas will be contained in the pipeline. Keep away from flame, sparks, excessive temperatures and open flames. Empty pipeline segments may contain explosive residues from natural gas liquids. Do not cut, heat, weld or expose containers to sources of ignition sections of pipeline unless the sections have been purged of natural gas residues.

Incompatibilities

Keep away from strong oxidizers, ignition sources and heat.

*** Section 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION ***

Component Exposure Limits

Methane (74-82-8)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases : Alkane C1-4)

Ethane (74-84-0)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases : Alkane C1-4)

Propane (74-98-6)

ACGIH: 2500 ppm TWA (listed under Aliphatic hydrocarbon gases : Alkane C1-4)

Butane (106-97-8)

ACGIH: 800 ppm TWA (listed under Aliphatic hydrocarbon gases : Alkane C1-4)

Pentanes (109-66-0)

ACGIH: 600 ppm TWA (listed under Pentane, all isomers)

Hexanes (110-54-3)

ACGIH: 50 ppm TWA (listed under n-Hexane)

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

Nitrogen (7727-37-9)

Simple Asphyxiant

Carbon Dioxide (124-38-9)

ACGIH: 5000 ppm TWA (listed under Carbon Dioxide)

Oxygen (7782-44-7)

N/A – Necessary for life

Engineering Measures

Use adequate ventilation to keep gas and vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces. Use explosion-proof equipment and lighting in classified / controlled areas.

Personal Protective Equipment: Respiratory

Use a NIOSH approved positive-pressure, supplied air respirator with escape bottle or self-contained breathing apparatus (SCBA) for gas concentrations above occupational exposure limits, for potential for uncontrolled release, if exposure levels are not known, or in an oxygen-deficient atmosphere. CAUTION: Flammability limits (i.e., explosion hazard should be considered when assessing the need to expose personnel to concentrations requiring respiratory protection.

Personal Protective Equipment: Hands

Use cold-impervious, insulating flame-retardant (FR) gloves where contact with pressurized gas may occur.

Personal Protective Equipment: Eyes

Where there is a possibility of pressurized gas contact, wear splash-proof safety goggles and faceshield.

Personal Protective Equipment: Skin and Body

Where contact with pressurized gas may occur, wear flame-retardant (FR) and a faceshield.

***** Section 9 – PHYSICAL AND CHEMICAL PROPERTIES *****

Appearance:	Colorless	Odor:	Odorless to slight petroleum odor
Physical State:	Gas	pH:	ND
Vapor Pressure:	40 atm @ -187°F (-86°C)	Vapor Density:	0.6
Boiling Point:	-259°F (-162°C)	Melting Point:	ND
Solubility (H₂O):	3.5%	Specific Gravity:	0.4 @ -263°F (-164°C)

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

Evaporation Rate:	ND	VOC:	ND
Octanol / H ₂ O Coeff.:	ND	Flash Point:	Flammable Gas
Flash Point Method:	N/A		
Lower Flammability Limit:	3.8 – 6.5	Upper Flammability Limit:	13-17
(LFL):		(UFL):	
Auto Ignition:	900-1170°F (482-632°C)	Burning Rate:	ND

*** Section 10 – CHEMICAL STABILITY & REACTIVITY INFORMATION ***

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Keep away from strong oxidizers, ignition sources and heat.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

*** Section 11 – TOXICOLOGICAL INFORMATION ***

Acute Toxicity

A: General Product Information

Methane and ethane, the main components of natural gas, are considered practically inert in terms of physiological effects. At high concentrations these materials act as simple asphyxiants and may cause death due to lack of oxygen.

B. Component Analysis – LD50/LC50

Methane (74-82-8)

Inhalation LC50 Mouse 326 g/m³ 2h

Ethane (74-84-0)

Inhalation LC50 Rat 658 mg/l 4h

Propane (74-98-6)

Inhalation LC50 Rat 658 mg/l 4h

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

Butanes (106-97-8)

Inhalation LC50 Rat 658 g/m³ 4h

Pentanes (109-66-0)

Inhalation LD50 Rat 364 g/m³ 4h

Hexanes (110-54-3)

Inhalation LC50 Rat > 20 mg/l 4h

Nitrogen (7727-37-9)

Simple Asphyxiant

Carbon Dioxide (124-38-9)

Inhalation LC50 Human 100,000 ppm 1minute

Oxygen (7782-44-7)

N/A – Necessary for life

Potential Health Effects: Skin Corrosion Property / Stimulativeness

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

This product is not reported to have any mutagenic effects.

Carcinogenicity

A: General Product Information

This product is not reported to have any carcinogenic effects.

B: Component Carcinogenicity

None of this product's components are listed by ACGIH, IARC, OSHA, NIOSH, or NTP.

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product may cause damage to the heart.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ repeat effects.

Aspiration Respiratory Organs Hazard

This product is not reported to have any aspiration hazard effects.

SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

*** Section 12 – ECOLOGICAL INFORMATION ***

Ecotoxicity

A: General Product Information

Keep gas and vapors out of sewers, drainage areas, and waterways. Report spills and releases, as applicable under Federal and State regulations.

B: Component Analysis – Ecotoxicity – Aquatic Toxicity

No ecotoxicity data are available for this product's components.

Persistence / Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

*** Section 13 – DISPOSAL CONSIDERATIONS ***

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment Recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents / container in accordance with local / regional / national / international regulations.

*** Section 14 – TRANSPORTATION INFORMATION ***

DOT Information

Shipping Name: Natural Gas, Compressed

UN #: 1971 **Hazard Class:** 2.1

Placard:



SAFETY DATA SHEET

Material Name: Dry Field Natural Gas

US GHS

***** Section 15 – REGULATORY INFORMATION *****

Regulatory Information

Component Analysis

None of this products components are listed under SARA Section 302 (40 CFR 355 Appendix A).

n-hexane is listed under SARA Section 313 (40 CFR 372.65). However the concentration of this component is approximately 0.01 % in compressed natural gas and is therefore far under the reporting threshold for the chemical.

n-hexane is listed under CERCLA (40 CFR 302.4). However the concentration of this component is approximately 0.01 % in compressed natural gas and is therefore far under the reporting threshold for the chemical.

SARA Section 311/312 – Hazard Classes

<u>Acute Health</u>	<u>Chronic Health</u>	<u>Fire</u>	<u>Sudden Release of Pressure</u>	<u>Reactive</u>
---	---	X	X	---

SARA Section 313 – Supplier Notification

This product contains one chemical (n-Hexane) that is subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-to-know act (EPCRA) of 1986 and of 40 CFR 372. However the concentration of this component is approximately 0.01 % in compressed natural gas and is therefore far under the reporting threshold for the chemical.

State Regulations

Component Analysis – State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
Methane	74-82-8	No	No	Yes	Yes	Yes	No
Ethane	78-84-0	No	No	Yes	Yes	Yes	No
Propane	74-98-6	No	No	Yes	Yes	Yes	Yes
Butane	106-97-8	Yes	No	Yes	Yes	Yes	Yes
Pentanes	109-66-0	Yes	No	Yes	Yes	Yes	Yes
Hexanes	110-54-3	Yes	Yes	Yes	Yes	Yes	Yes
Nitrogen	7727-37-9	No	No	No	No	No	No
Carbon Dioxide	124-38-9	Yes	No	Yes	Yes	Yes	Yes
Oxygen	7782-44-7	No	No	No	No	No	No

SAFETY DATA SHEET

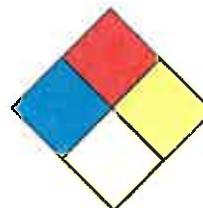
Material Name: Dry Field Natural Gas

US GHS

*** Section 16 – OTHER INFORMATION ***

NFPA® Hazard Rating

Health	1
Fire	4
Reactivity	0



HMIS® Hazard Rating

Health	1	Moderate
Fire	4	Severe
Physical	0	Minimal

* Chronic

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; NJTSR = New Jersey Trade Secret Registry.

Literature References

None

Other Information

The information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Date of Preparation: January 30, 2014

Date of Last Revision: March 4, 2014

End of Sheet

Material Name: Natural Gas Condensate

US GHS

SYNONYMS: Drips; Condensate; Field Condensate; Gas Well Condensate; High Pressure Inlet Liquids; Lease Condensate; Natural Gas Liquids; Pipeline Liquids

***** Section 1 – PRODUCT AND COMPANY IDENTIFICATION *****

PRODUCT NAME: Natural Gas Condensate	EMERGENCY PHONE: (800) 878-1373
PRODUCT CODES: 64741-47-5	AFTER HOURS: (800) 878-1373
PRODUCER: Antero Resources	
ADDRESS: 1615 Wynkoop Street Denver, Colorado 80202	CHEMTREC PHONE: (800) 424-9300

***** Section 2 – HAZARDS IDENTIFICATION *****

GHS Classification:

Flammable Liquids – Category 2.
Acute Toxicity Inhalation – Category 3
Germ Cell Mutagenicity – Category 1B
Carcinogenicity – Category 1A
Specific Target Organ Systemic Toxicity (STOT) – Single Exposure Category 3
Specific Target Organ Systemic Toxicity (STOT) – Repeat Exposure Category 1
Aspiration Toxicity – Category 1
Toxic to the Aquatic Environment Acute – Category 3

GHS LABEL ELEMENTS

Symbol(s)



Signal Word

Danger

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

Hazard Statements

Highly flammable liquid and vapor.

Toxic if inhaled.

May cause genetic defects.

May cause cancer.

May cause respiratory irritation.

May cause drowsiness or dizziness.

May cause damage to organs (liver, kidneys, blood, nervous system, and skin) through prolonged or repeated exposure.

May be fatal if swallowed and enters airways.

Harmful to aquatic life.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking.

Keep container tightly closed.

Ground/bond container and receiving equipment.

Use explosion-proof electrical/ventilating/lighting equipment.

Use only non-sparking tools.

Take precautionary measures against static discharge.

Wear protective gloves/protective clothing/eye protection/face protection.

Do not breathe gas/mist/vapors/spray.

Do not handle until all safety precautions have been read and understood.

Wash thoroughly after handling.

Do not eat, drink or smoke when using this product.

Use only outdoors or in a well-ventilated area.

Avoid release to the environment.

Response

If on SKIN (or hair): Wash with plenty of soap and water. Remove / Take off all contaminated clothing immediately. Rinse skin with water/shower.

If INHALED: Remove victim to fresh air and keep comfortable for breathing. Call a poison center/doctor if the victim feels unwell.

If SWALLOWED: Immediately call a poison center or doctor / physician. Do not induce vomiting.

If exposed or concerned: Get medical advice/attention.

In case of fire: Use water spray, fog or fire-fighting foam.

Storage

Store in a well-ventilated place. Keep cool.

Store in a secure area.

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

Disposal

Dispose of contents/containers in accordance with local/regional/national/international regulations.

*** Section 3 – COMPOSITION / INFORMATION ON INGREDIENTS ***

CAS #	Component	Percent
111-65-9	Octanes	25 - 95
142-82-5	Heptanes	25 - 95
110-54-3	Hexanes as n-Hexane	25 - 95
109-66-0	Pentanes as n-Pentane	5 - 70
106-97-8	N-butane	0 - 45
74-98-6	Propane	0 - 15
78-84-0	Ethane	0 - 5
71-43-2	Benzene	< 1
108-88-3	Toluene	< 1
1330-20-7	m-,o-,p-Xylene	< 1

Because natural gas condensate is a natural product, composition can vary greatly.

*** Section 4 – FIRST AID MEASURES ***

First Aid: Eyes

Flush eyes with clean running water for at least fifteen (15) minutes. Following flushing, seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops. Wash contaminated clothing before reuse.

First Aid: Ingestion (swallowing)

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean the victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

SAFETY DATA SHEET

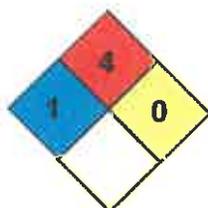
Material Name: Natural Gas Condensate

US GHS

First Aid: Inhalation (breathing)

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

***** Section 5 – FIRE FIGHTING MEASURES *****



NFPA 704 Hazard Class

Health: 1 Flammability: 4 Instability: 0 (0-Minimal, 1-Slight, 2-Moderate, 3-Serious, 4-Severe)

General Fire Hazards

See Section 9 for Flammability Properties.

Extremely flammable. Vapors may be ignited rapidly when exposed to heat, spark, open flame, or other source of ignition (e.g., static electricity, pilot lights, mechanical / electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Flammable vapors can burn in the open or explode in confined spaces. Vapors are heavier than air, and may travel distances to an ignition source and flash back. Runoff to sewer systems may cause fire or explosion.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, firefighting foam, water spray, carbon dioxide (CO₂), or other gaseous extinguishing agents. Use caution when applying CO₂ in confined spaces.

LARGE FIRES: Water spray, fog or fire-fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

Fire Fighting Equipment / Instructions

Small fires in the beginning stage may typically be extinguished using handheld portable fire extinguishers and other firefighting equipment. Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied firefighting foam.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full face piece and full protective clothing.

*** Section 6 – ACCIDENTAL RELEASE MEASURES ***

Recovery and Neutralization

Contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Notify relevant authorities in accordance with all applicable regulations. Immediate cleanup of any spill is recommended. Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal. If spilled on water remove with appropriate methods (e.g. skimming, booms or absorbents). In case of soil contamination, remove contaminated soil for remediation or disposal, in accordance with local regulations.

Recommended measures are based on the most likely spillage scenarios for this material; however local conditions and regulations may influence or limit the choice of appropriate actions to be taken.

Emergency Measures

Evacuate nonessential personnel and secure all ignition sources. No road flares, smoking or flames in hazard area. Consider wind direction. Stay upwind and uphill, if possible. Vapor cloud may be white, but color will dissipate as cloud disperses. Fire and explosion hazard is still present.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8). Extremely flammable. Spillages of liquid product will create a fire hazard and may form an explosive atmosphere. Keep all sources of

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

ignition and hot metal surfaces away from spill/release if safe to do so.

The use of explosion-proof electrical equipment is recommended. Stay upwind and away from spill/release. Avoid direct contact with material. For large spillages, notify persons downwind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate protective equipment, including respiratory protection, as conditions warrant (see Section 8). See Sections 2 and 7 for additional information on hazards and precautionary measures.

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of firefighting foam may be useful in certain situations to reduce vapors. If spill occurs on water notify appropriate authorities and advise shipping of any hazard. Spills into or upon navigable waters, the contiguous zone, or adjoining shorelines that cause a sheen or discoloration on the surface of the water, may require notification of the National Response Center (phone number 800-424-8802).

Prevention of Secondary Hazards

None

*** Section 7 – HANDLING AND STORAGE ***

Handling Procedures

Keep away from flame, sparks and excessive temperatures. Bond and ground containers. Use non-sparking tools. Use only outdoors or in well ventilated areas. Wear protective gloves / clothing and eye / face protection. Wash thoroughly after handling. Use good personal hygiene practices and wear appropriate personal protective equipment (see section 8).

Storage Procedures

Store only in approved containers. Bond and ground containers. Keep away from flame, sparks, excessive temperatures and open flames. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks."

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

Incompatibilities

Keep away from strong oxidizers, ignition sources and heat.

*** Section 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION ***
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Component Exposure Limits

Octanes (111-65-9)

ACGIH: 300 ppm TWA (listed under Octane, all isomers)

Heptanes (142-82-5)

ACGIH: 400 ppm TWA (listed under n-Heptane)

n-Hexane (110-54-3)

ACGIH: 20 ppm TWA (listed under n-Hexane)

n-Pentane (109-66-0)

ACGIH: 600 ppm TWA (listed under Pentane, all isomers)

n-Butane (106-97-8)

ACGIH: 600 ppm TWA (listed under n-Butane)

Propane (74-98-6)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases C1-C4)

Ethane (74-84-0)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases C1-C4)

Benzene (71-43-2)

ACGIH: 0.5 ppm (TWA); NIOSH: 0.1 ppm (TWA); OSHA 1 ppm (TWA)

Toluene (108-88-3)

ACGIH: 20 ppm TWA (listed under Toluene)

m-, o-, p-Xylene (1330-20-7)

ACGIH: 100 ppm TWA (listed under Xylene o, m & p isomers)

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Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces. Use explosion-proof equipment and lighting in classified / controlled areas.

Personal Protective Equipment: Respiratory

Use a NIOSH-approved positive-pressure, supplied air respirator with escape bottle or self-contained breathing apparatus (SCBA) for gas concentrations above occupational exposure limits, for potential for uncontrolled release, if exposure levels are not known, or in an oxygen-deficient atmosphere (oxygen content less than 19.5 percent). A respiratory program that meets or is equivalent to OSHA 29 CFR 1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant the use of a respirator.

If benzene concentrations equal or exceed applicable exposure limits, OSHA requirements for personal protective equipment, exposure monitoring, and training may apply (29 CFR 1910.1028 – Benzene).

CAUTION: Flammability limits (i.e., explosion hazard should be considered when assessing the need to expose personnel to concentrations requiring respiratory protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile or neoprene are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying. Eye protection that meets or exceeds ANSI Z.87.1 is recommended. Depending on conditions of use, a face shield may be necessary.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

Hygiene Measures

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use gasoline or solvents (naphtha, kerosene, etc.) for washing this product from

SAFETY DATA SHEET

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exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

*** Section 9 – PHYSICAL AND CHEMICAL PROPERTIES ***

Appearance:	Colorless to straw yellow	Odor:	Aromatic, Gasoline;
Physical State:	Liquid	pH:	ND
Vapor Pressure:	110 – 200 psia (Reid VP) @ 100°F/37.8°C	Vapor Density (air = 1):	> 1
Boiling Point:	Approx. 85 - 437°F (39 – 200°C)	Melting Point:	ND
Solubility (H2O):	Insoluble to slightly soluble	Specific Gravity:	AP 0.62-0.76 (varies)
Evaporation Rate:	High	VOC:	ND
Octanol / H2O Coeff.:	ND	Flash Point:	-40°F -40°C
Flash Point Method:	Tag Closed Cup (TCC)		
Lower Flammability Limit: (LFL):	ND (NFPA Gasoline 1.4)	Upper Flammability Limit: (UFL):	ND (NFPA Gasoline 7.6)
Auto Ignition:	AP 480°F (250°C)	Burning Rate:	ND

*** Section 10 – CHEMICAL STABILITY & REACTIVITY INFORMATION ***

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Keep away from ignition sources and high temperatures.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

*** Section 11 – TOXICOLOGICAL INFORMATION ***
--

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B. Component Analysis – LD50/LC50

Octanes (111-65-9)

Inhalation LC50 rat = 118,000 mg/m³ / 4H

Heptanes (142-82-5)

Inhalation LC50 rat = 103,000 mg/m³ / 4H

Hexanes as n-Hexane (110-53-3)

Inhalation LC50 rat = 48,000 ppm / 4H

Pentanes as n-Pentane (109-66-0)

Inhalation LC50 rat = 364,000 mg/m³ / 4H

Butanes as n-Butane (106-97-8)

Inhalation LC50 rat 658,000 mg/l / 4H

Propane (74-98-6)

Inhalation LC50 Rat > 800,000 ppm / 0.25H

Ethane (74-84-0)

Inhalation LC50 Rat 658,000 mg/l / 4H

Benzene (71-43-2)

Inhalation LC50 Rat 44,700 mg/m³ /

Toluene (108-88-3)

Inhalation LD50 Rat 12/5 mg/l / 4H

m-, o-, p-Xylene (1330-20-7)

Inhalation LC50 Rat 5000 ppm / 4H

Potential Health Effects: Skin Corrosion Property / Stimulativeness

May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

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Potential Health Effects: Eye Critical Damage / Stimulativeness

Contact with eyes may cause moderate irritation.

Potential Health Effects: Ingestion (swallowing)

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

Potential Health Effects: Inhalation (breathing)

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

Respiratory Organs Sensitization / Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

May cause genetic defects. Some crude oils and crude oil fractions have been positive in mutagenicity studies.

Carcinogenicity

A: General Product Information

May cause cancer.

This product contains benzene, although at very low concentrations. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

Exposure to light hydrocarbons in the same boiling range as this product have been associated in animal studies with effects to the central nervous system, peripheral nervous system, liver, and kidneys. The significance of these animal models to predict similar human response is uncertain. Observing good work practices and personal hygiene procedures (Sections 7 and 8) can minimize potential risks to humans.

B: Component Carcinogenicity

Benzene (71-43-2)

ACGIH:	A1 - Confirmed Human Carcinogen
OSHA:	5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH:	potential occupational carcinogen
NTP:	Known Human Carcinogen (Select Carcinogen)

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Material Name: Natural Gas Condensate

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IARC: Monograph 100F [in preparation]; Supplement 7 [1987]; Monograph 29 [1982] (Group 1 (carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

May cause damage to organs (liver, kidneys, blood, nervous system and skin) through prolonged or repeated exposure.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

*** Section 12 – ECOLOGICAL INFORMATION ***

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable under Federal and State regulations.

B: Component Analysis – Ecotoxicity – Aquatic Toxicity

Benzene (71-43-2)

Test and Species	Conditions
96 Hr LC50 Pimephales promelas	10.7-14.7 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	5.3 mg/L [flow-through]
96 Hr LC50 Lepomis macrochirus	22.49 mg/L [static]
96 Hr LC50 Poecilia reticulata	28.6 mg/L [static]
96 Hr LC50 Pimephales promelas	22330-41160 µg/L [static]
96 Hr LC50 Lepomis macrochirus	70000-142000 µg/L [static]
72 Hr EC50 Pseudokirchneriella subcapitata	29 mg/L
48 Hr EC50 Daphnia magna	8.76 - 15.6 mg/L [static]
48 Hr EC50 Daphnia magna	10 mg/L

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Material Name: Natural Gas Condensate

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Natural Gas condensates (68919-39-1)

Test and Species	Conditions
96 Hr LC50 Alburnus alburnus	119 mg/L [static]
96 Hr LC50 Cyprinodon variegatus	82 mg/L [static]
72 Hr EC50 Pseudokirchneriella subcapitata	56 mg/L
24 Hr EC50 Daphnia magna	170 mg/L

Persistence / Degradability

No information available

Bioaccumulation

No information available

Mobility in Soil

No information available

***** Section 13 – DISPOSAL CONSIDERATIONS *****

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment Recommendations.

Disposal of Contaminated Containers or Packaging

Recover or recycle if possible. It is the responsibility of the generator to determine the toxicity and physical properties of the material generated so as to properly classify the waste and ensure disposal methods comply with applicable regulations.

This material, if discarded should be fully characterized for ignitability (D001), reactivity (D003) and benzene (D018) prior to disposal (40 CFR261). Use which results in chemical or physical change or contamination may subject it to regulation as a hazardous waste. Along with properly characterizing all waste materials, consult state and local regulations regarding the proper disposal of this material. Do not dispose of by draining onto the ground. This will result in soil and groundwater contamination. Waste arising from spillage or tank cleaning should be disposed of in accordance with applicable regulations.

Container contents should be completely used and containers should be emptied prior to discard. Container rinsate could be considered a RCRA hazardous waste and must be disposed of with care and in full compliance with federal, state and local regulations. Larger empty containers, such as drums, should be returned to the distributor or to a qualified drum reconditioner. To assure proper disposal of smaller empty containers, consult with state and local regulations and disposal authorities.

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

*** Section 14 – TRANSPORTATION INFORMATION ***

DOT Information

Shipping Name: Petroleum Products, n.o.s. (condensate)

UN #: 1268 Hazard Class: 3

Additional Info.: Dependent on the product's properties, the shipper may also elect to classify as Gasoline UN1203 or Petroleum Crude Oil UN1267 - reference 49 CFR 172.101 for further description (e.g., packing group determination).

Placard:



*** Section 15 – REGULATORY INFORMATION ***

Regulatory Information

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Benzene (71-43-2)

SARA 313: 0.1% de minimis concentration

CERCLA: 10 lb final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule); 4.54 kg final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule)

SARA Section 311/312 – Hazard Classes

<u>Acute Health</u>	<u>Chronic Health</u>	<u>Fire</u>	<u>Sudden Release of Pressure</u>	<u>Reactive</u>
X	X	X	—	—

SARA SECTION 313 – SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

US GHS

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION PERCENT BY WEIGHT
Benzene (71-43-2)	<0.1 to 2

Canadian Regulatory Information

DSL/NDSL Inventory	This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the SDS contains all the information required by the Regulations.
Workplace Hazardous Materials Information System	B2 - Flammable Liquid D1A – Material Causing Immediate and Serious Toxic Effects - Very Toxic Material D2A: Material Causing Other Toxic Effects Very Toxic D2B - Material Causing Other Toxic Effects - Toxic Material

European Union Regulatory Information

Labeling	Product is dangerous as defined by the European Union Dangerous Substances / Preparations Directives. Contains: Low Boiling Point Naphtha
Symbol	F+ Extremely Flammable T Toxic N Dangerous for the Environment
Risk Phrases	R12-45-38-65-67-51/53 Extremely flammable. May cause cancer. Irritating to skin. Harmful: may cause lung damage if swallowed. Vapors may cause drowsiness and dizziness. Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
Safety Phrases	S16-53-45-2-23-24-29-43-62 Keep away from sources of ignition – No smoking. Avoid exposure – obtain special instructions before use. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). Keep out of reach of children. Do not breathe vapor. Avoid contact with skin. Do not empty into drains. In case of fire use foam/dry powder/CO2. If swallowed, do not induce vomiting: seek medical advice immediately and show this container or label.

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

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State Regulations

Component Analysis – State

The following components appear on one or more of the following state hazardous substances lists

Component	CAS	CA	MA	MN	NJ	PA	RI
Octanes	111-65-9	Yes	No	Yes	Yes	Yes	Yes
Heptanes	142-82-5	Yes	No	Yes	Yes	Yes	Yes
n-Hexane	110-54-3	Yes	Yes	Yes	Yes	Yes	Yes
n-Pentane	109-66-0	Yes	No	Yes	Yes	Yes	Yes
n-Butane	106-97-8	Yes	No	Yes	Yes	Yes	Yes
Propane	74-98-6	No	No	Yes	Yes	Yes	Yes
Ethane	78-84-0	No	No	Yes	Yes	Yes	No
Benzene	71-43-2	Yes	Yes	Yes	Yes	Yes	Yes
Toluene	108-88-3	Yes	Yes	Yes	Yes	Yes	Yes
m-, o-, p-Xylene	1330-20-7	Yes	Yes	Yes	Yes	Yes	Yes

The following statement(s) are provided under the California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65):

WARNING! This product contains a chemical known to the state of California to cause cancer.

WARNING! This product contains a chemical known to the state of California to cause Reproductive / developmental effects.

Component Analysis – WHMIS IDL

The following components are identified under the Canadian Hazardous Products Act

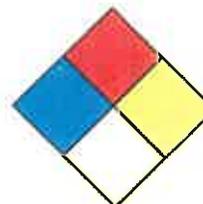
Ingredient Disclosure List:

Component	CAS #	Minimum Concentration
Benzene	71-43-2	0.1%

*** Section 16 – OTHER INFORMATION ***

NFPA® Hazard Rating

Health 1
Fire 4
Reactivity 0



HMIS® Hazard Rating

Health 1 Slight
Fire 4 Severe
Physical 0 Minimal
* Chronic

SAFETY DATA SHEET

Material Name: Natural Gas Condensate

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Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; NJTSR = New Jersey Trade Secret Registry.

Literature References

None

Other Information

The information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Date of Preparation: January 29, 2014

Date of Last Revision: March 4, 2014

End of Sheet



SAFETY DATA SHEET

Material Name: Produced Water

US GHS

SYNONYMS: Produced Brine Water, Brine, Brine Water, Formation Water

***** Section 1 – PRODUCT AND COMPANY IDENTIFICATION *****

PRODUCT NAME: Produced Water

EMERGENCY PHONE: (800) 878-1373

PRODUCT CODES: Mixture

AFTER HOURS: (800) 878-1373

PRODUCER: Antero Resources

ADDRESS: 1615 Wynkoop Street
Denver, Colorado 80202

CHEMTREC PHONE: (800) 424-9300

***** Section 2 – HAZARDS IDENTIFICATION *****

GHS Classification:

Eye Irritant – Category 2A.

GHS LABEL ELEMENTS

Symbol(s)



Signal Word

Warning

Hazard Statements

Causes serious eye irritation

Precautionary Statements

Prevention

Wear protective gloves/protective clothing/eye protection/face protection.

Response

If on SKIN (or hair): Rinse skin with water / shower. Remove / Take off all contaminated clothing immediately.

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Material Name: Produced Water

US GHS

If in EYES: Rinse cautiously with water for at least fifteen (15) minutes. Remove Contact Lenses, if present and easy to do. Continue rinsing.

If EYE irritation persists, get medical advice / attention.

Storage

Store in a secure area.

Disposal

Dispose of contents/containers in accordance with regulations.

***** Section 3 – COMPOSITION / INFORMATION ON INGREDIENTS *****

CAS #	Component	Percent
7732-18-5	Water	80
7647-14-5	Sodium Chloride	20

Because brine water is a natural product, composition can vary greatly.

***** Section 4 – FIRST AID MEASURES *****

First Aid: Eyes

Flush eyes with clean running water for at least fifteen (15) minutes. If irritation or redness develops from exposure, following flushing, seek medical attention.

First Aid: Skin

First aid is not required, normally. However, it is a good practice to wash any chemical from the skin.

First Aid: Ingestion (Swallowing)

First aid is not required, normally. If spontaneous vomiting occurs, lean the victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. If symptoms develop, seek medical attention.

First Aid: Inhalation (Breathing)

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

SAFETY DATA SHEET

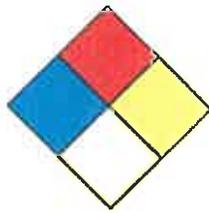
Material Name: Produced Water

US GHS

Most important symptoms and effects

None known or anticipated.

*** Section 5 – FIRE FIGHTING MEASURES ***



NFPA 704 Hazard Class

Health: 1 Flammability: 0 Instability: 0 (0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe)

General Fire Hazards

No fire hazards are expected.

General Fire Hazards

No unusual fire or explosion hazards are expected. If container is not properly cooled, it can rupture in the heat of a fire.

Extinguishing Media

The material is non-flammable. Use extinguishing agent suitable for the type of surrounding fire.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment / Instructions

Small fires in the beginning stage may typically be extinguished using handheld portable fire extinguishers and other firefighting equipment. Isolate area around container involved in fire and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from the immediate hazard area if it can be done safely. Cool equipment exposed to fire with water, if it can be done safely.

Hazardous Combustion Products

None Anticipated. See Section 9 for Flammable Properties including Flash Point and Flammable (Explosive) Limits

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

*** Section 6 – ACCIDENTAL RELEASE MEASURES ***

Recovery and Neutralization

Contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Notify relevant authorities in accordance with all applicable regulations. Immediate cleanup of any spill is recommended. Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal. If spilled on water remove with appropriate methods (e.g. skimming, booms or absorbents). In case of soil contamination, remove contaminated soil for remediation or disposal, in accordance with local regulations.

Recommended measures are based on the most likely spillage scenarios of this material. However, local conditions and regulations may influence or limit the choice of appropriate actions to be taken. See Section 13 for information on appropriate disposal.

Emergency Measures

The material is not considered hazardous. Nevertheless, evacuate nonessential personnel and secure the area. Stay upwind and uphill, if possible.

Personal Precautions and Protective Equipment

Stay upwind and away from the spill/release. Avoid direct contact with the material. For large spillages, notify persons downstream of the spill/release. Isolate the immediate hazard area and keep unauthorized personnel out. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking or absorbents, if possible. Do not flush down sewer or drainage systems. Use water sparingly to minimize environmental contamination and reduce disposal requirements. If a spill occurs on water, notify appropriate authorities and advise shipping of any hazard.

Prevention of Secondary Hazards

None

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

*** Section 7 – HANDLING AND STORAGE ***

Handling Procedures

Wash thoroughly after handling. Use good personal hygiene practices and wear appropriate personal protective equipment (see section 8).

Do not enter confined spaces such as tanks or pits without following proper entry procedures such as ASTM D-4276 and 29 CFR 1910.146. Do not wear contaminated clothing or shoes.

Storage Procedures

Keep container(s) tightly closed and properly labeled. Use and store this material in cool, dry, well ventilated areas. Store only in approved containers. Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage.

Incompatibilities

Keep away from excessive heat to prevent rupture of container.

*** Section 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION ***

Component Exposure Limits

Water (7732-18-5)

ACGIH: Not listed

Sodium Chloride (7647-14-5)

ACGIH: Not listed

Engineering Measures

If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits, additional engineering controls may be required.

Personal Protective Equipment: Respiratory

Emergencies or conditions that could result in significant airborne exposures may require the use of NIOSH approved respiratory protection. An industrial hygienist or other appropriate health and safety professional should be consulted for specific guidance under these situations.

A respiratory protection program that meets or is equivalent to OSHA 29 CFR

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant a respirator's use.

Personal Protective Equipment: Skin and Hands

The use of skin protection is not normally required; however, good industrial hygiene practice suggests the use of gloves or other appropriate skin protection whenever working with chemicals.

Personal Protective Equipment: Eyes

Safety glasses or goggles that meet or exceed ANSI Z-87.1 are recommended where there is a possibility of splashing or spraying.

Hygiene Measures

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse.

*** Section 9 – PHYSICAL AND CHEMICAL PROPERTIES ***

Appearance:	Clear to Brown	Odor:	Salty
Physical State:	Liquid	pH:	ND
Vapor Pressure:	< 0.36 psia @ 70°F / 21.1°C	Vapor Density:	> 1
Boiling Point:	212°F / 100°C	Melting Point:	2.4°F / -16.5°C
Solubility (H2O):	Complete	Specific Gravity:	1.1 @ 68°F / 20°C
Evaporation Rate:	Variable	VOC:	ND
Octanol / H2O Coeff.:	ND	Flash Point:	ND
Flash Point Method:	ND		
Lower Flammability Limit:	ND	Upper Flammability Limit:	ND
(LFL):		(UFL):	
Auto Ignition:	ND	Burning Rate:	ND

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

*** Section 10 – CHEMICAL STABILITY & REACTIVITY INFORMATION ***

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will react with alkali and alkaline metals to form flammable hydrogen gas.

Conditions to Avoid

Avoid contact with alkali metals (lithium, sodium, potassium), alkaline metals (beryllium, magnesium, calcium, strontium, and barium), and metallic hydrides like lithium aluminum hydride.

Hazardous Decomposition Products

Not anticipated under normal conditions of use.

Hazardous Polymerization

Not known to occur.

*** Section 11 – TOXICOLOGICAL INFORMATION ***

Acute Toxicity

A: General Product Information

Unlikely to be harmful.

B. Component Analysis – D50/LC50

Water (7732-18-5)

Oral LD50 Rat 90 g/kg

Sodium Chloride (7647-14-5)

Oral LD50 Rat 3 g/kg

Potential Health Effects: Skin Corrosion Property / Stimulativeness

May cause skin irritation with prolonged or repeated contact. Not expected to be a skin sensitizer.

Potential Health Effects: Eye Critical Damage / Stimulativeness

Contact with eyes may cause moderate irritation.

SAFETY DATA SHEET

Material Name: Produced Water

US GHS

Potential Health Effects: Ingestion

Ingestion may result in nausea, vomiting, diarrhea, abdominal cramps, and dehydration (thirst).

Potential Health Effects: Inhalation

No information available on the mixture. However, none of the components have been classified for respiratory sensitization (or are below the concentration threshold for classification).

Generative Cell Mutagenicity

Not expected to cause genetic effects.

Carcinogenicity

General Product Information

Not expected to cause cancer. This substance is not listed as a carcinogen by IARC, NTP or OSHA.

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

This product is not reported to have any specific target organ general toxicity multiple exposure effects.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

*** Section 12 – ECOLOGICAL INFORMATION ***
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Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas, and waterways. Report spills and releases, as applicable under Federal and State regulations.