UNDERGROUND INJECTION CONTROL (UIC) PERMIT APPLICATION PACKAGE CLASS 2 & 3

Office of Oil and Gas
601 57th Street, SE
Charleston, WV 25304
Phone: (304) 926-0450

"Promoting a healthy environment"

INSTRUCTIONS/GUIDANCE TO COMPLETE A CLASS 2 and CLASS 3 UNDERGROUND INJECTION CONTROL (UIC) PERMIT APPLICATION

A. GENERAL INSTRUCTIONS

The Office of Oil and Gas (OOG) has developed a comprehensive permit package and instruction/guidance document to assist in the preparation of a UIC permit application. Where possible, standardized forms have been created and identified as Appendices to the UIC application package. **NOTE** the instruction/guidance document identifies additional requirements to be submitted with the application.

B. FEES

The application fee for a UIC permit is $500.00. There will be an additional $50.00 fee for a groundwater protection plan (GPP).

C. SUBMITTAL

Please submit an original and a complete copy of the UIC permit application package along with the application fee of $550.00 to:

West Virginia Department of Environmental Protection
Office of Oil and Gas
Underground Injection Control (UIC)
601 57th Street, SE
Charleston, WV 25304

CHECKLIST FOR FILING A UIC PERMIT APPLICATION

Please utilize this checklist to ensure you have prepared, completed, and enclosed all required documentation and payment to ensure a timely review of your submittal.

Operator	HG Energy, LLC.		
Existing UIC Permit ID Number	2D0610317	UIC Well API Number	47-061-00317

Office of Oil and Gas Office Use Only	
Permit Reviewer	
Date Received	
Administratively Complete Date	
Approved Date	
Permit Issued	

Please check the fees and payment included.

Fees		Payment Type	
UIC Permit Fee: $500	✓	Check	✓
Groundwater Protection Plan (GPP) Fee: $50.00	✓	Electronic	
		Other	

Please check the items completed and enclosed.

- ✓ Checklist
- ✓ UIC-1
  - ✓ Section 1 – Facility Information
  - ✓ Section 2 – Operator Information
  - ✓ Section 3 – Application Information
  - ✓ Section 4 – Applicant/Activity Request and Type
  - ✓ Section 5 – Brief description of the Nature of the Business
  - ✓ CERTIFICATION
- ✓ Section 6 – Construction
  - ✓ Appendix A Injection Well Form
  - ✓ Appendix B Storage Tank Inventory
- ✓ Section 7 – Area of Review
  - ✓ Appendix C Wells Within the Area of Review

- [x] Appendix D Public Service District Affidavit
- [x] Appendix E Water Sources
- [ ] Appendix F Area Permit Wells
- [x] Section 8 – Geological Data on Injection and Confining Zones
- [x] Section 9 – Operating Requirements / Data
  - [x] Appendix G Wells Serviced by Injection Well
- [x] Section 10 – Monitoring
- [x] Section 11 – Groundwater Protection Plan (GPP)
  - [x] Appendix H Groundwater Protection Plan (GPP)
- [x] Section 12 – Plugging and Abandonment
- [x] Section 13 – Additional Bonding
- [x] Section 14 – Financial Responsibility
  - [x] Appendix I Financial Responsibility
- [x] Section 15 – Site Security Plan
  - [x] Appendix J Site Security for Commercial Wells
- [x] Section 16 – Additional Information
  - [x] Appendix K Other Permit Approvals

NOTE: For all 2D wells an additional bond in the amount of $5,000 is required.

Reviewed by (Print Name): Matthew J. McGuire

Reviewed by (Sign): _____

Date Reviewed: _____

SECTION 1-5

UIC-1
(4/25)

WEST VIRGINIA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS
601 57th Street, SE
Charleston, WV 25304
(304) 926-0450
www.dep.wv.gov/oil-and-gas

UNDERGROUND INJECTION CONTROL
(UIC)
PERMIT APPLICATION

UIC PERMIT ID # 2D0610317 API # 47-061-00317 WELL # Greer A-1

Section I. Facility Information

Facility Name: Greer A-1 SWD

Address: 1910 Snakehill Road

City: Masontown State: WV Zip: 26542

County: Monongalia

Location description:

From I-68, travel east on Earl L. Core Road for 2.3 miles. Make left onto Tyrone Road and travel for 2.8 miles. Make right onto Snake Hill Road and travel 4.4 miles. The facility is on the right at the intersection of Snake Hill Road and Shaffer Road. The Greer A-1 SWD is located Monongalia County near the border with Preston County, West Virginia. The site is at an elevation of approximately 2,066 feet with no surface water features within the vicinity of the site.

Location of well(s) or approximate center of field/project in UTM NAD 83 (meters):

Northing: 4,382,952 Easting: 600,591

Environmental Contact Information:

Name: Matt McGuire Title: ESHR Director

Phone: 304-420-1126 Email: mmcguire@hgenergyllc.com

Section 2. Operator Information

Operator Name: HG Energy, LLC.

Operator ID: 494497948

Address: 1910 Snakehill Road

City: Masontown State: **WV** Zip: 26542

County: Monongalia

Contact Name: Matt McGuire Contact Title: ESHR Director

Contact Phone: 304-420-1126 Contact Email: mmcguire@hgenergyllc.com

Section 3. Applicant Information

Ownership Status: ■ PRIVATE ☐ PUBLIC ☐ FEDERAL ☐ STATE
☐ OTHER (explain):

SIC code: ■ 1311 (2D, 2H, 2R) ☐ 1479 (3S) ☐ OTHER (explain):

Section 4. Applicant / Activity Request and Type:

A. Apply for a new UIC Permit: ☐ 2D ☐ 2H ☐ 2R ☐ 3S
B. Reissue existing UIC Permit: ■ 2D ☐ 2H ☐ 2R ☐ 3S
C. Modify existing UIC Permit: ☐ 2D ☐ 2H ☐ 2R ☐ 3S
(Submit only documentation pertaining to the modification request)
2D COMMERCIAL FACILITY: ■ YES ☐ NO

Section 5. Briefly describe the nature of business and the activities to be conducted:

HG Energy is an oil and gas producer. The Greer A-1 disposal well is used to dispose of HG Energy's produced water generated from oil and gas production in Monongalia and surrounding counties of West Virginia.

CERTIFICATION

CERTIFICATION

All permit applications must be signed by a responsible corporate officer for a corporation, by a general partner for a partnership, by the proprietor of a sole proprietorship, or by a principal executive or ranking elected official for a public agency, or a [1]duly authorized representative in accordance with 47CSR13-13.11.b.

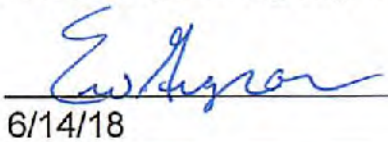
A. Name and title of person applying for permit:

Print Name: Eric Grayson

Print Title: Chief Operating Officer, Member

B. Signature and Date.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature: 

Date: 6/14/18

RECEIVED
Office of Oil and Gas
JUN 21 2018
WV Department of
Environmental Protection

[1] A person is a duly authorized representative if:

The authorization is made in writing by a person described in subdivision 47CSR13-13.11.a.

The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of the plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility.

The written authorization is submitted to the Director.

Promoting a healthy environment.

dep

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All permit applications must be signed by a responsible corporate officer for a corporation, by a general partner for a partnership, by the proprietor of a sole proprietorship, or by a principal executive or ranking elected official for a public agency, or a [1]duly authorized representative in accordance with 47CSR13-13.11.b.

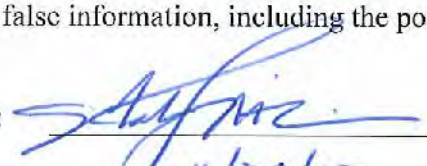
A. Name and title of person applying for permit:

Print Name: Matthew J. McGuire

Print Title: ESHR Director

B. Signature and Date.

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Signature: 

Date: 11/29/17

[1] A person is a duly authorized representative if:

The authorization is made in writing by a person described in subdivision 47CSR13-13.11.a.

The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of the plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility.

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Promoting a healthy environment.

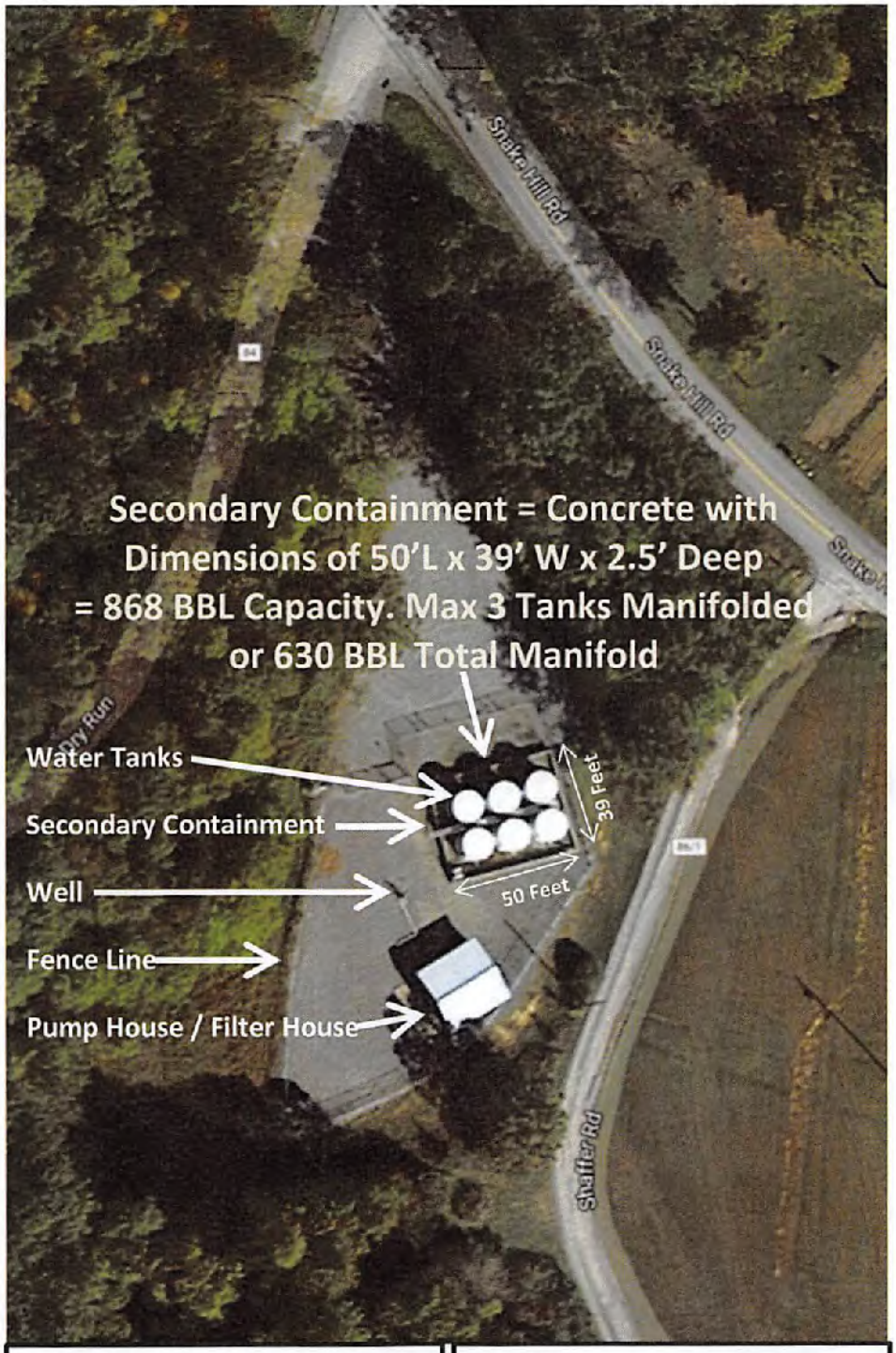
dep

SECTION 6

CONSTRUCTION

Section 6: Construction

1. Aerial Map

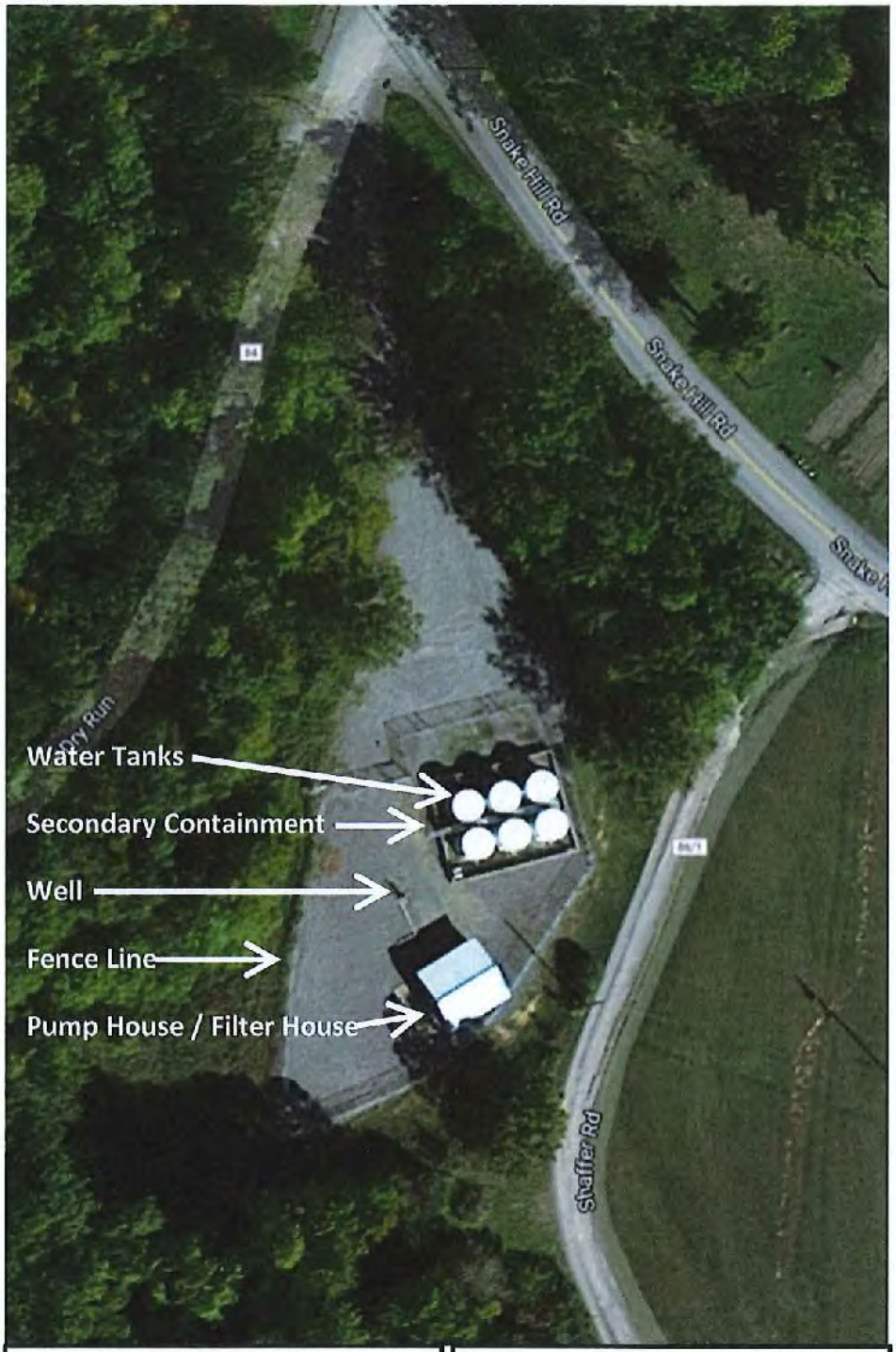


Greer A-1 SWD **Morgan District,** **Monongalia County, WV**	**LEGEND:** Aerial Map, 1" = 50' North ↑

RECEIVED
Office of Oil and Gas
JUN 21 2018
WV Department of
Environmental Protection

Section 6: Construction

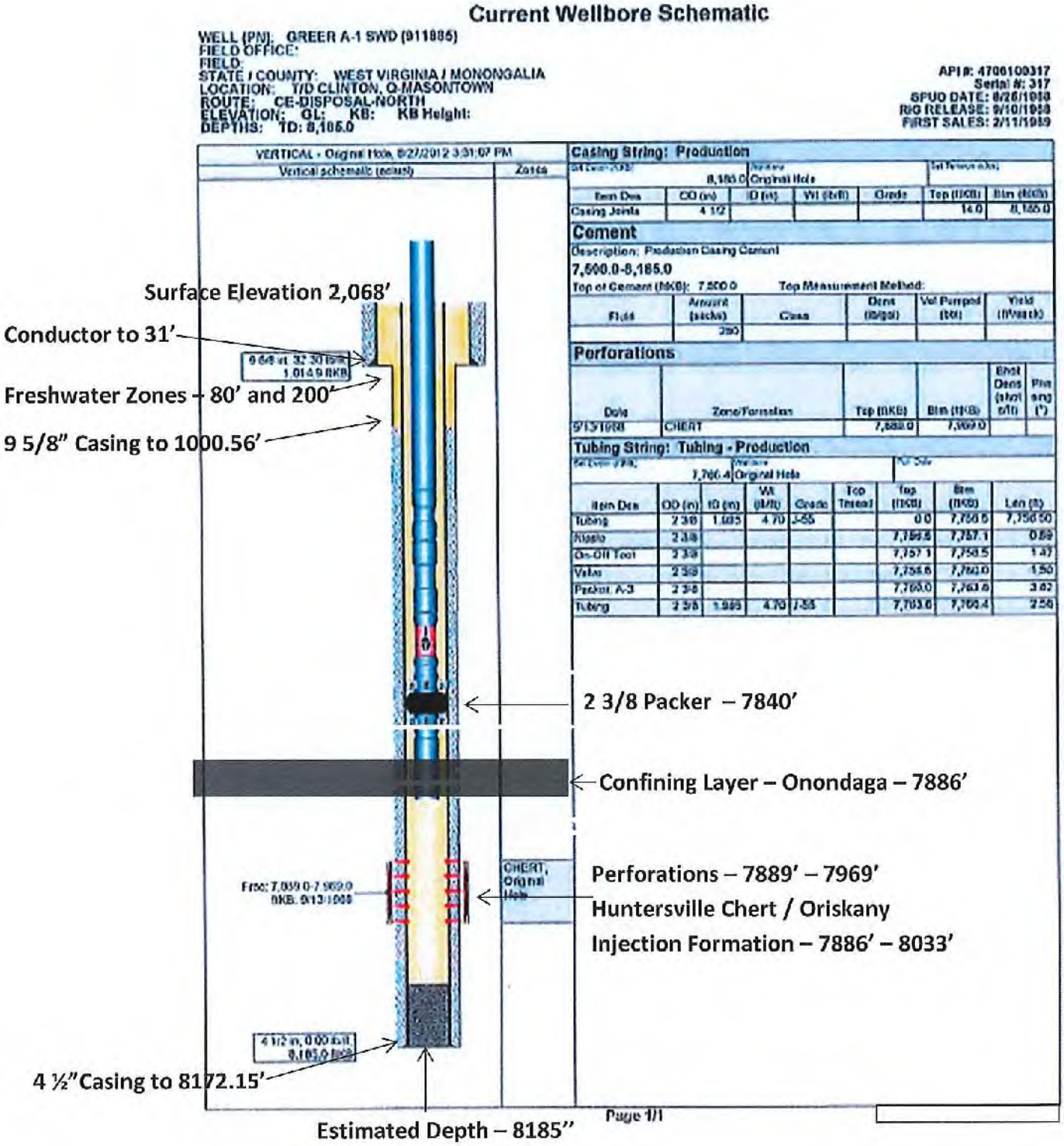
1. **Aerial Map**

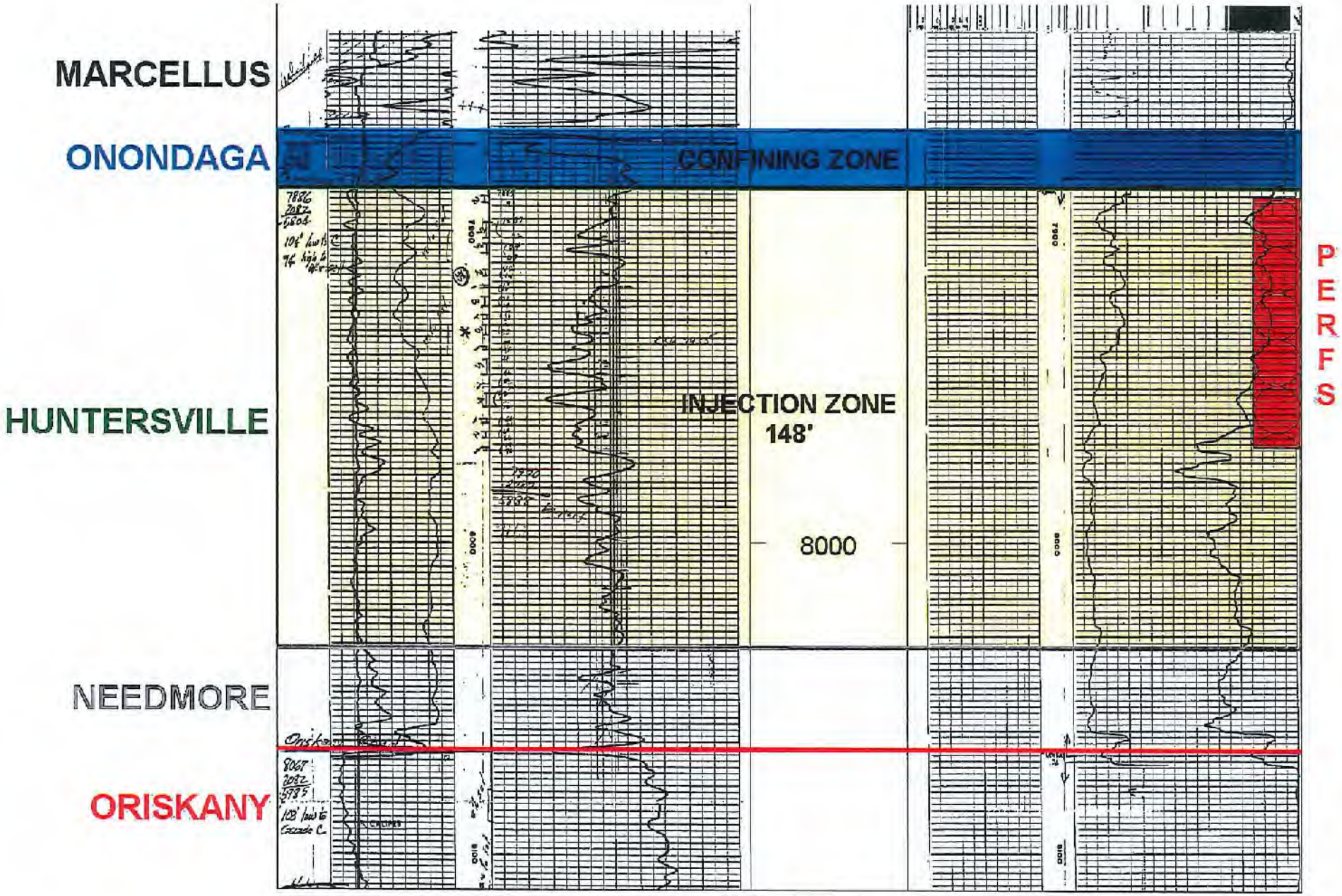


Greer A-1 SWD **Morgan District,** **Monongalia County, WV**	**LEGEND:** Aerial Map, 1" = 50' North ↑

Section 6: Construction

1. Well Schematic





Attachment 6

SYNERGETIC LOG SYSTEMS

SCHLUMBERGER FIELD FILE

This Presentation For:

HYDROCARBON IDENTIFICATION

Other Presentations:

COMPANY PHILLIPS PETROLEUM COMPANY

WELL GREER "AH-1

FIELD SOUTH BURNS CHAPEL

COUNTY MONONGALIA STATE WEST VIRGINIA

DATE 9-18-68

RUN NO. ONE

LOCATION

ELEV. 2082 KB
N.A. DF
2068 GL

We will name, location and borehole reference data were furnished by the customer.

All interpretations are opinions based on inferences from electrical or other measurements and we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, cost, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to Clause 7 of our General Terms and Conditions as set out in our current Price Schedule.

COMPANY PHILLIPS PETROLEUM COMPANY

WELL GREER "AH-1

FIELD SOUTH BURNS CHAPEL

COUNTY MONONGALIA STATE WEST VIRGINIA

Rm @ °F
Rmf @ °F
Rmc @ °F
BHT °F

SWSC FR 8171
SWSC TO 8178
DRLR TD 8185
Elevs:
KB 2082
DF N.A.
GL 2068

Attachment "7"

SCHLUMBERGER — PERFORATING DEPTH CONTROL

FILE COPY

FIELD FILE

COMPANY PHILLIPS PETROLEUM COMPANY

WELL GREER "A"-1

FIELD SOUTH BURNS CHAPEL

COUNTY MONONGALIA STATE WEST VIRGINIA

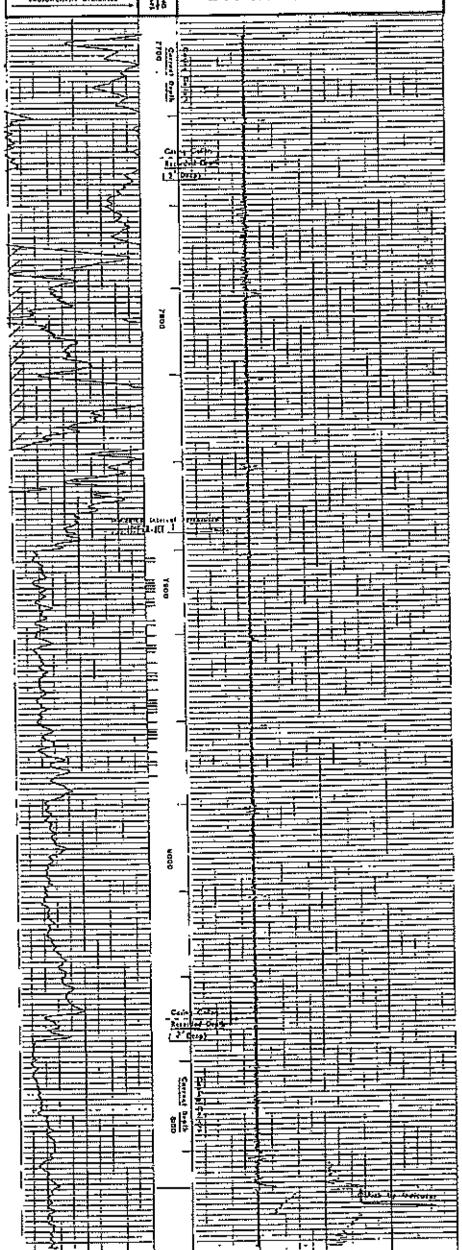
EQUIPMENT DATA

	Gamma Ray
Run No.	ONE
Tool Model No.	SKT-F
Diameter	3 3/8
Detr. Model No.	SGD-F
Type	SCINT
Length	5"
	General
Hoist Truck No.	1866
Inst. Truck No.	1866
Tool Serial No.	
Location	PA RGNT
Remarks	

SHOOTING 3 3/8 HYPER JETS 1 SHOT PER FT. AT

7589-91'
7697-7922
7904-07
7912-14
7913-18
7921-24
7927-28
7932-33
7933-38
7941-46
7949-52
7953-56
7958-61
7964-66
7969-72

GAMMA RAY — RADIOACTIVITY INCREASES →	CASING COLLARS	CASING COLLAR LOG BEFORE PERFORATION	CASING COLLAR LOG AFTER PERFORATION



GAMMA RAY — RADIOACTIVITY INCREASES →	CASING COLLARS	CASING COLLAR LOG BEFORE PERFORATION	CASING COLLAR LOG AFTER PERFORATION

COMPANY PHILLIPS PETROLEUM COMPANY Rm ____ @ ____ °F SWSC TO 8135 OVER TO 8 54

WELL GREER "A"-1

FIELD SOUTH BURNS CHAPEL Elev.: KB 2052 DF N.A. GL 2068

COUNTY MONONGALIA STATE WEST VIRGINIA

APPENDIX A

APPENDIX A
Injection Well Form

1) GEOLOGIC TARGET FORMATION: Huntersville Chert / Oriskany

Depth: 7886 Feet (top) 8033 Feet (bottom)

2) Estimated Depth of Completed Well, (or actual depth of existing well): 8185 Feet

3) Approximate water strata depths: Fresh 80 & 200 Feet Salt None Feet

4) Approximate coal seam depths: None

5) Is coal being mined in the area? Yes ☐ No ☑

6) Virgin reservoir pressure in target formation 4150 psig Source Previous Application - Field Estimate

7) Estimated reservoir fracture pressure 2980 psig (BHFP)

8) MAXIMUM PROPOSED INJECTION OPERATIONS:

Injection rate (bbl/hour)	41.7
Injection volume (bbl/day)	1000
Injection pressure (psig)	2682
Bottom hole pressure (psig)	2980

9) DETAILED IDENTIFICATION OF MATERIALS TO BE INJECTED, INCLUDING ADDITIVES:

Produced water / brine water with scale inhibitor and a wetting agent (iron oxide control compound).

Temperature of injected fluid: (°F) Ambient

10) FILTERS (IF ANY)

50 micron bag filter, 20 micron rope filter, 10 micron rope filter.

11) SPECIFICATIONS FOR CATHODIC PROTECTION AND OTHER CORROSION CONTROL

Pipeline protective coating, fiberglass storage tanks

APPENDIX A (cont.)

12. Casing and Tubing Program

TYPE	Size	New or Used	Grade	Weight per ft. (lb/ft)	FOOTAGE: For Drilling	INTERVALS: Left in Well	CEMENT: Fill-up (Cu. Ft.)
Conductor	13 3/8			48	47	31.22	UNK/50 SKS
Fresh Water	9 5/8			32.3	1014.89	1000.56	UNK/350 SKS
Coal							
Intermediate 1							
Intermediate 2							
Production	4 1/2			11.6	8185	8172.15	UNK/250SKS
Tubing	2 3/8					7872	
Liners							

TYPE	Wellbore Diameter	Casing Size	Wall Thickness	Burst Pressure	Cement Type	Cement Yield (cu. ft./sk)	Cement to Surface ? (Y or N)
Conductor		13 3/8					UNK/50 SKS
Fresh Water		9 5/8					UNK/350 SKS
Coal							
Intermediate 1							
Intermediate 2							
Production		4 1/2					UNK/250SKS
Tubing		2 3/8					
Liners							

PACKERS	Packer #1	Packer #2	Packer #3	Packer #4
Kind:	Baker A-3 Lok-Set			
Sizes:	2 3/8			
Depths Set:	7840			

APPENDIX B

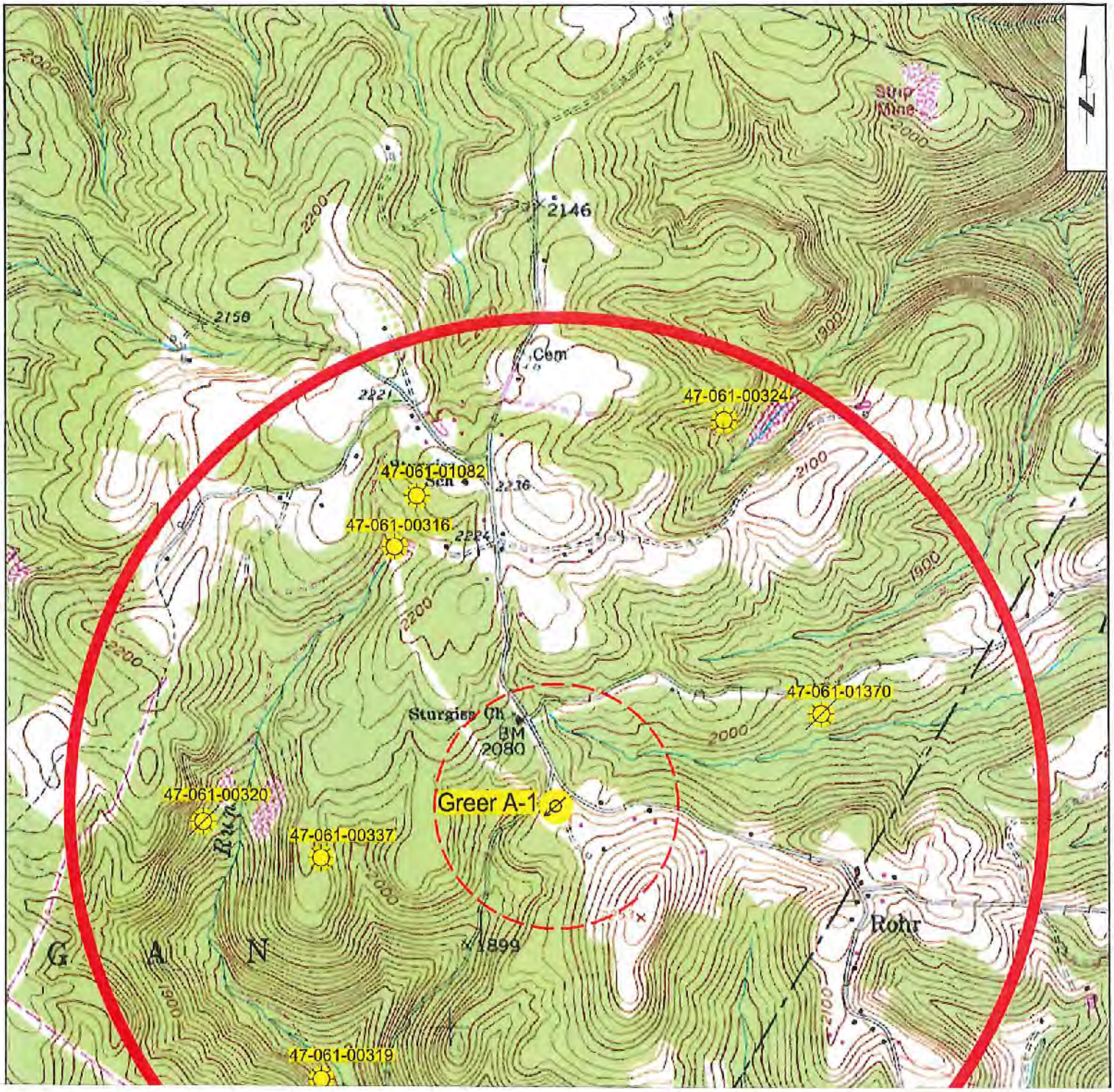
APPENDIX B
Storage Tank Inventory

API #	Tank ID	Tank Location (UTM NAD 83 Meters)		Installation Date	Tank Age (Months)	Construction Material (Steel, plastic, etc.)	Capacity (gallons)	Type of Fluid Stored	Volume of Fluid Stored (gallons)	Tank Type Single/Double Wall
		Northing	Easting							
DEP Tank ID: 031-00000359	679	4,382,907	600,570	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single
DEP Tank ID: 031-00000360	680	4,382,908	600,574	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single
DEP Tank ID: 031-00000361	681	4,382,909	600,579	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single
DEP Tank ID: 031-00000362	682	4,382,903	600,571	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single
DEP Tank ID: 031-00000363	683	4,382,904	600,576	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single
DEP Tank ID: 031-00000364	684	4,382,905	600,580	est. 2007	650	Fiberglass	8820	Brine / Produced Water	Varies	Single

SECTION 7

AREA OF REVIEW

APPENDIX C


Strip Mine
2146
2158
Cem
2221
47-061-00324
47-061-01082
2216
47-061-00316
2224
2200
2100
1900
2000
47-061-01370
Sturgiss Ch
BM
2080
Greer A-1
47-061-00320
47-061-00337
Rohr
1899
G A N
47-061-00319

APPENDIX C

Wells within the Area of Review

API #	Well Type	Well Status (Active, Abandoned, Shut-in, Plugged)	Northing (UTM NAD 83 Meters)	Easting (UTM NAD 83 Meters)	Penetrate Injection Zone (Y or N)	Penetrate Confining Zone (Y or N)	Total Vertical Depth	Surface Elevation
47-061-00316	Vertical	Active	4,383,762	600,031	Y	Y	8154	2124
47-061-00319	Vertical	Abandoned	4,382,010	599,787	Y	Y	7735	1897
47-061-00320	Vertical	Plugged	4,382,857	599,399	Y	Y	8275	1952
47-061-00324	Vertical	Abandoned	4,384,121	601,242	Y	Y	8105	1955
47-061-00337	Vertical	Abandoned	4,382,950	599,629	Y	Y	8109	1996
47-061-01082	Vertical	Active	4,383,929	600,105.38	N	N	3043	2124
47-061-01370	Vertical	Plugged	4,383,205	601,440.88	Y	Y	8260	2224

Make as many copies as necessary and include page numbers as appropriate.

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permi

The appearance of an API number on the web page does not signify that a permit has been issued. The API number is used as a tracking mechanism until the permit has b

Well API	Operator	Surface Owner	Well Number
4706100316	HG ENERGY, LLC	GREER STEEL/CASCADE CO.	C-1

The operator listed above is the CURRENT operator of the well.

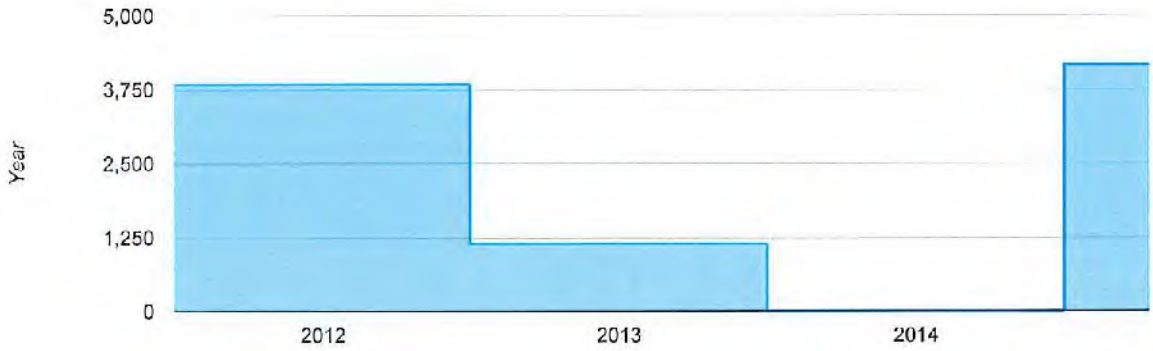
This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

All amounts expressed in mcfg (thousand cubic feet)

Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
HG ENERGY, LLC	2016	433	501	677	436	28
SWN PRODUCTION COMPANY, LLC	2016	431	498	673	434	28
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	56	42
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	289	264	247	109	
CHESAPEAKE APPALACHIA, L.L.C.	2012	208	256	406	410	43

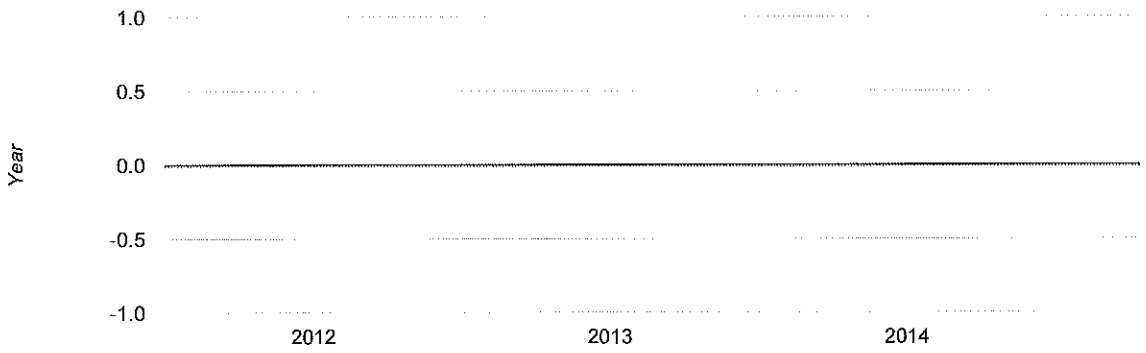


Well Lifetime Oil Production

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
HG ENERGY, LLC	2016	0	0	0	0	
SWN PRODUCTION COMPANY, LLC	2016	0	0	0	0	
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	

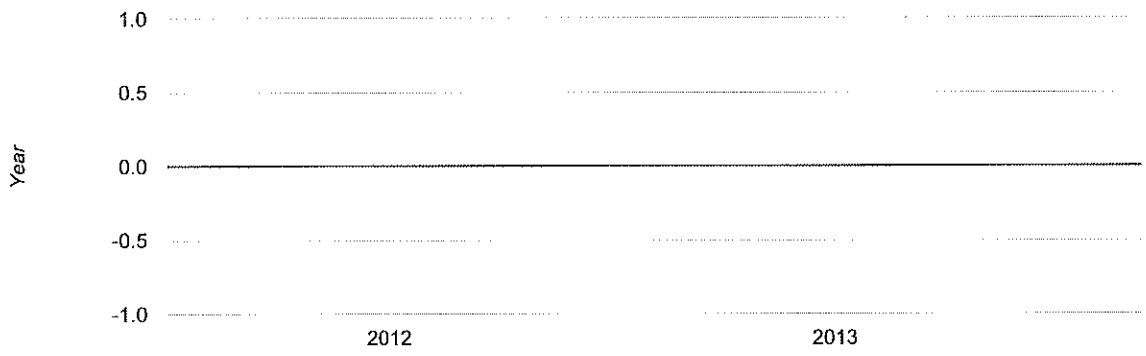
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0



Well Lifetime NGL Production

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	Mi
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0	



The West Virginia Department of Environmental Protection (WVDEP) makes oil and gas well information and production data available to the general public through this int

The oil and gas related data originate from the information reported to the Office of Oil and Gas at WVDEP by West Virginia oil and gas operators. The WVDEP does not gu

Neither the West Virginia Department of Environmental Protection nor its staff members are liable or responsible for any damage or loss resulting from the use of these dat

We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better se

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

Ori. & 1 - State of West Virginia, Dept. of Mines, Oil & Gas Div., Charleston, W. Va., 25305

Form OG-10

47-061-00316

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS DIVISION

WELL RECORD

Rotary ☒ Spudder ☐ Cable Tools ☐ Storage ☐

Oil or Gas Well Gas (KIND)

Quadrangle Morgantown

Permit No. MON-316

Company Phillips Petroleum
Address Bartlesville, Oklahoma
Farm Cascade "B" Acres 336.8
Location (waters) 1400' W of 79 Deg. 50'; 5250' N of 39 Deg. 35'
Well No. 1 Elev. 2124'
District Morgan County Monongalia
The surface of tract is owned in fee by The Cascade Corporation Address 230 Spruce Street, Morgantown, West Virginia
Mineral rights are owned by Same Address
Drilling commenced May 7, 1968
Drilling completed June 1, 1968
Date Shot None From To
With
Open Flow /10ths Water in Inch
/10ths Merc. in Inch
Volume 11,410 MCF/day (CAOFP) Cu. Ft.
Rock Pressure 3350# lbs. 236 hrs.
Oil None bbls., 1st 24 hrs.
WELL ACIDIZED (DETAILS) See reverse side.
WELL FRACTURED (DETAILS) See reverse side.

RESULT AFTER TREATMENT (Initial open Flow or bbls.) See gas volume above. (11,410 MCF)
ROCK PRESSURE AFTER TREATMENT - 3350 # HOURS
Fresh Water 85' Feet Salt Water Feet
Producing Sand Onondaga Chert & Oriskany Sand Depth 8154' - PBTD 8118'

Casing and Tubing	Used in Drilling	Left in Well	Packers
Size			
16	Set 0'		Kind of Packer
13 3/8"	40'	31.58'	(65 Sax) by Halli
10 9 5/8"	1021.15'	1005.70'	(350 Sax) Size of by Halli
8¼			
6⅝			Depth set
5 3/16			
4½ 4½" 11.60#	8154'	8173.83'	(200 Sax) by Hal
3			Perf. top See attac
2			Perf. bottom rand
Liners Used			Perf. top 7852
			Perf. bottom 8049

Attach copy of cementing record.
CASING CEMENTED 4½" SIZE 8173.83' No. Ft. 5/29/68 Da
Amount of cement used (bags) 200 Sax
Name of Service Co. Halliburton
COAL WAS ENCOUNTERED AT FEET INCHI
FEET INCHES FEET INCHI
FEET INCHES FEET INCHI

Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth	Remarks
DRILLER'S LOG:					GAMMA RAY LOG:		
Surface Soil, Sand Rock			0'	44'	FORMATION:	FROM: TO:	
Sand			44'	180'	Big Lime	531' 720'	
Sandy Shale, Red Rock			180'	295'	Weir	875' 934'	
Red Rock & Shale			295'	505'	80 Foot Sand	1084' 1176'	
Sand			505'	600'	30 Foot Sand	1198' 1246'	
Sand, Sandy Shale			600'	725'	Gordon Sand	1445' 1451'	
Shale & Sand			725'	890'	5th Sand	1705'	
Sand			890'	1070'	Speechley Sand	1821' 1863'	
Sand, Sandy Shale			1070'	1220'	Riley Sand	2521' 2544'	
Sand & Shale			1220'	1732'	Benson Sand	3637' 3767'	
Sand, Sandy Shale			1732'	1960'	Tully	3997'	
Shale & Sand Streaks			1960'	2367'	Marcellus Shale	7342'	
Sand & Shale			2367'	2650'	Onondaga Lime	7733'	
Sand, Sandy Shale			2650'	2870'	Onondaga Chert	7833'	
Sand			2870'	3060'	Oriskany Sand	7846'	
Sand & Shale			3060'	3250'	Helderberg Lime	8030'	
Shale			3250'	7343'	Sch TD	8084'	
Tully Lime			7343'	7440'	DTD	8155'	
Shale			7440'	7851'		8154'	
Lime			7851'	8035'			
Sand			8035'	8100'			
Lime			8100'	8154'			
			PBTD	8118'			

RECEIVED JUL 1968 West Virginia Dept. of Mines

CC: Consolidated Gas Supply Corp., 445 West Main St., Clarksburg, W. Va.
P.P. Co. - B'Ville, Okla.

JUL 15 1968

Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth Found	Remarks

WELL ACIDIZED (DETAILS) F/ REVERSE SIDE:
5/30/63: Following perforating 4½" csg opposite Oriskany Sand f/ 8040'-8049' - Halliburton pmp'd down 4½" csg & broke Oriskany Sand down thru perforations @ 4300# - pmp'd 5 Bbls of acid into formation - avg pmp rate 5 Bbls/minute w/ two pmps @ 4400#.

WELL FRACTURED (DETAILS) F/ REVERSE SIDE:
5/31/63: Halliburton fraced well down 4½" csg thru csg perforations f/ 7852'-8049' opposite Onondaga Chert & Oriskany Sand - fraced w/ 55,000# of 20-40 sand; 60,960 gal. of treating fluid (55,800 gal. of which was 3% acid jel) - used 2000# of WG6 & 300# of CFA - pmp'd into formation w/ one pmp @ 2400# - dropped five perf balls - had 522 Bbls of treating fluid in hole - perf balls on btm w/ 644 Bbls in - press. increased f/ 4100# to 4150#; dropped five more perf balls w/ 1148 bbls of fluid in - balls on btm w/ 1270 Bbls fluid in - had increase in press. f/ 4300# to 4400# - pmp inj. rate 45.4 Bbls/minute; max. T.P. 4900#; min. T.P. 4000#; displacement 4500#; inst. SIP 2700#; 5-min. SIP 2500#; hydraulic horsepower available 4725; hydraulic horsepower used 4698. (Ran Gamma Ray Log - logged over perforations f/ 7852'-8049' - all perforations on Onondaga Chert Section showed to take fluid - Oriskany showed did not take any frac treatment.

Date July 2, 19 6

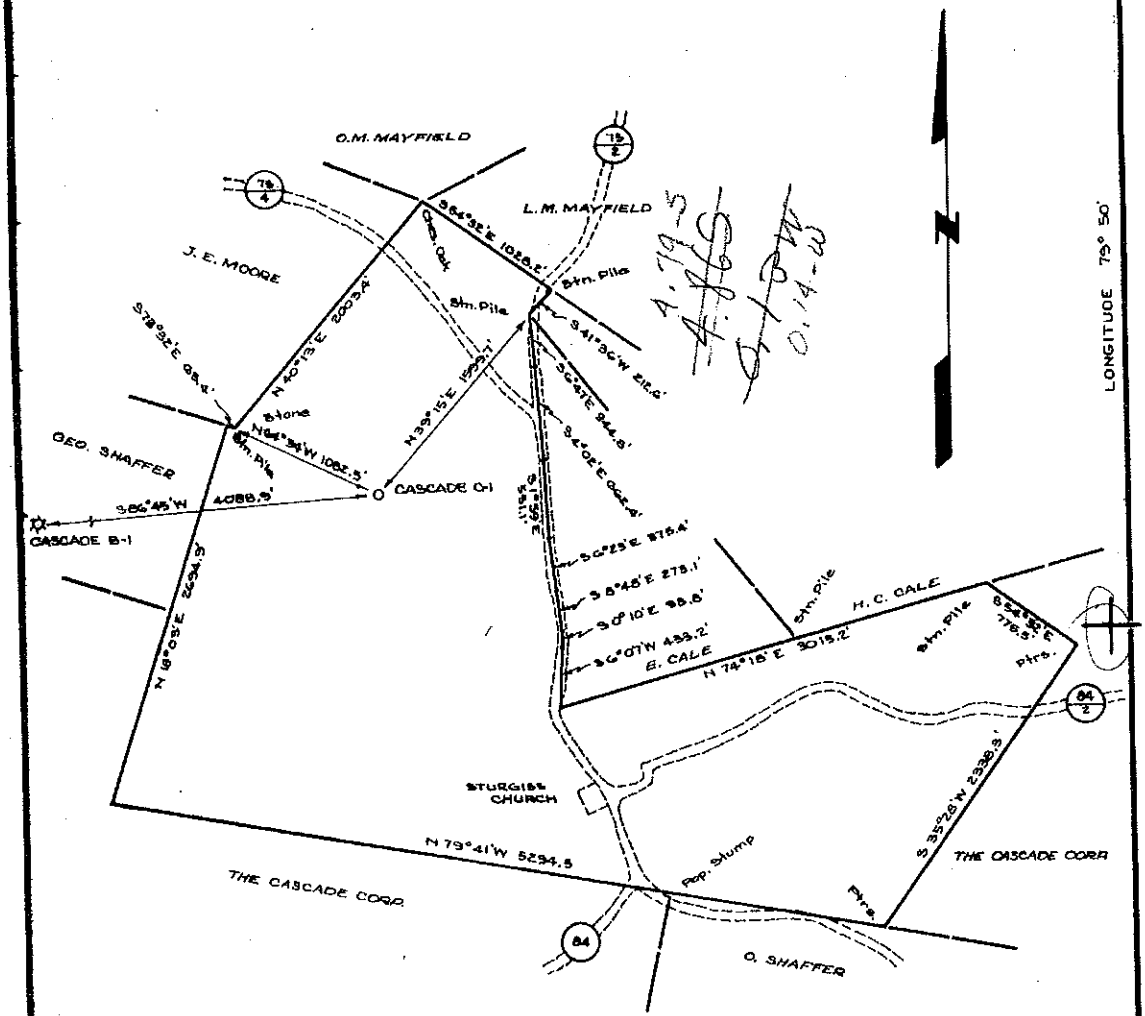
APPROVED E. S. MILES, Ow

By

DIST. PROD. SUPT. (Title)

Plot V Log VV Card 1 CSD 72 Mflm VVV

Plot ___ Log ___ Card ___ CSD 39-40 Mflm ___



"I, the undersigned, hereby certify that this map is correct to the best of my knowledge and belief and shows all of the information required by Paragraph 5 of the rules and regulations of the Oil and Gas Section of the mining laws of West Virginia".

Edward C. Caswell

EDWARD C. CASWELL
TEXAS REG. NO. 5998

NEW LOCATION ☒

DRILL DEEPER ☐

ABANDONMENT ☐

COMPANY PHILLIPS PETROLEUM COMPANY

ADDRESS BARTLESVILLE, OKLAHOMA

FARM THE CASCADE CORPORATION

TRACT 5 ACRES 556.8 LEASE NO. 70087

WELL (FARM) NO. C-1 SERIAL NO. ____

ELEVATION (SPIRIT LEVEL) 2124'

QUADRANGLE MORGANTOWN C

COUNTY MONONGALIA DISTRICT MORGAN

ENGINEER Edward C. Caswell

ENGINEER'S REGISTRATION NO. 5998-TEXAS

FILE NO. ____ DRAWING NO. ____

DATE MARCH 22, 1966 SCALE 1" = 1000'

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES

OIL AND GAS DIVISION

CHARLESTON

WELL LOCATION MAP

FILE NO. MON-316

+ DENOTES LOCATION OF WELL ON UNITED STATES TOPOGRAPHIC MAPS, SCALE 1 TO 62,500. LATITUDE AND LONGITUDE LINES BEING REPRESENTED BY BORDER LINES AS SHOWN

— DENOTES ONE INCH SPACES ON BORDER LINE OF ORIGINAL TRACING.

Deep Well

MAY 6 1963

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permi

The appearance of an API number on the web page does not signify that a permit has been issued. The API number is used as a tracking mechanism until the permit has b

Well API	Operator	Surface Owner	Well Number	Well Statu
4706100319	HG ENERGY, LLC	GREER STEEL	GREER B-1	Abandoned

The operator listed above is the CURRENT operator of the well.

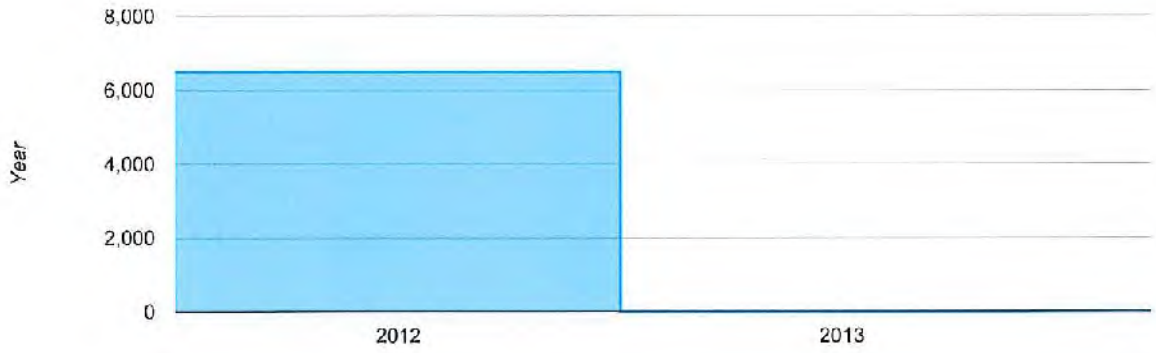
This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

All amounts expressed in mcfg (thousand cubic feet)

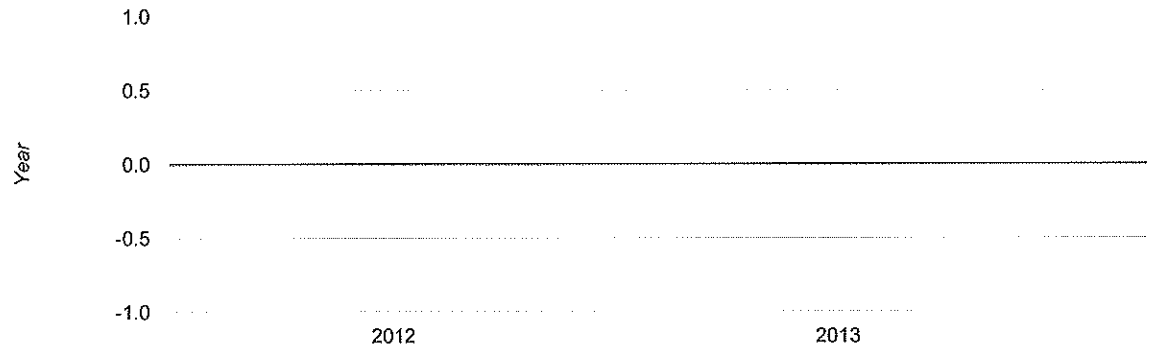
Reporting Operator	Year	Jan	Feb	Mar	Apr	May
HG ENERGY, LLC	2016	0	0	0	0	0
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	0
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	0
CHESAPEAKE APPALACHIA, L.L.C.	2012	672	631	630	634	584



Well Lifetime Oil Production

All amounts expressed in barrels

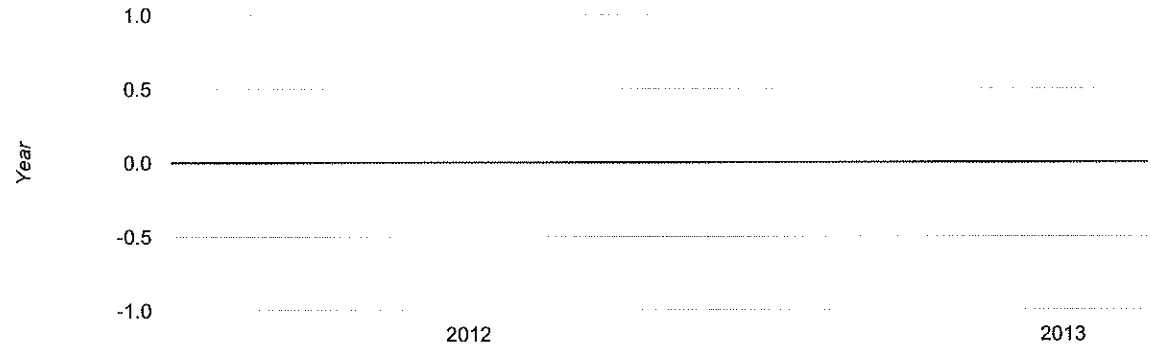
Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
HG ENERGY, LLC	2016	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0	



Wel

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0	



The West Virginia Department of Environmental Protection (WVDEP) makes oil and gas well information and production data available to the general public through this int

The oil and gas related data originate from the information reported to the Office of Oil and Gas at WVDEP by West Virginia oil and gas operators. The WVDEP does not gu

Neither the West Virginia Department of Environmental Protection nor its staff members are liable or responsible for any damage or loss resulting from the use of these dat

We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better se

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

Orig - State
1 - Consolidated
1 - B'ville
1 - Okla. City
1 - File

47-061-00319

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS DIVISION

WELL RECORD

Rotary ☒
Spudder ☐
Cable Tools ☐
Storage ☐

Quadrangle Morgantown
Permit No. MON-319
Oil or Gas Well Gas (KIND)

Company Phillips Petroleum Company
Address Bartlesville, Oklahoma
Farm Greer "B" Acres 481.1
Location (waters) 350' S of Lat 39°35' and 1230' W of long 79°50'
Well No. 1 Elev. 1597'
District Morgan County Monongalia
The surface of tract is owned in fee by Greer Steel Company
Address Morgantown, W.Va.
Mineral rights are owned by Same
Address
Drilling commenced 11-5-68
Drilling completed 11-26-68
Date Shot From To
With
Open Flow /10ths Water in Inch
/10ths Merc. in Inch
Volume See reverse side Cu. Ft.
Rock Pressure lbs. hrs.
Oil bbls., 1st 24 hrs.
WELL ACIDIZED (DETAILS) See Reverse Side
WELL FRACTURED (DETAILS) See reverse side
RESULT AFTER TREATMENT (Initial Open Flow or bbls.) See reverse side 5,163,000
ROCK PRESSURE AFTER TREATMENT HOURS
Fresh Water 30' & 65' Feet Salt Water Feet
Producing Sand Chert Depth 7287' - Upper & 7419' - Lower

Casing and Tubing	Used in Drilling	Left in Well	Packers
Size	Set at:		
16 20" OD	29'	0	Kind of Packer
13-3/8" OD	48'	29'	(50 sx by Hallib)
9-5/8" OD	997'	981'	Size of
6¾			(400 sx by Hallib)
5 3/16		(1/2)	Depth set
4½ OD	7735'	7748'	
3			Perf. top 7291'
2			Perf. bottom 7546'
Liners Used			Perf. top
			Perf. bottom

Attach copy of cementing record.
CASING CEMENTED 4½" SIZE 7748 No. Ft. 11-27-68 Date
Amount of cement used (bags) 225 w/20% Diacel D - Hallib
Name of Service Co. Halliburton
COAL WAS ENCOUNTERED AT FEET INCHES FEET INCHES
FEET INCHES FEET INCHES
FEET INCHES FEET INCHES

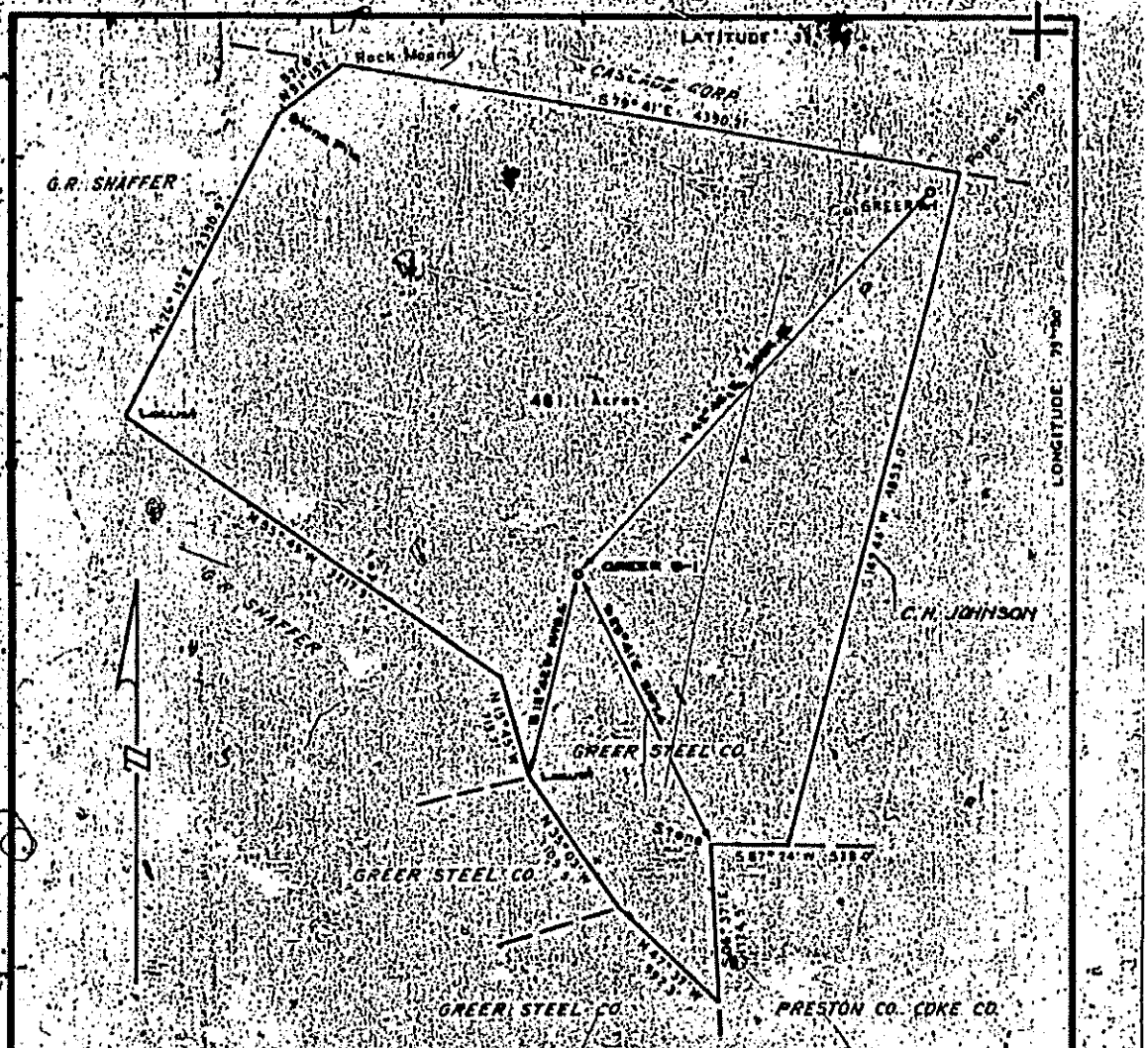
Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth	Remarks
Per Driller's Log:							
Rock & dirt			0	52'			
Sand			52'	245'			
Sand & red rock			245'	355'			
Sand & shale			355'	865'			
Shale			865'	1004'			
Shale & red rock			1004'	1120'			
Shale, sand, red rock			1120'	1338'			
Sand & shale			1338'	1630'			
Sandy shale & sand			1630'	2240'			
Sand & shale			2240'	2512'			
Sand & shale & sandy shale			2512'	3340'			
Shale			3340'	4090'			
Sandy shale & shale			4090'	6870'			
Lime			6870'	6920'			
Lime & shale			6920'	7115'			
Shale			7115'	7270'			
Lime			7270'	7285'			
Chert			7285'	7340'			
Shale			7340'	7395'			
Lime			7395'	7410'			
Chert			7410'	7617'			
Sand & lime			7617'	7710'			
Lime			7710'	7735'			
				7735'			Total Depth
				7699'			Plugged Back Total Depth

(FORMATION TOPS) - Per Schlumberger Logs:

Tulley Lime	6857'
Onondaga Lime	7270' & 7400'
Onondaga Chert	7287' - 7419'
Oriskany Sand	7616'
Helderberg Lime	7664'

JAN 1969
RECEIVED
West Virginia
Dept. of Mines

10/7/68 CEN



I, the undersigned, hereby certify that this map is correct to the best of my knowledge and belief and shows all of the information required by Paragraph 5 of the rules and regulations of the Oil and Gas Section of the mining laws of West Virginia.

Edward C. Caswell

EDWARD C. CASWELL
Texas Reg. No. 5998

NEW LOCATION ☒

DRILL DEEPER ☐

ABANDONMENT ☐

COMPANY PHILLIPS PETROLEUM COMPANY

ADDRESS BARTLESVILLE, OKLAHOMA

FARM GREER STEEL COMPANY

TRACT 3 ACRES 461.1 LEASE NO. C-70087

WELL FARM NO. B-1 SERIAL NO.

ELEVATION (SPIRIT LEVEL) 1037.0'

QUADRANGLE MORGANTOWN

COUNTY MONONGALIA DISTRICT MORGAN

ENGINEER Edward C. Caswell

ENGINEER'S REGISTRATION NO. 5998 - TEXAS

FILE NO. DRAWING NO.

DATE SEPT. 27, 1968 SCALE 1" = 1000'

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES

OIL AND GAS DIVISION

CHARLESTON

WELL LOCATION MAP

FILE NO. Mon-319

+ DENOTES LOCATION OF WELL ON UNITED STATES TOPOGRAPHIC MAPS, SCALE 1 TO 62,500. LATITUDE AND LONGITUDE LINES BEING REPRESENTED BY BORDER LINES AS SHOWN

— DENOTES ONE INCH SPACES ON BORDER LINE OF ORIGINAL TRACING.

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permit from the director of the WVDEP Office of Oil and Gas.

The appearance of an API number on the web page does not signify that a permit has been issued. The API number is used as a tracking mechanism until the permit has been issued. Under no circumstances should well work be commenced without a signed permit.

Well API	Operator	Surface Owner	Well Number	Well Status	Well Type	Last Permit Issue Date
4706100320	U.S. ARMY CORPS OF ENGINEERS	GREER STEEL COMPANY	C-1	Plugged	Vertical	

The operator listed above is the CURRENT operator of the well.

This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

No Production Reported

Well Lifetime Oil Production

No Production Reported

Well Lifetime NGL Production

No Production Reported

The West Virginia Department of Environmental Protection (WVDEP) makes oil and gas well information and production data available to the general public through this internet service free of charge.

The oil and gas related data originate from the information reported to the Office of Oil and Gas at WVDEP by West Virginia oil and gas operators. The WVDEP does not guarantee their accuracy, precision, or completeness.

Neither the West Virginia Department of Environmental Protection nor its staff members are liable or responsible for any damage or loss resulting from the use of these data or from inaccuracies contained in the data.

We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better service.

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

Orig - State
1 - Consolidated
1 - Bville
1 - Okla. City
1 - File

Form IX-10

47-061-00350

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS DIVISION

WELL RECORD

Rotary ☒ Spudder ☐ Cable Tools ☒ Storage ☐

Oil or Gas Well Non-Commercial - P&A (KIND)

Quadrangle Morgantown

Permit No. MON-320

Company Phillips Petroleum Company
Address Bartlesville, Oklahoma
Farm Greer "C" Acres 481.1
Location (waters) 27,750' S of Lat 39°40' & 2500' W of Long 79°50', Monongalia County, W. Va.
Well No. 1 Elev. GL 1952'
District Morgan County Monongalia
The surface of tract is owned in fee by Greer Steel Company Address Morgantown, W. Va.
Mineral rights are owned by Same Address
Drilling commenced December 10, 1968
Drilling completed January 1, 1969
Date Shot From To
With

Open Flow /10ths Water in Inch
/10ths Merc. in Inch
Volume Non-Commercial - P&A Cu. Ft.
Rock Pressure lbs. hrs.
Oil bbls. 1st 24 hrs.
WELL ACIDIZED (DETAILS) See Reverse Side
WELL FRACTURED (DETAILS) See Reverse Side

RESULT AFTER TREATMENT (Initial Open Flow or bbls.) Non-Commercial
ROCK PRESSURE AFTER TREATMENT HOURS
Fresh Water Feet Salt Water Feet
Producing Sand Depth

Casing and Tubing	Used in Drilling	Left in Well	Packers
Size 16 48#	(RKB) Set at: 50'	(GL) 32.2'	GL to RKB 14.40'
13 3/8" OD			Kind of Packer (60 sx by Hallib)
10			Size of
8 5/8" OD 32.3#	1035'	(LT) 1018.8'	(350 sx by Hallib)
6 5/8			Depth set
5 3/16			
4½ OD	8275'	(LT) 8267.18'	(225 sx by Hallib)
3			Perf. top (See reverse side)
2			Perf. bottom
Liners Used			Perf. top
			Perf. bottom

Attach copy of cementing record.
CASING CEMENTED 4½" SIZE 8267' No. FT. 1-2-69 Date
Amount of cement used (bags) 225
Name of Service Co. Halliburton Company.
COAL WAS ENCOUNTERED AT FEET INCHES
FEET INCHES FEET INCHES
FEET INCHES FEET INCHES

DRILLER'S LOG

Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth	Remarks
Surface Soil & Rock			0	50'	Formation Tops - Per Logs:		
Sand, Red Rock			50'	110'	Tulley Lime -	7193'	
Sand, Red Rock, Shale			110'	220'	Onondaga Lime -	7800'	
Sand, Shale			220'	390'	Onondaga Chert -	7828'	
Sand			390'	500'	Oriskany Sand -	8162'	
Sand, Shale			500'	1200'			
Shale			1200'	1535'			
Sandy Shale			1535'	1840'			
Shale			1840'	2710'			
Sandy Shale			2710'	2975'			
Shale			2975'	4735'			
Sandy Shale			4735'	4820'			
Shale			4820'	5025'			
Sandy Shale			5025'	5165'			
Shale			5165'	7194'			
Lime			7194'	7251'			
Shale			7251'	7650'			
O. Lime			7650'	7700'			
Shale			7700'	7831'			
Chert			7831'	7865'			
Shale, Chert			7865'	8095'			
Chert			8095'	8155'			
O. Sand.			8155'	8220'			
Sand, Lit.			8220'	8275'	Total Depth (RKB)		

RECEIVED
JAN 1969
West Virginia
Dept. of Mines

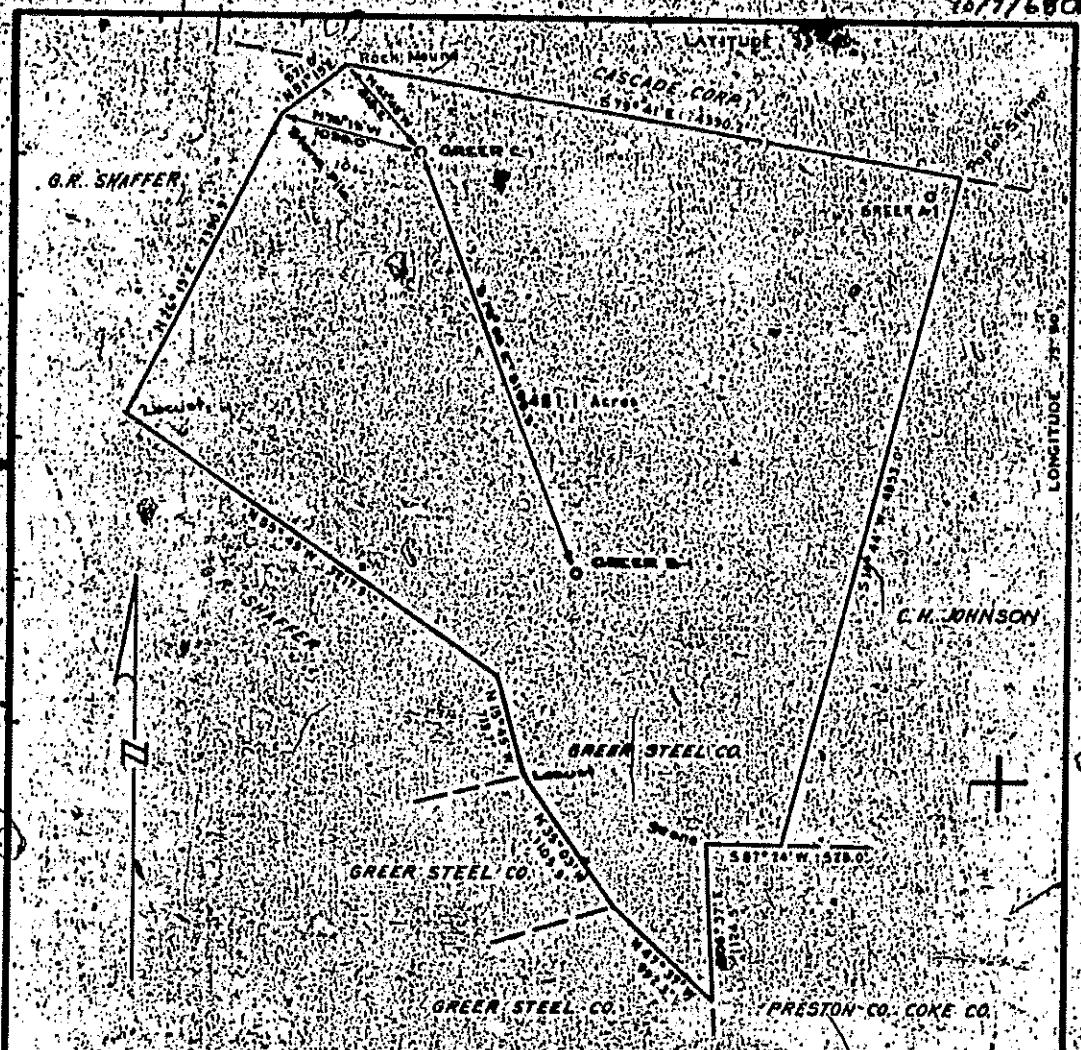
Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth Found	Remarks
January, 1969							
4							Ran Schlumberger Logs & perforated 7838-8117' (40 holes). Frac'd thru perforations w/55,000# sand & 55,400 gals 3% gelled acid. ISIP 3750#. 5 min SIP 3400#. Opened to pit to clean up well.
5/6/7/8							Well would not flow. Press'd hole w/gas to blow fluid out of hole. Unable to flow well without blowing w/gas.
9							Pulled tubing. Well flowed some water.
10/11							Killed well w/135 BW. Plugged back w/cement plug 7920-7900'. Schlumberger perforated 7833-7878' (23 holes). Set 2-3/8" tbg at 7881'. Spotted 1000 gals acid over perf.
12							Pulled tubing.
13							Frac'd w/61744 sand & 16,950 gals 3% gelled acid. ISIP 4800#. 5 min SIP 3600#. 4 hour SICP 750#, TP 60#. 2-3/8" tubing set @ 7893'.
14							6 hour SICP 1000#, TP 60#. Press'd well w/gas to blow fluid out of hole.
15							Tested @ 8:30 AM - CP 1300#, TP 0# - no flow. Press'd well w/gas @ intervals to blow fluid out of hole. Well would not flow without being press'd w/gas.
16							Well open to pit 13 hrs - would not flow - well dead. Halliburton mixed 35 sx jel, 8.4#, pmpd down tubing & circ hole. Pulled tbg. Schlumberger RU to run CIBP to 7800' to Plug and Abandon hole.
17/18							Set CIBP @ 7800', spotted 2 sx cmt 7800-7778'. Cut 4½" csg off @ 6361', pulled 2 jts & spotted 25 sx cmt 6300-6228'. Pulled 4½" csg to 1047' & spotted 25 sx cmt 1047-983' Pulled balance of 4½" csg. Ran 60' tbg & spotted 25 sx cmt 50' to top of 9-5/8" csg. Job completed 8 AM, 1-18-69. Well site marker erected 24" x 30" steel plate 4' above ground in middle of cellar. Sign reads "Phillips Petroleum Company, Greer C-1, Plugged 1-18-69." Total 4½" csg recovered - 194 jts, 6361'.

Date January 20, 19 69

APPROVED Phillips Petroleum Company, Owner

By C. T. Slagle (Title) Dist. Supt.

10/7/68 OCR



I, the undersigned, hereby certify that this map is correct to the best of my knowledge and belief and shows all of the information required by Paragraph 5 of the rules and regulations of the Oil and Gas Section of the mining laws of West Virginia.

Edward C. Caswell

EDWARD C. CASWELL
Texas Reg. No. 5998

NEW LOCATION ☒

DRILL DEEPER ☐

ABANDONMENT ☒ 1-20-69

COMPANY PHILLIPS PETROLEUM COMPANY

ADDRESS BARTLESVILLE, OKLAHOMA

FARM GREER STEEL COMPANY

TRACT 3 ACRES 48.1 LEASE NO. C-70087

WELL (FARM) NO. C-1 SERIAL NO.

ELEVATION (SPIRIT LEVEL) 1032.0'

QUADRANGLE MORGANTOWN

COUNTY MONONGALIA DISTRICT MORGAN

ENGINEER Edward C. Caswell

ENGINEER'S REGISTRATION NO. 5998 - TEXAS

FILE NO. DRAWING NO.

DATE Sept. 27, 1968 SCALE 1" = 1000'

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS DIVISION
CHARLESTON

WELL LOCATION MAP
FILE NO: Mon-320-P

+ DENOTES LOCATION OF WELL ON UNITED STATES TOPOGRAPHIC MAPS, SCALE 1 TO 62,500. LATITUDE AND LONGITUDE LINES BEING REPRESENTED BY BORDER LINES AS SHOWN.

— DENOTES ONE INCH SPACES ON BORDER LINE OF ORIGINAL TRACING.

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permi

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Well API	Operator	Surface Owner	Well Number
4706100324	CONSOL GAS COMPANY	SHAFER, JAMES N.	11307

The operator listed above is the CURRENT operator of the well.

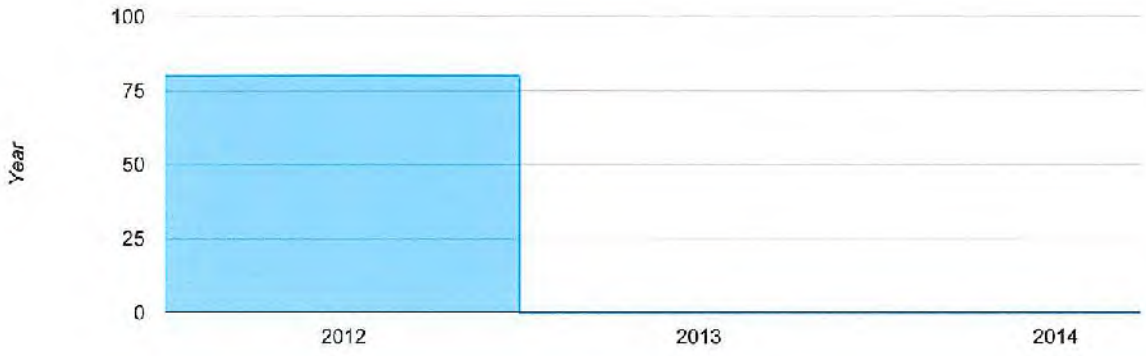
This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

All amounts expressed in mcfg (thousand cubic feet)

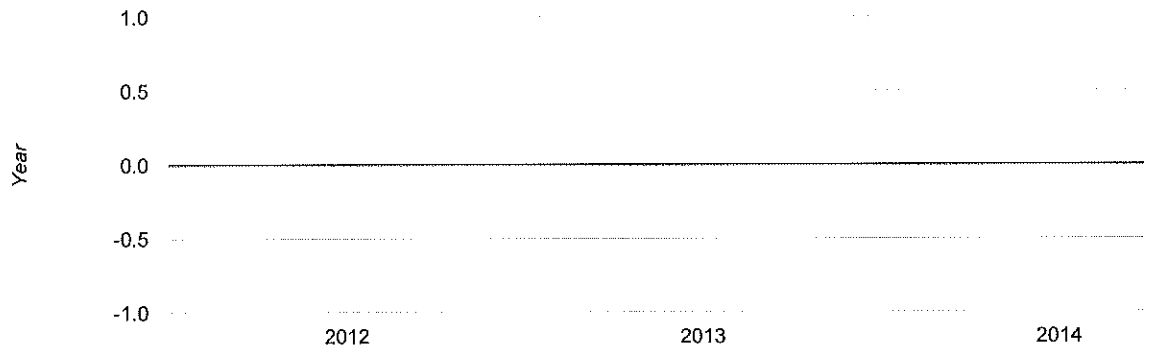
Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2016	0	0	0	0	0
CONSOL GAS COMPANY	2015	0	0	0	0	0
CONSOL GAS COMPANY	2014	0	0	0	0	0
CONSOL GAS COMPANY	2013	0	0	0	0	0
CONSOL GAS COMPANY	2012	0	0	80	0	0



Well Lifetime Oil Production

All amounts expressed in barrels

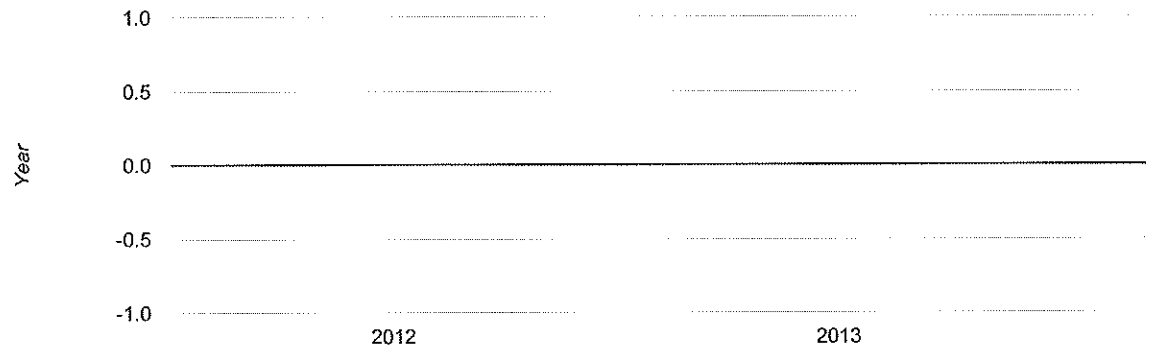
Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2016	0	0	0	0	0
CONSOL GAS COMPANY	2015	0	0	0	0	0
CONSOL GAS COMPANY	2014	0	0	0	0	0
CONSOL GAS COMPANY	2013	0	0	0	0	0
CONSOL GAS COMPANY	2012	0	0	0	0	0



Well Lifetime NGL Production

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2015	0	0	0	0	0
CONSOL GAS COMPANY	2014	0	0	0	0	0
CONSOL GAS COMPANY	2013	0	0	0	0	0
CONSOL GAS COMPANY	2012	0	0	0	0	0



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Neither the West Virginia Department of Environmental Protection nor its staff members are liable or responsible for any damage or loss resulting from the use of these dat

We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better se

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

Form OG-10

RECEIVED
JAN 1 8 1971
OIL & GAS DIVISION
DEPT. OF MINES

47-061-00324

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS WELLS DIVISION

Rotary ☒ Spudder ☐ Cable Tools ☐ Storage ☐

Quadrangle MORGANTOWN

Permit No. MON-324

WELL RECORD

Oil or Gas Well Gas (KIND)

Company Consolidated Gas Supply Corporation
Address Clarksburg, West Virginia 26301
Farm James N. Shafer Acres 117
Location (waters)
Well No. 11307 Elev. 1955'
District Morgan County Monongalia
The surface of tract is owned in fee by
Address
Mineral rights are owned by
Address
Drilling commenced 11-11-70
Drilling completed 12-19-70
Date Shot Not shot From To
With
Open Flow /10ths Water in Inch
/10ths Merc. in Inch
Volume 2,903,000 (Natural) Cu. Ft.
Rock Pressure Not Taken lbs. hrs.
Oil None bbls., 1st 24 hrs.
WELL ACIDIZED (DETAILS) No
WELL FRACTURED (DETAILS) 12-29-70 with 1400 bbl. fluid, 50,000# sand, 2000 gal. 28% acid 1500 # walnut Hulls and 4393 HHP
RESULT AFTER TREATMENT (Initial open Flow or bbls.) 4,795,000 cubic feet
ROCK PRESSURE AFTER TREATMENT 3450# HOURS 5 days
Fresh Water 55 Feet Salt Water 3525 Feet
Producing Sand Chert Depth 7669 - 7803

Casing and Tubing	Used in Drilling	Left in Well	Packers
Size			
16			Kind of Packer
13	25'	25'	
10 9 5/8"	1273	1273	Size of
8¼			
6⅝			Depth set
5 3/16			
4½	8015	8015	
3			Perf. top 7669
2			Perf. bottom 7735
Liners Used			Perf. top 7757
			Perf. bottom 7803

Attach copy of cementing record. 13" & 9" to surface
CASING CEMENTED SIZE No. Ft. Date
Amount of cement used (bags) 4 1/2" with 600 bags
Name of Service Co. Halliburton
COAL WAS ENCOUNTERED AT None FEET INCHES
FEET INCHES FEET INCHES
FEET INCHES FEET INCHES

Formation	Color	Hard or Soft	Top	Bottom	Oil, Gas or Water	Depth	Remarks
Little Lime			402	413	water	55'	
Big Lime			437	673			
Weir			737	869			
50' sand			1013	1057			
4th sand			1626	1645			
5th sand			1659	1684			
Bayard			1714	1752			
Speechley			2381	2408			
Balltown			2596	2656			
Riley			3539	3649	water gas	3525' 3554	Show
Tully			7207	7297			
Onondaga			7644	7666			
Chert			7666	7839	gas	7669-7803'	
Oriskany			7839	7914			
Helderberg			7914				
Total Depth				8105			

(over)

FORM OG 1

WELL RECORD, FORM OG 10 MUST BE SUBMITTED TO OBTAIN RELEASE OF WELL UNDER BOND.

RECEIVED
OCT 15 1970 - CEN

OIL & GAS DIVISION
DEPT. OF MINES

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS WELLS DIVISION

NOTICE OF PROPOSED LOCATION OF OIL AND GAS WELL

To The Department of Mines,
Charleston, W. Va.

No Operations
COAL OPERATOR OR COAL OWNER

ADDRESS

James N. Shafer
COAL OPERATOR OR COAL OWNER
43 Morgantown Ave
Morgantown, W. Va.
ADDRESS

Same
OWNER OF MINERAL RIGHTS

ADDRESS

Consolidated Gas Supply Corporation
NAME OF WELL OPERATOR

Clarksburg, W. Va.
COMPLETE ADDRESS

October 13, 1970, 19

PROPOSED LOCATION

Morgan, District

Monongalia, County

Well No. 11307

James N. Shafer Farm

Elevation 1955' Acres 117.118.7

GENTLEMEN:

The undersigned well operator is entitled to drill upon the above named farm or tract of land for oil and gas, having fee title thereto, (or as the case may be) under grant or lease dated 5-19-66, made by Pearl D. Garner to Phillips Petroleum Co., and recorded on the 27th day of May, 1966, in the office of the County Clerk for said County in Book 648, page 284.

The enclosed plat was prepared by a competent engineer and shows the proposed location of a well to be drilled for oil and gas by the undersigned well operator on the farm and in the Magisterial District and County above named, determined by survey and courses and distances from two permanent points, or land marks.

The undersigned well operator is informed and believes there are no coal operators operating beds of coal beneath said farm or tract of land on which said well is located, or within 500 feet of the boundaries of the same, who have mapped their workings and filed their maps as required by law excepting the coal operators or coal owners (if any) above named as addressees.

The above named coal operators or coal owners (if any) are notified that any objections they may desire to make to such proposed location, or which they are required to make by Section 3 of said Code, if the drilling of a well at said proposed location will cause a dangerous condition in or about their respective coal mines, must be received by, or filed with the Department of Mines within ten* days from the receipt of a copy of this notice and accompanying plat by said Department. Said coal operators are further notified that forms for use in making such objections will be furnished to them by the Department of Mines promptly on request and that all such objections must set forth as definitely as is reasonably possible the ground or grounds on which such objections are based and indicate the direction and distance the proposed location should be moved to overcome same.

(The next paragraph is to be completed only in Department's copy.)

Copies of this notice and the enclosed plat were mailed by registered mail, or delivered to the above named coal operators or coal owners at their above shown respective address____ day___ before, or on the same day with the mailing or delivery of this copy to the Department of Mines at Charleston, West Virginia.

Very truly yours,

(Sign Name) R E Bruce Mgr. Prod.
WELL OPERATOR

Consolidated Gas Supply Corporation

Address of Well Operator
STREET
445 West Main Street

CITY OR TOWN
Clarksburg, W. Va.
STATE

WELL DRILLING PERMIT

All provisions being in accordance with Chapter 22 of the W. Va. Code, the location is hereby approved for drilling.

This permit shall expire if drilling is not commenced by: February 15, 1971

Deputy Director - Oil and Gas Division

*Section 3 . . . . If no such objections be filed or be found by the department of mines, within said period of ten days from the receipt of said notice and plat by the department of mines, to said proposed location, the department shall forthwith issue to the well operator a drilling permit reciting the filing of such plat, that no objections have been made by the coal operators to the location, or found thereto by the department, and that the same is approved and the well operator authorized to proceed to drill at said location.

Mon - 324
PERMIT NUMBER

BLANKET BOND

THIS IS AN ESTIMATE ONLY
ACTUAL INFORMATION WILL BE SUBMITTED ON OG-10 UPON COMPLETION

PROPOSED WORK ORDER TO: xx DRILL _____ DEEPEN _____ FRACTURE _____ WELL

WELL OPERATOR
NAME Consolidated Gas Supply Corporation
ADDRESS Bridgeport, W. Va
TELEPHONE 623-3611

RESPONSIBLE AGENT:
NAME R. E. Bayne
ADDRESS Bridgeport, W. Va.
TELEPHONE 623-3611

DRILLING CONTRACTOR: (IF KNOWN)
NAME Delta Drilling Co.
TELEPHONE - -

LAND OWNER:
NAME James N. Shafer
TELEPHONE -- -

ESTIMATED DEPTH OF COMPLETED WELL: _____
ROTARY Yes
PROPOSED GEOLOGICAL FORMATION: Oriskany
CABLE TOOLS _____

TYPE OF WELL: OIL _____ GAS xx COMB. _____ STORAGE _____ DISPOSAL _____
TYPE WASTE _____ RECYCLING _____ WATER FLOOD _____ OTHER _____

TENTATIVE CASING PROGRAM:

CASING AND TUBING	CEMENT TO BE USED	FOR DRILLING	TO BE LEFT
20			
16			
13 3/8	To surface	40'	All
11 3/4			
10 3/4			
9 5/8	To surface	1100'	All
8 5/8			
7			
5 1/2			
4 1/2	300 Bags	5115	All
3 1/2			
2 3/8			
LINERS USED			

APPROXIMATE DEPTHS OF EXPECTED POTABLE WATER STRATA Unknown _____, _____, _____,
APPROXIMATE DEPTHS OF EXPECTED WORKABLE COAL SEAMS? 565' _____, _____, _____,
IS COAL BEING MINED IN THE AREA? No

Not applicable

WAIVER: I the undersigned, Agent for _____ Coal Company, owner or operator of the coal under this lease have examined and placed : mine maps this proposed well location.

We the _____ Coal Company have no objections to said well being drilled at this location, providing operator has complied with all rules and regulations in Articles 4, 5, and 7, Chapter 22 of the West Virginia Code.

_____
For Coal Company

_____
Official Title

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permi

The appearance of an API number on the web page does not signify that a permit has been issued. The API number is used as a tracking mechanism until the permit has b

Well API	Operator	Surface Owner	Well Number
4706100337	CONSOL GAS COMPANY	GREER STEEL	11701

The operator listed above is the CURRENT operator of the well.

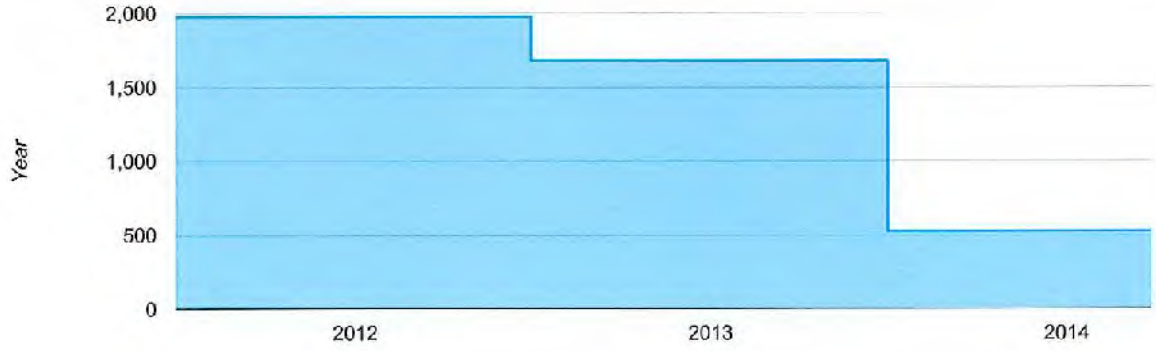
This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

All amounts expressed in mcfg (thousand cubic feet)

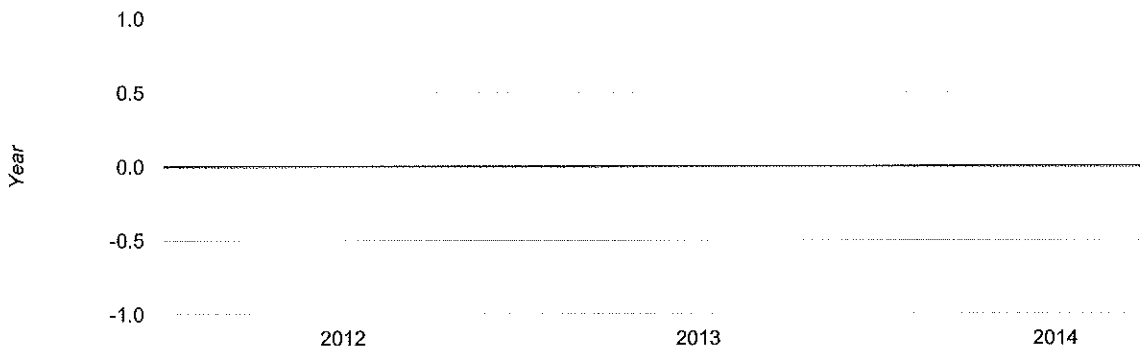
Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2016	31	109	192	243	264
CONSOL GAS COMPANY	2015	31	17	113	230	281
CONSOL GAS COMPANY	2014	38	1	53	58	38
CONSOL GAS COMPANY	2013	201	130	194	270	139
CONSOL GAS COMPANY	2012	194	205	225	170	211



Well Lifetime Oil Production

All amounts expressed in barrels

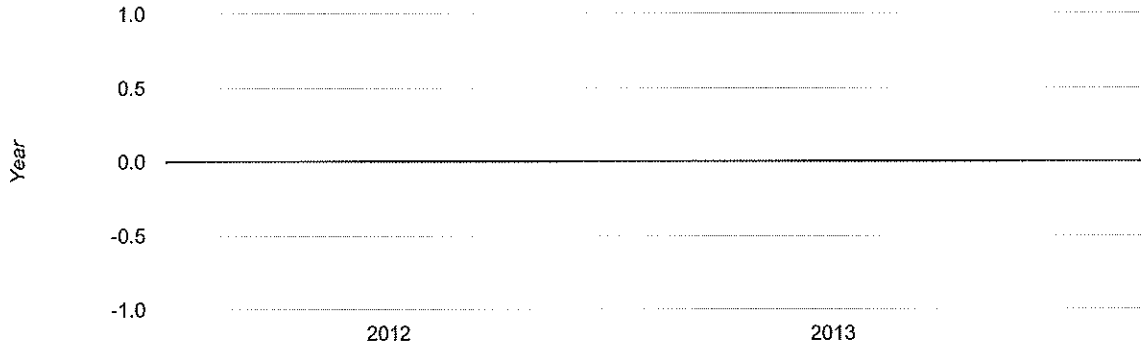
Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2016	0	0	0	0	0
CONSOL GAS COMPANY	2015	0	0	0	0	0
CONSOL GAS COMPANY	2014	0	0	0	0	0
CONSOL GAS COMPANY	2013	0	0	0	0	0
CONSOL GAS COMPANY	2012	0	0	0	0	0



Well Lifetime NGL Production

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	May
CONSOL GAS COMPANY	2015	0	0	0	0	0
CONSOL GAS COMPANY	2014	0	0	0	0	0
CONSOL GAS COMPANY	2013	0	0	0	0	0
CONSOL GAS COMPANY	2012	0	0	0	0	0



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Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

west virginia department of environmental protection

Office of Oil and Gas
601 57th Street, S.E.
Charleston, WV 25304
(304) 926-0450
fax: (304) 926-0452

Jim Justice , Governor
Austin Caperton , Cabinet Secretary
www.dep.wv.gov

Friday, September 15, 2017
WELL WORK PERMIT
Vertical / Plugging

CONSOL GAS COMPANY
1000 CONSOL ENERGY DRIVE

CANNONSBURG, PA 163176506

Re: Permit approval for 11701
47-061-00337-00-00

This well work permit is evidence of permission granted to perform the specified well work at the location described on the attached pages and located on the attached plat, subject to the provisions of Chapter 22 of the West Virginia Code of 1931, as amended, and all rules and regulations promulgated thereunder, and to any additional specific conditions and provisions outlined in the pages attached hereto. Notification shall be given by the operator to the Oil and Gas Inspector at least 24 hours prior to the construction of roads, locations, and/or pits for any permitted work. In addition, the well operator shall notify the same inspector 24 hours before any actual well work is commenced and prior to running and cementing casing. Spills or emergency discharges must be promptly reported by the operator to 1-800-642-3074 and to the Oil and Gas Inspector.

Please be advised that form WR-35, Well Operators Report of Well Work is to be submitted to this office within 90 days of completion of permitted well work, as should form WR-34 Discharge Monitoring Report within 30 days of discharge of pits, if applicable. Failure to abide by all statutory and regulatory provisions governing all duties and operations hereunder may result in suspension or revocation of this permit and, in addition, may result in civil and/or criminal penalties being imposed upon the operators.

Per 35 CSR 4-5.2.g this permit will expire in two (2) years from the issue date unless permitted well work is commenced. If there are any questions, please feel free to contact me at (304) 926- 0450.

James A. Martin
Chief

Operator's Well Number: 11701
Farm Name: GREER STEEL
U.S. WELL NUMBER: 47-061-00337-00-00
Vertical / Plugging
Date Issued: 9/15/2017

Promoting a healthy environment.

09/15/2017

OG-10
Rev. 9-71

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
Oil and Gas Division
WELL RECORD

47-061-00337

Rotary X Oil
Cable Gas X
Recycling Comb.
Water Flood Storage
Disposal (Kind)

Quadrangle Morgantown
Permit No. MON-337

Company Consolidated Gas Supply Corp.
Address Clarksburg, WV
Farm Greer Steel Co. Acres 154.34
Location (waters) Deckers Creek
Well No. 11701 Elev. 1996
District Morgan County Monongalia
The surface of tract is owned in fee by
Greer Steel Co.
Address Morgantown, WV
Mineral rights are owned by Same
Address
Drilling Commenced 7-16-74
Drilling Completed 8- 9-74
Initial open flow cu. ft. bbls.
Final production 1600 M cu. ft. per day bbls.
Well open 11 days hrs. before test 3046# RP.

Casing and Tubing	Used in Drilling	Left in Well	Cement fill up Cu. ft. (Sks.)
Size 20-16 Cond.			
13-10"	32	32	To Surface
9 5/8	1042	1042	375 SKS
8 5/8			
7			
5 1/2			
4 1/2	8047	8047	300 SKS
3			
2	7933	7933	
Liners Used			

Attach copy of cementing record.

Well treatment details:
Fractured 10-3-74. Loaded hole with 1000 gal. hyd. acid. 1st stage with 1115 bbl. 5% hyd. acid. Trailed in 750# walnut shells. 2nd stage with 1000 gal. 20% hyd. acid, 625 bbl. 5% hyd. acid. Trailed in 750# walnut shells. Perf. 7891-96, 5 holes; 7901-14, 13 holes; 7922-27, 5 holes; 7940-53, 13 holes; 7958-71, 13 holes.

Coal was encountered at Feet Inches
Fresh water 29, 45, 760 Feet Salt Water Feet
Producing Sand Chert - Huntersville Depth 7891-7971

Formation	Color	Hard or Soft	Top Feet	Bottom Feet	Oil, Gas or Water	* Remarks
Electric Log						
Greenbrier			403	612		
Speechley			2389	2412		
Benson			3870	3908		
Tully			7286	7390		
Onondaga			7835	7881		
Chert			7881			
Total Depth				8109 G.L.		

K. B. Measurement 16' above G.L.

(over)

* Indicates Electric Log tops in the remarks section.

FEB 26 1975

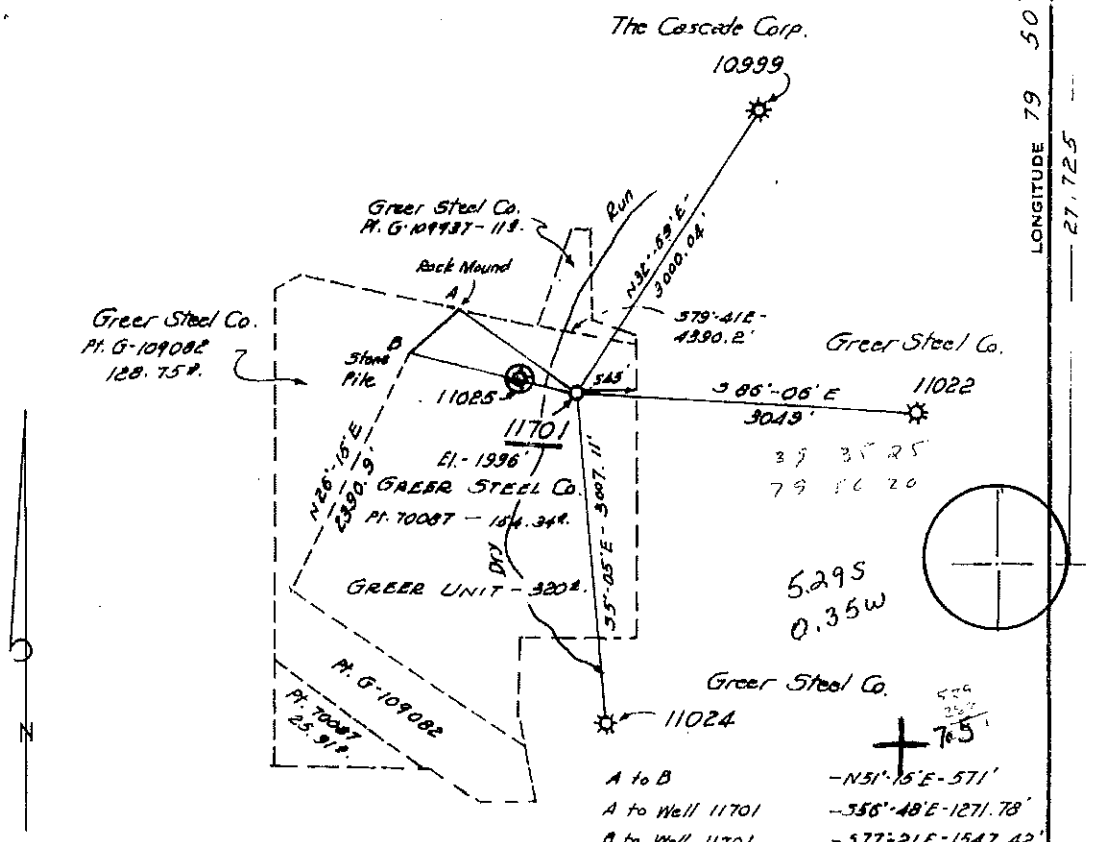
Plot ✓ Log ✓ Card ✓ CSD MW Mflm MM

5/22/74 CRM

39 37 30

LATITUDE 39 ° 40 '

LONGITUDE 79 30 ', 27,725



39 37 25
79 26 20

5.29S
0.35W

765

A to B	-N51°-15'E-571'
A to Well 11701	-S58°-48'E-1271.78'
B to Well 11701	-S77°-21'E-1547.42'
⊥ Dist. to Unit Line	- East - 545'
Well 11025 to Well 11701	-S79°-25'E- 518'

Minimum Error of Closure 1' IN 200'

Source of Elevation B.M.- CONSOLIDATED GAS SUPPLY CORP.
WELL Nº 11025 - ELEV. 1952'

"I, the undersigned, hereby certify that this map is correct to the best of my knowledge and belief and shows all the information required by paragraph 6 of the rules and regulations of the oil and gas section of the mining laws of West Virginia."

New Location ☒
Drill Deeper ☐
Abandonment ☐

MAP SHEET - 933 C-2

FB 1674 PG. 39
FB 1647 PG. 10-13

Company CONSOLIDATED GAS SUPPLY CORP.
Address CLARKSBURG, W. VA.
Farm GREER STEEL CO.
Tract ____ Acres 154.34 Lease No. Pt. 70087
Well (Farm) No. ____ Serial No. 11701
Elevation (Spirit Level) 1996'
Quadrangle MORGANTOWN (C")
County MONONGALIA District MORGAN
Engineer Jackson M. Jarvis
Engineer's Registration No. 2397
File No. ____ Drawing No. ____
Date Nov. 26, 1973 Scale 1" = 1320'

STATE OF WEST VIRGINIA
DEPARTMENT OF MINES
OIL AND GAS DIVISION
CHARLESTON

WELL LOCATION MAP

FILE NO. MON-337

+ Denotes location of well on United States Topographic Maps, scale 1 to 62,500, latitude and longitude lines being represented by border lines as shown.

— Denotes one inch spaces on border line of original tracing.

47 061

6-6 South Burns Chapel (313) (Drink) Deep Well JUN 21 1974 6466

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-8. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permi

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Well API	Operator	Surface Owner	Well Number
4706101082	HG ENERGY, LLC	SHAFFER, JOHN G. ETAL.	GREER A-1909

The operator listed above is the CURRENT operator of the well.

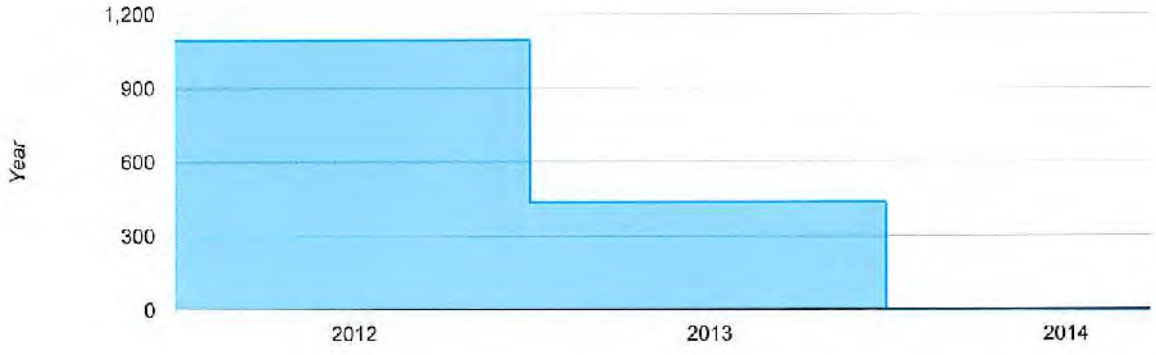
This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

All amounts expressed in mcfg (thousand cubic feet)

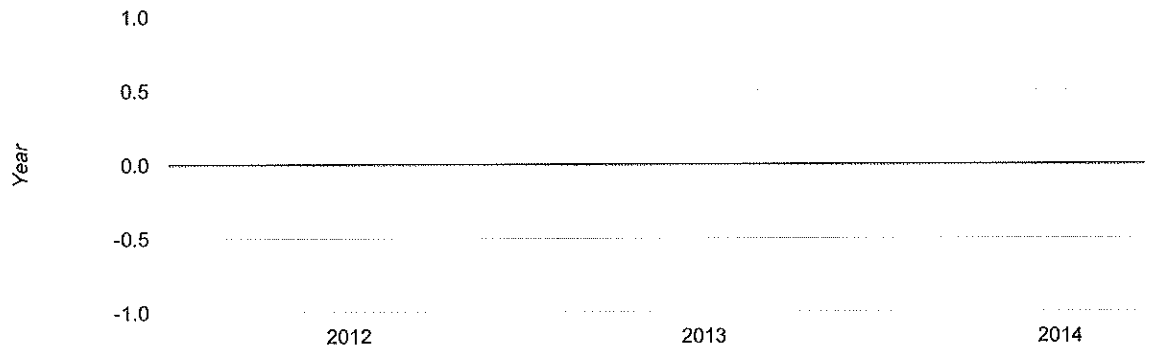
Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
HG ENERGY, LLC	2016	0	0	0	0	
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	93	99	111	132	
CHESAPEAKE APPALACHIA, L.L.C.	2012	160	86	85	85	8



Well Lifetime Oil Production

All amounts expressed in barrels

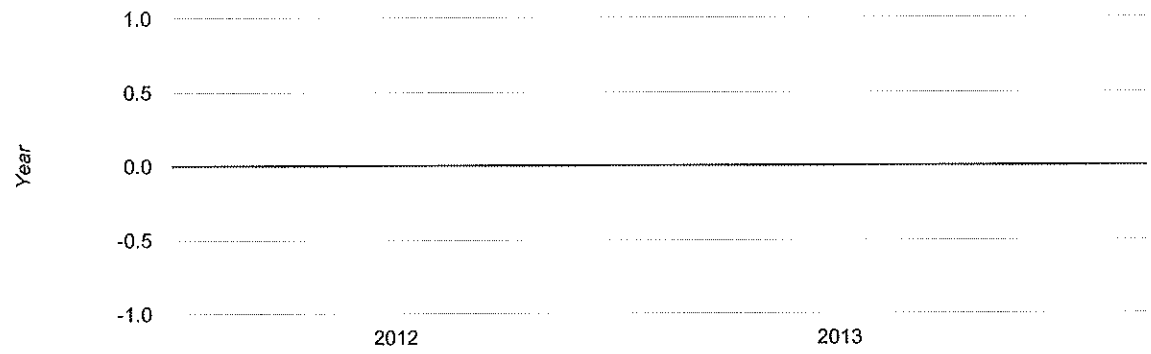
Reporting Operator	Year	Jan	Feb	Mar	Apr	Ma
HG ENERGY, LLC	2016	0	0	0	0	
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0	



Well Lifetime NGL Production

All amounts expressed in barrels

Reporting Operator	Year	Jan	Feb	Mar	Apr	Mi
SWN PRODUCTION COMPANY, LLC	2015	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2014	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2013	0	0	0	0	
CHESAPEAKE APPALACHIA, L.L.C.	2012	0	0	0	0	



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We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better se

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

WR-35

OCT 16 92
WV Division of Environmental Protection

08-Sep-92
API # 47- 61-01082

State of West Virginia
Division of Environmental Protection
Section of Oil and Gas

Well Operator's Report of Well Work

Farm name: SHAFFER, JOHN G. ETAL. Operator Well No.: GREER A-1909

LOCATION: Elevation: 2193.00 Quadrangle: MASONTOWN

District: MORGAN County: MONONGALIA
Latitude: 9375 Feet South of 39 Deg. 37Min. 30 Sec.
Longitude 300 Feet West of 79 Deg. 50 Min. 0 Sec.

Company: ALAMCO, INC.
200 W. MAIN ST., P.O. BOX 1740
CLARKSBURG, WV 26302-1740

Agent: MARTY L. PERRI

Inspector: RANDAL MICK
Permit Issued: 09/08/92
Well work Commenced: 09/11/92
Well work Completed: 10/06/92
Verbal Plugging
Permission granted on: -
Rotary X Cable Rig
Total Depth (feet) 3043'KB
Fresh water depths (ft) 38'

Salt water depths (ft) None

Is coal being mined in area (Y/N)? N
Coal Depths (ft): 175' - 179'

Casing & Tubing	Used in Drilling	Left in Well	Cement Fill Up Cu. Ft.
Size 11-3/4"	40'	-	-
8-5/8"	796'	796'	To Surface
4-1/2"	3010'	3010'	To 2180' KB
2-3/8"	2850'	2850'	-

OPEN FLOW DATA: (No Test)

Producing formation Speechley & Balltown Pay zone depth (ft) 2607' KB - 2882' KB
Gas: Initial open flow - MCF/d Oil: Initial open flow - Bbl/d
Final open flow - MCF/d Final open flow - Bbl/d
Time of open flow between initial and final tests - Hours
Static rock Pressure 680 psig (surface pressure) after 72 Hours

Second producing formation Pay zone depth (ft)
Gas: Initial open flow MCF/d Oil: Initial open flow Bbl/d
Final open flow MCF/d Final open flow Bbl/d
Time of open flow between initial and final tests Hours
Static rock Pressure psig (surface pressure) after Hours

NOTE: ON BACK OF THIS FORM PUT THE FOLLOWING: 1). DETAILS OF PERFORATED INTERVALS, FRACTURING OR STIMULATING, PHYSICAL CHANGE, ETC. 2). THE WELL LOG WHICH IS A SYSTEMATIC DETAILED GEOLOGICAL RECORD OF ALL FORMATIONS, INCLUDING COAL ENCOUNTERED BY THE WELLBORE.

For: ALAMCO, INC.

By: [signature]
Date: 10-12-92

Reviewed TM6
Recorded

FORMATION DEPTHS:

Top	Bottom	Rock Type
0	80	Sand & Shale
80	175	Sand
175	179	Coal & Black Shale
179	330	Sand & Shale
330	360	Red Rock & Shale
360	540	Sand & Shale
540	559	Little Lime
559	577	Sand & Shale
577	685	Big Lime
685	800	Sand & Shale
800	890	Big Injun
890	920	Sand & Shale
920	989	Weir
989	1115	50-Ft. Sand
1115	1676	Sand & Shale
1676	1704	Sand
1704	1920	Sand & Shale
1920	1996	Shale
1996	2014	Sand
2014	2092	Shale
2092	2150	Sand & Shale
2150	2551	Shale
2551	2577	1st Speechley
2577	2603	Shale
2603	2637	2nd Speechley
2637	2681	Sand & Shale
2681	2697	3rd Speechley
2697	2738	Shale
2738	2745	1st Balltown
2745	2866	Sand & Shale
2866	2884	2nd Balltown
2884	3043	Sand & Shale

1/2" H_2O @ 38'

Gas Check @ 635' N/S
Gas Check @ 667' N/S
Gas Check @ 948' N/S
Gas Check @ 1748' N/S
Gas Check @ 1870' N/S
Gas Check @ 1995' N/S
Gas Check @ 2489' N/S
Gas Check @ 2729' Slight Blow
Gas Check @ 2797' N/S
Gas Check @ 2960' Smell Gas
Gas Check @ TD N/S

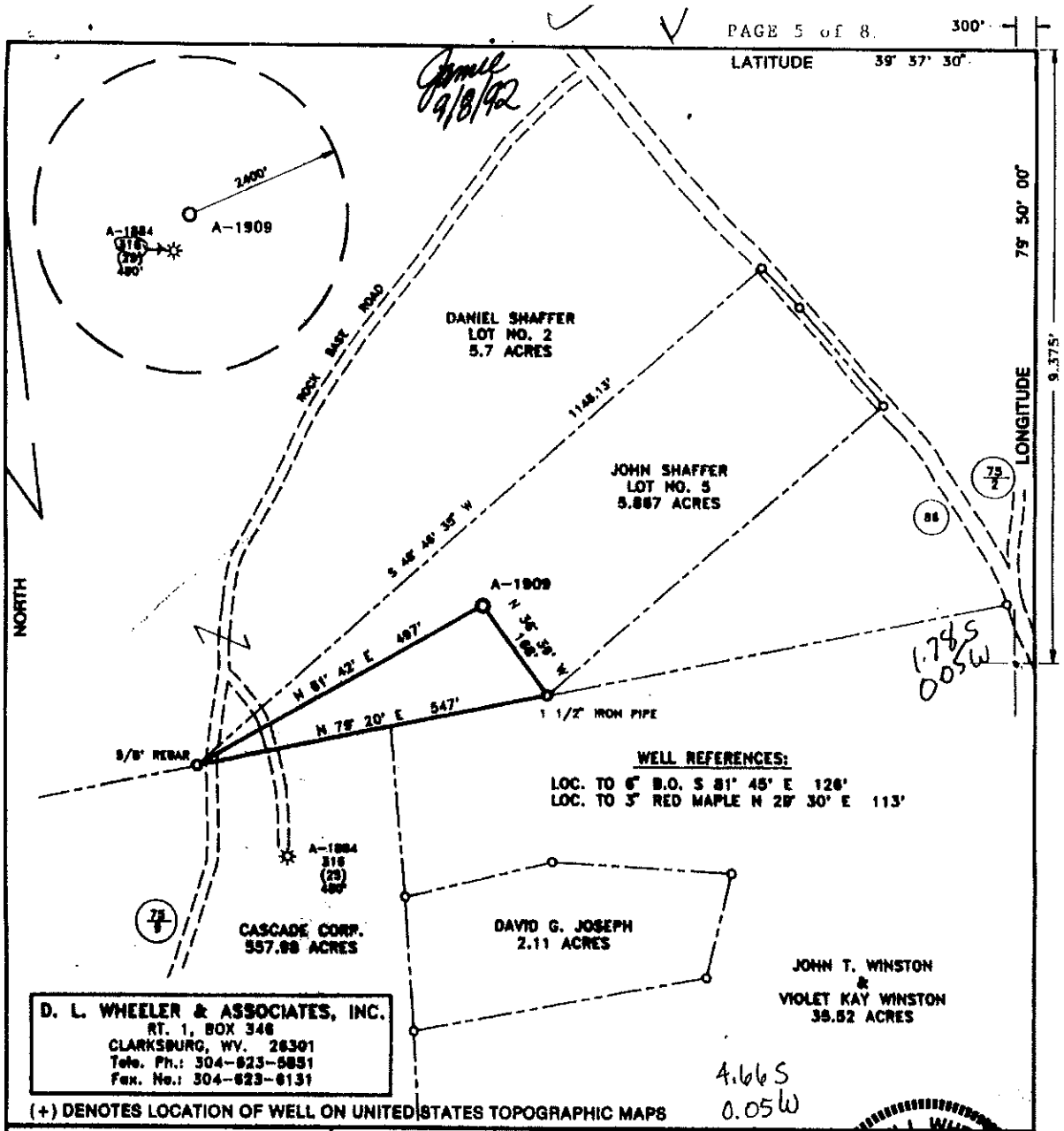
Perforation Intervals:

2607' KB-2625' KB - 7 Holes
2651' KB - 1 Hole
2683' KB-2693' KB - 6 Holes
2738' KB-2744' KB - 4 Holes
2868' KB-2882' KB - 8 Holes

Well A-1909 was fractured on on 09/28/92 with 20,000 lbs. of 20/40 sand in Speechley sands and 20,000 lbs. of 20/40 sand in Balltown Sands.

13997

RSQ\1012921.8



D. L. WHEELER & ASSOCIATES, INC.
RT. 1, BOX 346
CLARKSBURG, WV. 26301
Tele. Ph.: 304-623-5851
Fax. No.: 304-623-6131

(+) DENOTES LOCATION OF WELL ON UNITED STATES TOPOGRAPHIC MAPS

FILE NO. _____
DRAWING NO. _____
SCALE 1" = 200'
MINIMUM DEGREE OF ACCURACY 1 IN 200
PROVEN SOURCE OF ELEVATION WELL API NO. 316 ELEV. 2124'

I THE UNDERSIGNED, HEREBY CERTIFY THAT THIS PLAT IS CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND SHOWS ALL THE INFORMATION REQUIRED BY LAW AND THE REGULATIONS ISSUED AND PRESCRIBED BY THE DEPARTMENT OF ENERGY.

(SIGNED) Daniel L. Wheeler

R.P.E. _____ L.L.S. 530 DANIEL L. WHEELER

DANIEL L. WHEELER LICENSED No. 530 STATE OF WEST VIRGINIA LAND SURVEYOR
PLACE SEAL HERE

STATE OF WEST VIRGINIA
DEPARTMENT OF ENERGY
OIL AND GAS DIVISION

DATE JULY 8, 19 92
OPERATOR'S WELL NO. A-1909
API WELL NO.
47 - 061 - 1082
STATE COUNTY PERMIT

WELL TYPE: OIL ___ GAS X LIQUID INJECTION ___ WASTE DISPOSAL ___
(IF "GAS,") PRODUCTION X STORAGE ___ DEEP ___ SHALLOW X
LOCATION: ELEVATION 2193' WATER SHED DRY RUN OF DECKERS CREEK
DISTRICT MORGAN COUNTY MONONGALIA
QUADRANGLE MASONTOWN 7.5' Morgantown C
SURFACE OWNER JOHN SHAFFER ACREAGE 5.867 AC.
OIL & GAS ROYALTY OWNER GREER STEEL CO., ET. AL. LEASE ACREAGE 320 AC.
LEASE NO. _____
PROPOSED WORK: DRILL X CONVERT ___ DRILL DEEPER ___ REDRILL ___ FRACTURE OR STIMULATE ___ PLUG OFF OLD FORMATION ___ PERFORATE NEW FORMATION ___ OTHER PHYSICAL CHANGE IN WELL (SPECIFY) _____
PLUG AND ABANDON ___ CLEAN OUT AND REPLUG ___
TARGET FORMATION SPEECHLY/BALLTOWN ESTIMATED DEPTH 3400'
WELL OPERATOR ALAMCO, INC. DESIGNATED AGENT MARTI PERRY
ADDRESS P.O. BOX 1740 OLD ADDRESS P.O. BOX 1740
CLARKSBURG, WV. 26301 6-6.2 South Burns Chapel (313) CLARKSBURG, WV. 26301

SEP 11 1992

COUNTY NAME
PERMIT

FORM WW-6
H.T. HALL 4875

WVDEP Office of Oil and Gas - Well Search

Disclaimer: Per §22-6-6. Permit required for all well work; permit fee; application; soil erosion control plan.

(a) It is unlawful for any person to commence any well work, including site preparation work, which involves any disturbance of land, without first securing a well work permit from the director of the WVDEP Office of Oil and Gas.

The appearance of an API number on the web page does not signify that a permit has been issued. The API number is used as a tracking mechanism until the permit has been issued. Under no circumstances should well work be commenced without a signed permit.

Well API	Operator	Surface Owner	Well Number	Well Status	Well Type	Last Permit Issue Date
4706101370	COLUMBIA NATURAL RESOURCES, LLC	CALE, PERCY & THELMA	623827	Plugged	Vertical	12/23/1999

The operator listed above is the CURRENT operator of the well.

This operator may or may not have recorded production for this well for the years listed below.

The production listed below spans this well's 5 last years, regardless of the operator who originally recorded a particular year's production numbers.

Well Lifetime Gas Production

No Production Reported

Well Lifetime Oil Production

No Production Reported

Well Lifetime NGL Production

No Production Reported

The West Virginia Department of Environmental Protection (WVDEP) makes oil and gas well information and production data available to the general public through this internet service free of charge.

The oil and gas related data originate from the information reported to the Office of Oil and Gas at WVDEP by West Virginia oil and gas operators. The WVDEP does not guarantee their accuracy, precision, or completeness.

Neither the West Virginia Department of Environmental Protection nor its staff members are liable or responsible for any damage or loss resulting from the use of these data or from inaccuracies contained in the data.

We encourage you to report any problems, inconsistencies, or errors noted in using this data to the Office of Oil and Gas so that we can correct them and provide better service.

Office of Oil and Gas
Department of Environmental Protection
601 57th St
Charleston, West Virginia 25304
Phone: (304) 926-0499
Fax: (304) 926-0452

WR-38

API # 47 - 61 - 01370P

Office of Oil & Gas Permitting

JAN 12 2000

WV Division of Environmental Protection

STATE OF WEST VIRGINIA
DIVISION OF ENVIRONMENTAL PROTECTION
SECTION OF OIL AND GAS

AFFIDAVIT OF PLUGGING AND FILLING WELL

AFFIDAVIT SHOULD BE IN TRIPLICATE, one copy mailed to the Division, one copy to be retained by the Well Operator and the third copy (and extra copies if required) should be mailed to each coal operator at their respective addresses.

Farm name: Cale, Percy & Thelma Operator Well No.: 623827

LOCATION: Elevation: 1947.00 Quadrangle: Masontown

District: Morgan County: Monongalia

Latitude: 11850 Feet South of 39 Deg. 37 Min. 30 Sec.

Longitude: 7600 Feet West of 79 Deg. 47 Min. 30 Sec.

Well Type: OIL _____ GAS XX

Company: Columbia Natural Resources, Inc.
Rt. 1, Box 107-10
Buckhannon, WV 26201

Coal Operator: No Record Declaration

Agent: R. Mark Hackett

Coal Owner: Preston County Coal & Coke Co.
PO Box 1900
Morgantown, WV 26505

Permit Issued: 12/23/99

AFFIDAVIT

STATE OF WEST VIRGINIA,
County of Upshur ss:

Mark Jenkins and Mark Hackett being first duly sworn according to law depose and say that they are experienced in the work of plugging and filling oil and gas wells and were employed by the above named well operator, and participated in the work of plugging and filling the above well, and Randal Mick Oil and Gas Inspector representing the Director, say that said work was commenced on the 10th day of December, 1999, and that the well was plugged and filled in the following manner:

TYPE	FROM	TO	PIPE REMOVED	LEFT
6% Gel	TD	Surface	6000' - 4-1/2"	341' - 11-3/4"
Class A 50 sx	8000	7400		2821' - 8-5/8"
Class A 60 sx	6000	5800		2189' - 4-1/2"
Class A 30 sx	4000	3900		
Class A 60 sx	2900	2700		
Class A 30 sx	100	surface		

1/19/00

Description of monument : 5' of 8-5/8" casing, vented
and that the work of plugging and filling said well was completed on the 14th day of December, 1999.

And further deponents saith not.

Mark Jenkins

Mark Hackett

Sworn and subscribed before me this 6th day of January, 2000

My commission expires: Dec 9, 2002

Elsie M. Cox
Notary Public

Oil and Gas Inspector: Randal Mick

COLUMBIA NATURAL RESOURCES
ELSIE M. COX
STATE OF WEST VIRGINIA
NOTARY PUBLIC
Route 1, Box 107-10
Buckhannon, WV 26201

MONO 1370 P

WR-35

DATE: 09-Sep-99
API #: 47-61-01370

State of West Virginia
Division of Environmental Protection
Section of Oil and Gas

Revised K

Well Operator's Report of Well Work

Farm name: CALE, PERCY & THELMA Operator Well No.: 623827

LOCATION: Elevation: 1,947.00 Quadrangle: MASONTOWN

District: MORGAN County: Monongalia

Latitude: 11850 Feet Sout of 39 Deg. 37 Min. 30 Sec.

Longitude 7600 Feet West of 79 Deg. 47 Min. 30 Sec.

RECEIVED
Office of Oil & Gas
Permitting
JAN 10 2000
WV Division of
Environmental Protection

Company: COLUMBIA NATURAL RESOURCES

Address: Rt. 1, Box 107-10
Buckhannon, WV 26201

Agent: R. Mark Hackett

Inspector: Randal Mick

Date Permit Issued: 09/10/99

Date Well Work Commenced: 09-22-99

Date Well Work Completed: 12-14-99

Verbal Plugging:

Date Permission granted on:

Rotary X Cable Rig

Total Depth (feet): 8260

Fresh Water depths (ft): 40, 381

Salt water depths (ft): None

Is coal being mined in area (Y/N)? N

Coal Depths (ft): None

	Casing & Tubing	Used in drilling	Left in well	Cement fill up Cu. Ft.
	11-3/4	341	341	CTS
	8-5/8	2821	2821	CTS
	4-1/2	8189	8189	200 SXS

OPEN FLOW DATA

Producing formation Chert Pay zone depth (ft) 7947-8010 KB

Gas: Initial open flow 0 MCF/d Oil: Initial open flow n/a Bbl/d

Final open flow 0 MCF/d Final open flow n/a Bbl/d

Time of open flow between initial and final tests 4 Hours

Static rock Pressure 900 psig (surface pressure) after 72 Hours

Second producing formation _____ Pay zone depth (ft) _____

Gas: Initial open flow _____ MCF/d Oil: Initial open flow _____ Bbl/d

Final open flow _____ MCF/d Final open flow _____ Bbl/d

Time of open flow between initial and final tests _____ Hours

Static rock Pressure _____ psig (surface pressure) after _____ Hours

NOTE: ON BACK OF THIS FORM PUT THE FOLLOWING: 1). DETAILS OF PERFORATED INTERVALS, FRACTURING OR STIMULATING, PHYSICAL CHANGE, ETC. 2). THE WELL LOG WHICH IS A SYSTEMATIC DETAILED GEOLOGICAL RECORD OF ALL FORMATIONS, INCLUDING COAL ENCOUNTERED BY THE WELLBORE.

Signed: COLUMBIA NATURAL RESOURCES, INC.

By: R. Mark Hackett

Date: 01/06/2000

MOND 1370

FEB 10 2000

FORMATION RECORD:
0 to 466 from Driller's Log Book, 466 to TD from Gamma Ray Log

FROM	TO	ROCK TYPE (described rock types and other minerals penetrated and record occurrences of oil, gas and water from surface to total depth)
0	35	Sd.
35	290	Sd. & Sh.
290	355	Sd.
355	466	Sd. & Sh.
466	500	Little Lime
500	620	Greenbrier Limestone
620	1671	Sd. & Sh.
1671	1704	4th Sd.
1704	1803	Sd. & Sh.
1803	1849	5th Sh.
1849	2455	Sd. & Sh.
2455	2488	Speechley
2488	2720	Sd. & Sh.
2720	2735	Balltown
2735	6430	Sd. & Sh.
6430	6550	Fault zone
6550	7411	Sd. & Sh.
7411	7510	Tully
7510	7580	Hamilton
7580	7610	Fault zone
7610	7803	Hamilton
7803	7914	Marcellus
7914	7944	Onondaga
7944	8089	Chert
8089	8130	Oriskany
8130		Helderberg
	8260	DTD
	8224	LTD

WATER:

Depth (ft)	Amount	Type
40	damp	fresh
381	damp	fresh

GAS CHECKS:

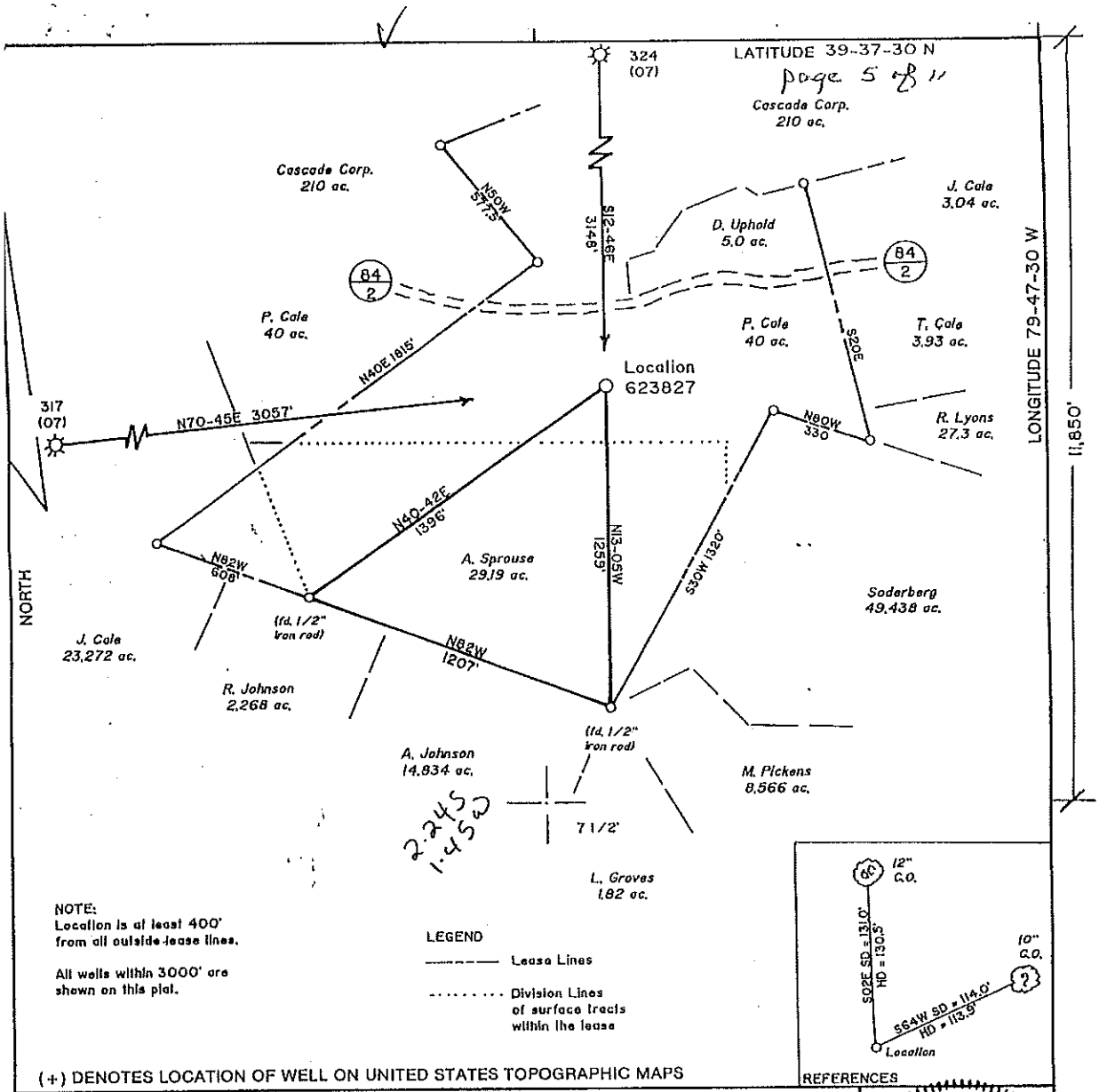
Depth(ft)	MCF/D
All	NS

OIL SHOWS:

Depth	Amount
None	

PERFORATIONS:
Chert (22 holes) 7947-8010' KB.

STIMULATION:
500 gals. 15% HCl acid.



(+) DENOTES LOCATION OF WELL ON UNITED STATES TOPOGRAPHIC MAPS

FILE NO. _____
DRAWING NO. 1
SCALE 1" = 500'
MINIMUM DEGREE OF ACCURACY 1 in 200
PROVEN SOURCE OF ELEVATION Road intersection 4043' NW of Location; elev. 2224'

I THE UNDERSIGNED, HEREBY CERTIFY THAT THIS PLAT IS CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF AND SHOWS ALL THE INFORMATION REQUIRED BY LAW AND THE REGULATIONS ISSUED AND PRESCRIBED BY THE DEPARTMENT OF ENERGY.
(SIGNED) David L Jackson
R.P.E. _____ L.L.S. 708

DAVID L. JACKSON LICENSED NO. 708 STATE OF WEST VIRGINIA PROFESSIONAL SURVEYOR
PLACE SEAL HERE

STATE OF WEST VIRGINIA
Division of Environmental Protection
OFFICE OF OIL AND GAS

DATE April 15, 1999
OPERATOR'S WELL NO. 623827
API WELL NO.
47 _ 061 _ 01370
STATE COUNTY PERMIT

WELL TYPE: OIL ___ GAS X LIQUID INJECTION ___ WASTE DISPOSAL ___
(IF "GAS,") PRODUCTION X STORAGE ___ DEEP X SHALLOW ___
LOCATION: ELEVATION 1947 WATER SHED Bee Run
DISTRICT Morgan COUNTY Monongalia
QUADRANGLE Masontown 7 1/2'
SURFACE OWNER Percy R. Cole and Thelma E. Cole ACREAGE 40
OIL & GAS ROYALTY OWNER Preston County Coal and Coke Corp. LEASE ACREAGE 3252.81
LEASE NO. 7004204
PROPOSED WORK: DRILL X CONVERT ___ DRILL DEEPER ___ REDRILL ___ FRACTURE OR STIMULATE ___ PLUG OFF OLD FORMATION ___ PERFORATE NEW FORMATION X OTHER PHYSICAL CHANGE IN WELL (SPECIFY) _____
PLUG AND ABANDON ___ CLEAN OUT AND REPLUG ___
TARGET FORMATION Huntersville Chert ESTIMATED DEPTH 8300
WELL OPERATOR Columbia Natural Resources, Inc. DESIGNATED AGENT W. A. Watson Jr.
ADDRESS P. O. Box 6070, Charleston, WV 25362 ADDRESS P. O. Box 6070, Charleston, WV 25362

COUNTY NAME MONO
PERMIT 1370

SEP 10 1999

APPENDIX D

APPENDIX D

Public Service District Affidavit

Underground Injection Control Permit applicants must identify all publically recorded drinking water sources within a one (1) mile radius of the proposed injection well facility. If no drinking water sources are present within this radius a written affidavit shall be supplied by the local Public Service District (PSD) as ample verification.

"I certify under penalty of law that (state name of business)

HG Energy, LLC.

has verified with the public service district (state name of PSD)

Masontown Water Works

that there are no such publically recorded sources."

Donna Montgomery

(Signature of Authorized Representative)

Sworn and subscribed to before me this 16th day of November, 2017.

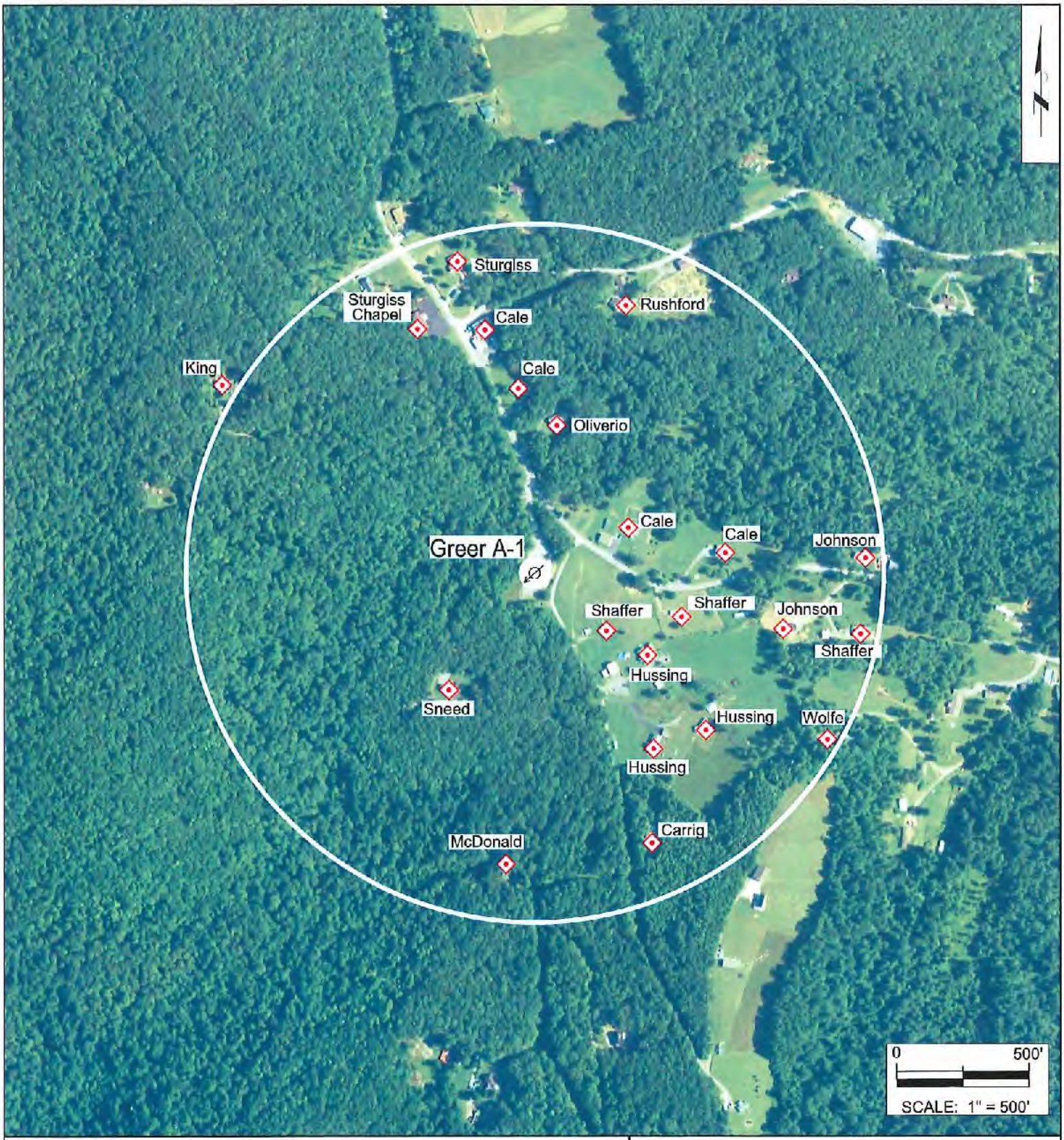
_____, my commission expires May 21, 2022

(Notary Signature)

JoAnn Galusky

JO ANN GALUSKY
Notary Public Official Seal
State of West Virginia
My Commission Expires May 21, 2022
201 Pleasant Street, PO Box [illegible], Masontown WV 26542

APPENDIX E



Map Showing UIC Area of Review
and Possible Water Supply Sources for:

Greer A-1 SWD

(47-061-00317)

Morgan District, Monongalia County, W.Va.

6/23/2017

Legend

- Subject Well - Greer A-1 (47-061-00317)
- Possible Water Supply Source & Owner
- 1/4 Mile Area of Review

HG ENERGY LLC

Water Supply Sources Investigated for:

GREER A-1 SWD (47-051-00317) - UIC Permit Renewal

TEST	MAP	PARCEL	OWNER	C/O	ADDRESS	PHONE	VISITED	WSW / CITY WATER	UTM (NAD 83) N	UTM (NAD 83) E	LAT	LONG	COMMENTS
YES	14	23	CALE BERNARD & ELLA		2541 SNAKE HILL RD , MASONTOWN , WV 26542	304-864-2227	9/8/2017	WSW	4,382,826	600,676	39.592164	79.827562	Has 1 WSW.
YES	14	13.1	CALE THELMA F		2579 SNAKE HILL RD , MASONTOWN , WV 26542	304-864-3676	9/8/2017	WSW	4,383,125	600,536	39.591962	79.829159	Has 1 WSW. Truck garage is on City Water.
YES	14	13.4	JOHNSON RICKY E & PATRICIA RAE		2519 SNAKE HILL RD , MASONTOWN , WV 26542	Unlisted	9/8/2017	WSW & City	4,382,918	600,898	39.595008	79.824980	WSW & City Water as per Jerald Johnson (brother). Multiple calls and a site visit completed. Certified letter sent asking permission to test 9-14-17. No response.
YES	14	22; 23	MCCANIE, CHARLES & CLARE		122 GANDALF RD , MASONTOWN , WV 26542	304-638-5743	9/13/2017	WSW	4,382,542	600,528	39.592704	79.829345	Has 1 WSW. Clare Mccanie Cell - 304-288-5409
YES	14	12	RUSHFORD WILLIAM JEFFREY & PATRICIA		56 STURGISS SCHOOL RD , MASONTOWN , WV 26542	304-864-3851	9/8/2017	WSW	4,383,232	600,757	39.595893	79.826576	Barn Well. Rushfords want to be present during testing
YES	14	22.2	RUSHFORD WILLIAM JEFFREY & PATRICIA		56 STURGISS SCHOOL RD , MASONTOWN , WV 26542	304-864-3851	9/8/2017	WSW	4,383,119	600,649	39.595783	79.827835	House Well. Rushfords want to be present during testing
YES	14	18	WOLFE CALVIN & HAZEL		1837 SNAKE HILL RD , MASONTOWN , WV 26542	304-864-5674	9/8/2017	WSW	4,383,240	600,465	39.596002	79.829970	Has 1 WSW
YES	14	16.5; 16.16	WOLFE JAMES L & NANCY I		2064 SNAKE HILL RD , MASONTOWN , WV 26542	304-864-5735	9/13/2017	WSW	4,382,807	601,061	39.589030	79.823059	Outside of 1/4 Mile But we should test
NO	14	16.1; 16.3	BLANEY DAVID T & ROBIN L		25 STURGISS SCHOOL RD , MASONTOWN , WV 26542	304-864-8068	9/13/2017	WSW	4,383,543	600,528	39.598824	79.823220	WSW Beyond Quarter Mile Radius
NO	14	16.2	CARRIG PAMELA		77 DIEW DR , MASONTOWN , WV 26542	NA	9/13/2017	City					City Water as per Bobby & Sunni Hussing
NO	14	12.3	FEDAN JEFFREY S & KATHLEEN B		110 STURGISS SCHOOL RD , MASONTOWN , WV 26542	NA	9/13/2017	WSW	4,383,290	600,873	39.598042	79.826215	WSW Beyond Quarter Mile Radius
NO	14	16.26	FIELDS DEREK J		2064 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/13/2017	NA					City Water as per Bobby Hussing (Fields Father-In-Law)
NO	14	16.26	FIELDS DEREK J		2064 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/13/2017	City					City Water according to Bobby Hussing
NO	14	10.11	GARBRICK BARRY L & AMY J		1822 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	City					City Water as per Mother-in-law
NO	14	25; 46	GREER INDUSTRIES INC		PO BOX 1900 , MORGANTOWN , WV 26507	NA	9/8/2017	NA					No Structures on Property
NO	14	13.5	HOSTETLER JOSEPH E & SUEANN M		1948 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	City					City Water according to Bernard Cale (Father)
NO	14	16.6; 16.10; 16.12; 16.15; 16.20; 16.23; 16.24; 16.25	HUSSING BOBBY L & SUNNI		1950 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/13/2017	City					Visited with Bobby Hussing. He said all of properties in Hussing's name have City Water.
NO	14	16.6; 16.14; 16.17	JOHNSON JERALD & DANA		2020 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	City					Has City Water as per Jerald Johnson
NO	14	16.3	JOHNSON JODY LOREN		2016 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	City					Has City Water as per Jerald Johnson (Father)
NO	14	26	LANE BRUCE D & AMANDA R		211 SAWYER DR , HARPERS FERRY , WV 25425	NA	9/8/2017	NA					No Structures on Property
NO	14	13.2; 15.3	OLIVERIO MICHAEL A & KATHRYN L		1893 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	City					Has City Water as per Michael Oliverio
NO	14	18.2	PAINTER GARY D		PO BOX 4037 , STAR CITY , WV 26504	NA	9/8/2017	WSW	4,383,159	600,398	39.593548	79.830735	WSW Beyond Quarter Mile Radius
NO	14	16.19	PRIDE PAULA ANN		PO BOX 1542, MORGANTOWN, WV 26542	NA	9/13/2017	City					Has City Water as per Paula Pride
NC	14	16	SHAFFER BURTON, DAVID, FRANCES JOHNSON, JUDY ANN THORN	C/O BOBBY & SUNNI HUSSING	1950 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/8/2017	NA					No Structures on Property
NC	14	16.7	SHAFFER HARVEY W & LINDA S		1980 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/13/2017	NA					No Structures on Property
NC	14	16.11	SHAFFER JACK E		1982 SNAKE HILL RD , MASONTOWN , WV 26542	NA		City					Has City Water as per Jack Shafer
NC	14	16.22	SHAFFER ROBERT E & PAUL W	% NANCY WOLFE	2064 SNAKE HILL RD , MASONTOWN , WV 26542	NA	9/13/2017	City					City Water according to Bobby Hussing
NC	14	55	SNEED EVERETT L & TRACEY L		20 ROBERTS GLEN , MASONTOWN , WV 26542	NA	9/13/2017	City					Has City Water as per Sneed's son
NC	14	27	STONE MICHAEL & AMANDA BROOKE		187 GANDALF RD , MASONTOWN , WV 26542	NA	9/8/2017	WSW					WSW Beyond Quarter Mile Radius
NC	14	10.4; 11; 11.1	STURGISS CHAPEL U M CHURCH	DANIEL SHAFFER	1612 SNAKE HILL RD , MASONTOWN , WV 26542	304-864-0526	9/13/2017	WSW & City	4,383,196	600,418	39.592611	79.830525	As per Daniel Shaffer, Church is using City Water and the pump in the well is not working
NC	14	21	WILSON CHASE ALAN		812 OAKLAND ST , MORGANTOWN , WV 26505	NA	9/13/2017	City					Has City Water as per Chase Wilson
NC	14	10.5	WINSTON THOMAS S & RAE ANNE		PO BOX 474 , REEDSVILLE , WV 26547	NA	9/13/2017	NA					No Structures on Property

Updated - 9/14/2017

APPENDIX E
Water Sources

Operator: HG Energy, LLC. Year 2017 UIC Permit # 2D0610317

		Source # 1	Source # 2	Source # 3	Source # 4
Water Source Name		Calvin Wolfe	Thelma Cale	Jeff Rushford House	Jeff Rushford Barn
Northing		4,383,240	4,383,125	4,383,219	4,383,232
Easting		600,465	600,536	600,649	600,757
Parameter	Units				
TPH - GRO	mg/L	ND	ND	ND	ND
TPH - DRO	mg/L	ND	ND	ND	ND
TPH - ORO	mg/L	ND	ND	ND	ND
BTEX	mg/L	ND	ND	ND	ND
Chloride	mg/L	1.61	58	8.87	6.08
Sodium	mg/L	0.60	27.4	2.78	1.38
Total Dissolved Solids (TDS)	mg/L	23	163	38	34
Aluminum	mg/L	0.02	0.13	0.02	0.04
Arsenic	mg/L	ND	ND	ND	ND
Barium	mg/L	0.013	0.114	0.021	0.015
Iron	mg/L	ND	0.02	ND	0.04
Manganese	mg/L	ND	0.91	0.003	0.005
pH	SU	7.7	5.5	8	7.4
Calcium	mg/L	1.28	10.4	2.09	2.47
Sulfate	mg/L	4.43	14.9	2.84	1.98
MBAS	mg/L	ND	ND	ND	ND
Dissolved Methane	mg/L	ND	ND	ND	ND
Dissolved Ethane	mg/L	ND	ND	ND	ND
Dissolved Butane	mg/L	ND	ND	ND	ND
Dissolved Propane	mg/L	ND	ND	ND	ND
Bacteria (Total Coliform)	c/100ml	PRESENT	ABSENT	ABSENT	PRESENT

Promoting a healthy environment.

dep

APPENDIX E
Water Sources

Operator: HG Energy, LLC. Year 2017 UIC Permit # 2D0610317

		Source # 5	Source # 6	Source # 7	Source #
Water Source Name		James Wolfe	Bernard Cale	Charles McDaniel	
Northing		4,382,807	4,382,928	4,382,542	
Easting		601,061	600,676	600,528	
Parameter	Units				
TPH - GRO	mg/L	ND	ND	ND	
TPH - DRO	mg/L	ND	ND	ND	
TPH - ORO	mg/L	ND	ND	ND	
BTEX	mg/L	ND	ND	ND	
Chloride	mg/L	17.1	197	4.26	
Sodium	mg/L	6.34	65.3	1.2	
Total Dissolved Solids (TDS)	mg/L	44	368	48	
Aluminum	mg/L	ND	0.51	ND	
Arsenic	mg/L	ND	ND	ND	
Barium	mg/L	0.05	0.366	0.24	
Iron	mg/L	0.29	NA	0.13	
Manganese	mg/L	0.016	0.369	0.03	
pH	SU	7	4.7	7.6	
Calcium	mg/L	4.37	21	4.74	
Sulfate	mg/L	6.98	2.48	1.83	
MBAS	mg/L	ND	ND	ND	
Dissolved Methane	mg/L	ND	ND	ND	
Dissolved Ethane	mg/L	ND	ND	ND	
Dissolved Butane	mg/L	ND	ND	ND	
Dissolved Propane	mg/L	ND	ND	ND	
Bacteria (Total Coliform)	c/100mL	ABSENT	ABSENT	ABSENT	

Promoting a healthy environment.

dep

HG Energy, LLC
5260 Dupont Road
Parkersburg, WV 26101
(304) 420-1100 - Office
(304) 863-3172 - Fax

November 7, 2017

Ricky and Patricia Rae Johnson
2019 Snake Hill Road
Masontown, WV 26542

RE: Attempts to Sample Water Well on Your Property by Sturm Environmental
Monongalia County, West Virginia

Dear Mr. and Mrs. Johnson:

Good afternoon. HG Energy, LLC contracted with Sturm Environmental to take water samples and provide analysis of the water sampled for water sources in your immediate area. Sturm has tried contacting you to set up an appointment to come to your home and take the samples. I wanted to extend another opportunity to you to accept these services. We would also make the water analysis results available to you.

Should you have any questions and/or want to make an appointment, please call me at 304-420-1119.

Very truly yours,

Diane White

Diane C. White

PLACE STICKER AT TOP OF ENVELOPE TO THE RIGHT OF THE RETURN ADDRESS. FOLD AT DOTTED LINE
CERTIFIED MAIL®

7015 3430 0000 4724 8723

7015 3430 0000 4724 8723

U.S. Postal Service™
CERTIFIED MAIL® RECEIPT
Domestic Mail Only

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- ☐ Return Receipt (electronic) $
- ☐ Certified Mail Restricted Delivery $
- ☐ Adult Signature Required $
- ☐ Adult Signature Restricted Delivery $

Postage
$

Total Postage and Fees
$

Postmark Here

Water Testing

Sent To: Ricky and Patricia Rae Johnson
Street and Apt. No., or PO Box No.: 2019 Snake Hill Road
City, State, ZIP+4®: Masontown WV 26542

PS Form 3800, April 2015 PSN 7530-02-000-9047 See Reverse for Instructions

REIC

Improving the environment, one client at a time...

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304) 255-2500
Website: www.reiclabs.com

3029-C Peters Creek Road
Roanoke, VA 24019
TEL: 540.777.1276

1557 Commerce Road, Suite 201
Verona, VA 24482
TEL: 540.248.0183

16 Commerce Drive
Westover, WV 26501
TEL: 304.241.5861

Wednesday, October 18, 2017

Kim Krehel
STURM ENVIRONMENTAL SERVICES
P O BOX 650
BRIDGEPORT, WV 26330

TEL: (304) 623-6549
FAX: (304) 623-6552

RE: H.G. ENERGY, LLC.
Work Order #: 17100647

Dear Kim Krehel:

REI Consultants, Inc. received 2 sample(s) on 10/4/2017 for the analyses presented in the following report.

Sincerely,

Jimmy Suttle

Jimmy Suttle
Project Manager
(304) 250-6234

REI Consultants, Inc. - Case Narrative

WO#: 17100647

Date Reported: 10/18/2017
Original

Client: STURM ENVIRONMENTAL SERVICES

Project: H.G. ENERGY, LLC.

The analytical results presented in this report were produced using documented laboratory SOPs that incorporate appropriate quality control procedures as described in the applicable methods. Verification of required sample preservation (as required) is recorded on associated laboratory logs. Any deviation from compliance or method modification is identified within the body of this report by a qualifier footnote which is defined at the bottom of this page.

All sample results for solid samples are reported on an "as-received" wet weight basis unless otherwise noted.

Results reported for sums of individual parameters, such as TTHM and HAA5, may vary slightly from the sum of the individual parameter results, due to rounding of individual results, as required by EPA.

The test results in this report meet all NELAP and/or VELAP requirements for parameters clearly designated as PA, VA, PA/VA, or VELAP in the column labeled NELAP.

Please note if the sample collection time is not provided on the Chain of Custody, the default recording will be 0:00:00. This may cause some tests to be apparently analyzed out of hold.

All tests performed by REIC Service Centers are designated by an annotation on the test code. All other tests were performed by REIC's Main Laboratory in Beaver, WV.

This report may not be reproduced, except in full, without the written approval of REIC.

DEFINITIONS:
MCL: Maximum Contaminant Level
MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.
Mg/Kg or mg/L: Units of part per million (PPM) - milligram per Kilogram (weight/weight) or milligram per Liter (weight/volume).
NA: Not Applicable
ND: Not Detected at the PQL or MDL
PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.
Qual: Qualifier that applies to the analyte reported.
TIC: Tentatively Identified Compound, Estimated Concentration denoted by "J" qualifier.
Ug/Kg or ug/L: Units of part per billion (PPB) - microgram per kilogram (weight/weight) or microgram per liter (weight/volume).

QUALIFIERS:
X: Reported value exceeds required MCL
B: Analyte detected in the associated Method Blank at a concentration > 1/2 the PQL
E: Analyte concentration reported that exceeds the upper calibration standard. Greater uncertainty is associated with this result and data should be considered estimated.
H: Holding time for preparation or analysis has been exceeded.
J: Analyte concentration is reported, and is less than the PQL and greater than or equal to the MDL. The result reported is an estimate.
S: % REC (% recovery) exceeds control limits

CERTIFICATIONS:
Beaver, WV: WVDHHR 00412CM, WVDEP 060, VADCLS 00281, KYDEP 90039, NCDWQ 466, PADEP 68-00839, VADCLS(VELAP) 460148
Bioassay (Beaver, WV): WVDEP 060, VADCLS(VELAP) 460148, PADEP 68-00839
Roanoke, VA: VADCLS(VELAP) 460150
Verona, VA: VADCLS(VELAP) 460151
Morgantown, WV: WVDHHR 003112M, WVDEP 387

REI Consultants, Inc. - Analytical Report

WO#: 17100647

Date Reported: 10/18/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/2/2017 11:00:00 AM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/4/2017
Lab ID:	17100647-01A	**Matrix:**	Drinking Water
Client Sample ID:	17187 CALVIN WOLFE	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: YT**
TPH (Diesel Range: C10 - C28)	ND	0.13	0.26	NA	mg/L	10/08/17 1:47PM	10/12/17 8:43PM	
TPH (Oil Range: C22 - C36)	ND	0.13	0.26	NA	mg/L	10/08/17 1:47PM	10/12/17 8:43PM	
Surr: o-Terphenyl	62.5	NA	17.6-135	NA	%Rec	10/08/17 1:47PM	10/12/17 8:43PM	
DISSOLVED GASES				**Method: GC-FID**				**Analyst: YT**
Methane	ND	5.00	10.0	NA	µg/L		10/16/17 4:43PM	
Ethane	ND	7.50	15.0	NA	µg/L		10/16/17 4:43PM	
Propane	ND	10.0	20.0	NA	µg/L		10/16/17 4:43PM	
Butane	ND	12.5	25.0	NA	µg/L		10/16/17 4:43PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: CB**
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA	mg/L	10/05/17 4:27PM	10/06/17 4:24PM	
Surr: 2,5-Dibromotoluene	96.5	NA	53.5-143	NA	%Rec	10/05/17 4:27PM	10/06/17 4:24PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**				**Analyst: CB**
Benzene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:24PM	
Toluene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:24PM	
Ethylbenzene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:24PM	
m,p-Xylene	ND	1.00	2.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:24PM	
o-Xylene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:24PM	
Surr: 1,1,1-Trifluorotoluene	83.9	NA	57.1-139	NA	%Rec	10/05/17 4:27PM	10/06/17 4:24PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: CALVIN WOLFE

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-02-17 1100

DATE/TIME RECEIVED: 10-02-17 1320

LABORATORY ID: HG 171002-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FIELD pH	7.2	units			10-02-17 1100	LG
FIELD TEMP	14.8	°C			10-02-17 1100	LG
FIELD COND	26	µmhos			10-02-17 1100	LG
pH O	7.7	units	SM 22nd 4500 H B	.1	10-03-17 0837	KH
TDS	23 J	mg/L	SM22nd 2540 C	4	10-03-17 1135	MRS
SO_4	4.43 J	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-05-17 1252	DC
Cl^-	1.61	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-04-17 0233	DC
MBAS	U	mg/L	SM22nd 5540C	.01	10-03-17 2322	SW
Na	.60	mg/L	EPA 200.7 Rev 4.4-1994	.03	10-05-17 0604	DB
Al	.02 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-04-17 0552	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-11-17 1637	RC
Ba	.013 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-04-17 0552	DB
Fe	U	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-04-17 0552	DB
Mn	U	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-04-17 0552	DB
Ca	1.28	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-04-17 0552	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Doug W. Burns

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: CALVIN WOLFE

SAMPLED BY: L. GARLITZ

LOG NO: W676-17

DATE/TIME SAMPLED: 10-02-17 1100

DATE/TIME RECEIVED: 10-02-17 1320

LABORATORY ID: HG 171002-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	PRESENT	P/A (Cfu)	9223 Colilert	1	10-02-17 1339	LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	10-02-17 1339	LM

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Microbiological analysis results will be discarded after 5 years

Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas M Bennett

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWD
Special Reporting: ☐ Email Results ☐ Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) Please Check One
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: X on file	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
CALVIN WOLFE					10/2/17	1100 AM	X	X					X	X			X				X		11	7.2		26			14.8

Comments
Reco... a retained for 1 years

Relinquished by:	Date	Time	Received by:	Date	Time
	10-2-17	1320		10/2/17	1320
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: 4.6
Bottles Preserved? Y N

collect ##
740 17

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard ___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: 1,4-D/2	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
CALVIN WOLFE					10/2/17	1100 AM	X	X					X	X			X			X			11	7.2		26			14.8

Comments: Keep 4 years all for 5 years

Relinquished by:	Date	Time	Received by:	Date	Time
	10-2-17	1320		10/2/17	1320
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: 4.6
Bottles Preserved? Y N

Coolest #
740 17

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: THELMA CALE

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-02-17 1200

DATE/TIME RECEIVED: 10-02-17 1320

LABORATORY ID: HG 171002-2

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FIELD pH	5.0	units			10-02-17 1200	LG
FIELD TEMP	15.2	°C			10-02-17 1200	LG
FIELD COND	256	µmhos			10-02-17 1200	LG
pH O	5.5	units	SM 22nd 4500 H B	.1	10-03-17 0837	KH
TDS	163 J	mg/L	SM22nd 2540 C	4	10-03-17 1135	MRS
SO_4	14.9	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-05-17 1252	DC
Cl^-	58.0	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-04-17 0233	DC
MBAS	U	mg/L	SM22nd 5540C	.01	10-03-17 2322	SW
Na	27.4	mg/L	EPA 200.7 Rev 4.4-1994	.03	10-05-17 0604	DB
Al	.13 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-04-17 0552	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-11-17 1637	RC
Ba	.114	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-04-17 0552	DB
Fe	.02 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-04-17 0552	DB
Mn	.191	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-04-17 0552	DB
Ca	10.4	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-04-17 0552	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas M Bach

REI Consultants, Inc. - Analytical Report

WO#: 17100647

Date Reported: 10/18/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/2/2017 12:00:00 PM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/4/2017
Lab ID:	17100647-02A	**Matrix:**	Drinking Water
Client Sample ID:	17188 THELMA CALE	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: YT**
TPH (Diesel Range: C10 - C28)	ND	0.12	0.24	NA	mg/L	10/08/17 1:47PM	10/12/17 9:16PM	
TPH (Oil Range: C22 - C36)	ND	0.12	0.24	NA	mg/L	10/08/17 1:47PM	10/12/17 9:16PM	
Surr: o-Terphenyl	64.1	NA	17.6-135	NA	%Rec	10/08/17 1:47PM	10/12/17 9:16PM	
DISSOLVED GASES				**Method: GC-FID**				**Analyst: YT**
Methane	ND	5.00	10.0	NA	µg/L		10/16/17 5:07PM	
Ethane	ND	7.50	15.0	NA	µg/L		10/16/17 5:07PM	
Propane	ND	10.0	20.0	NA	µg/L		10/16/17 5:07PM	
Butane	ND	12.5	25.0	NA	µg/L		10/16/17 5:07PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: CB**
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA	mg/L	10/05/17 4:27PM	10/06/17 4:55PM	
Surr: 2,5-Dibromotoluene	93.5	NA	53.5-143	NA	%Rec	10/05/17 4:27PM	10/06/17 4:55PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**				**Analyst: CB**
Benzene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:55PM	
Toluene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:55PM	
Ethylbenzene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:55PM	
m,p-Xylene	ND	1.00	2.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:55PM	
o-Xylene	ND	0.500	1.00	NA	µg/L	10/05/17 4:27PM	10/06/17 4:55PM	
Surr: 1,1,1-Trifluorotoluene	82.9	NA	57.1-139	NA	%Rec	10/05/17 4:27PM	10/06/17 4:55PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: THELMA CALE

SAMPLED BY: L. GARLITZ

LOG NO: W677-17

DATE/TIME SAMPLED: 10-02-17 1200

DATE/TIME RECEIVED: 10-02-17 1320

LABORATORY ID: HG 171002-2

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	ABSENT	P/A (Cfu)	9223 Colilert	1	10-02-17 1339	LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	10-02-17 1339	LM

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Microbiological analysis results will be discarded after 5 years

Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas M Burton

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) Please Check One
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR:									FREQUENCY				# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
THELMA CALE					10/2/17	1200 PM	X	X					X	X			X				4 on File												11	5.0		256			15.2

Comments

Record is retained for 5 years

Relinquished by:	Date	Time	Received by:	Date	Time
	10-2-17	1320		10/2/17	1320
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: Y <6 N
Bottles Preserved?

colilert # 73117

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Green SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard ___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE DATE	TIME	PRESERVATIVE Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: Field File	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
THELMA CALE					10/2/17	1200 PM	X	X					X	X			X						11			256			15.2

Comments

Reco is retained for 1 years

Relinquished by:	Date	Time	Received by:	Date	Time
	10-2-17	1320		10/2/17	1320
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: 2.6
Bottles Preserved? Y N

collect # 73117

DBPix Evaluation

CHAIN OF CUSTODY RECORD

17100647

STURM ENVIRONMENTAL SERVICES
STU001
Jimmy Suttle

REIC

Research Environmental & Industrial Consultants, Inc.

MAIN LABORATORY & CORPORATE HEADQUARTERS:
PO Box 269 - 225 Industrial Park Rd, Beaver WV 25813
800-999-0105 - 304-256-2500 - 304-253-1572 FAX - www.reicLabs.com

Client: Sturm Environmental — PO#: 7736
Contact Person: Kim — Phone: 304-633-6549
Quote #: — Fax: — Email:
Address: on File — City: — State: — Zip:
Billing Address (if different): — City: — State: — Zip:
Send To/State: — Project ID: — Sampler: C. Garlitz

MID-OHIO VALLEY Service Center
101 17th Street
Ashland, KY 41101
606-393-2027

SHENANDOAH Service Center
557 Commerce Rd, Suite 201
Verona, VA 24482
540-248-0183

ROANOKE Service Center
6128-C Peters Creek Rd
Roanoke, VA 24019
540-777-1276

MORGANTOWN Service Center
15 Commerce Drive
Morgantown, WV 26501
304-241-3861

TURNAROUND TIME
X NORMAL
RUSH TURNAROUND* 5 DAY | 3 DAY | 2 DAY | 1 DAY
*Rush work needs prior laboratory approval and will incur additional charges.

Send Results Via:
Email
Fax

All analytical requests are subject to REIC's Standard Terms and Conditions.

ANALYSIS & METHOD REQUESTED
TPH-DRO DRO GRO
BTEX
D-22: Propane, Butane, Methane, Ethane

Preservative Codes:
0 None
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide
6 Sodium Ascorbate
7 Ammonium Sulfate
8 Sodium Bisulfate/Metabisulfite
9 Ammonium Chloride
10 ZnAc Buffer
11 Sodium Sulfite + Sodium Hydroxide

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab	ENTER PRESERVATIVE CODE
17157	12 VOAs 1 1/2	10-2-17 1100	DW	Grab	X X X X X X
17158	" "	" 1200	DW	Grab	X X X X X X

COMMENTS:
Residential water
Not for
Compliance
corrected LR#4

CUSTODY SEALS | Y | N

Temperature at arrival: 0.3 °C ICED? Y ✓ N Containers provided by: [✓] REIC [ ] Client Delivered by: [ ] Client [✓] REIC [ ] UPS [ ] FedEx [ ] USPS Other

	10-4-17 1225		
	10/4/17 1225		
10/4/17	1625	→ 10/4/17 1805	

REIC
Improving the environment, one client at a time...

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304)255-2500
Website: www.reiclabs.com

Sample Receipt Checklist H.G. ENERGY, LLC.

Client Name:	STU001			Work Order Number:	17100647
RCPNo:	1	Date and Time Received:	10/4/2017 6:05:00 PM	Received by:	William Myers
Completed By:	Doug Arthur		Reviewed By:	Jimmy Suttle	
Completed Date:	10/5/2017 2:34:36 PM		Reviewed Date:	10/6/2017 7:16 AM	

Carrier Name: REIC

1.	Chain of custody present?	Yes [x]	No [ ]	
2.	Chain of custody signed when relinquished and received?	Yes [x]	No [ ]	
3.	Are matrices correctly identified on Chain of custody?	Yes [x]	No [ ]	
4.	Is it clear what analyses were requested?	Yes [x]	No [ ]	
5.	Custody seals intact?	Yes [ ]	No [ ]	Not Present [x]
6.	Samples in proper container type and preservative?	Yes [x]	No [ ]	
7.	Were correct preservatives noted on COC?	Yes [x]	No [ ]	NA [ ]
8.	Sample containers intact?	Yes [x]	No [ ]	
9.	Sufficient sample volume for indicated test?	Yes [x]	No [ ]	
10.	Were container labels complete?	Yes [x]	No [ ]	
11.	All samples received within holding time?	Yes [x]	No [ ]	
12.	Was an attempt made to cool the samples?	Yes [x]	No [ ]	NA [ ]
13.	Sample Temp. taken and recorded upon receipt?	Yes [x]	No [ ]	To 0.3 °C
14.	Water - Were bubbles absent in VOC vials?	Yes [x]	No [ ]	No Vials [ ]
15.	Are Samples considered acceptable?	Yes [x]	No [ ]	
16.	COC filled out properly?	Yes [x]	No [ ]	

Client Notification/Response

Client Name: STU001 Work Order Number: 17100647

Comment:

Client Contacted: Yes [ ] No [ ] NA [x] Person Contacted:

Contact Mode: Phone [ ] Fax: [ ] Email: [ ] In Person: [ ]

Date Contacted: Contacted By:

Regarding:

Client Instructions:

Corrective Action:

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304) 255-2500
Website: www.reilabs.com

Improving the environment, one client at a time...

3029-C Peters Creek Road
Roanoke, VA 24019
TEL: 540.777.1276

1557 Commerce Road, Suite 201
Verona, VA 24482
TEL: 540.248.0183

16 Commerce Drive
Westover, WV 26501
TEL: 304.241.5861

Monday, November 06, 2017

Kim Krehel
STURM ENVIRONMENTAL SERVICES
P O BOX 650
BRIDGEPORT, WV 26330

TEL: (304) 623-6549
FAX: (304) 623-6552

RE: H.G. ENERGY, LLC.
Work Order #: 17103512

Dear Kim Krehel:

REI Consultants, Inc. received 3 sample(s) on 10/27/2017 for the analyses presented in the following report.

Sincerely,

Jimmy Suttle
Project Manager
(304) 250-6234

REI Consultants, Inc. - Case Narrative

WO#: 17103512

Date Reported: 11/6/2017
Original

Client: STURM ENVIRONMENTAL SERVICES

Project: H.G. ENERGY, LLC.

The analytical results presented in this report were produced using documented laboratory SOPs that incorporate appropriate quality control procedures as described in the applicable methods. Verification of required sample preservation (as required) is recorded on associated laboratory logs. Any deviation from compliance or method modification is identified within the body of this report by a qualifier footnote which is defined at the bottom of this page.

All sample results for solid samples are reported on an "as-received" wet weight basis unless otherwise noted.

Results reported for sums of individual parameters, such as TTHM and HAA5, may vary slightly from the sum of the individual parameter results, due to rounding of individual results, as required by EPA.

The test results in this report meet all NELAP and/or VELAP requirements for parameters clearly designated as PA, VA, PA/VA, or VELAP in the column labeled NELAP.

Please note if the sample collection time is not provided on the Chain of Custody, the default recording will be 0:00:00. This may cause some tests to be apparently analyzed out of hold.

All tests performed by REIC Service Centers are designated by an annotation on the test code. All other tests were performed by REIC's Main Laboratory in Beaver, WV.

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DEFINITIONS:
MCL: Maximum Contaminant Level
MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.
Mg/Kg or mg/L: Units of part per million (PPM) - milligram per Kilogram (weight/weight) or milligram per Liter (weight/volume).
NA: Not Applicable
ND: Not Detected at the PQL or MDL
PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.
Qual: Qualifier that applies to the analyte reported.
TIC: Tentatively Identified Compound, Estimated Concentration denoted by "J" qualifier.
Ug/Kg or ug/L: Units of part per billion (PPB) - microgram per kilogram (weight/weight) or microgram per liter (weight/volume).

QUALIFIERS:
X: Reported value exceeds required MCL
B: Analyte detected in the associated Method Blank at a concentration > 1/2 the PQL
E: Analyte concentration reported that exceeds the upper calibration standard. Greater uncertainty is associated with this result and data should be considered estimated.
H: Holding time for preparation or analysis has been exceeded.
J: Analyte concentration is reported, and is less than the PQL and greater than or equal to the MDL. The result reported is an estimate.
S: % REC (% recovery) exceeds control limits

CERTIFICATIONS:
Beaver, WV: WVDHHR 00412CM, WVDEP 060, VADCLS 00281, KYDEP 90039, NCDWQ 466, PADEP 68-00839, VADCLS(VELAP) 460148
Bioassay (Beaver, WV): WVDEP 060, VADCLS(VELAP) 460148, PADEP 68-00839
Roanoke, VA: VADCLS(VELAP) 460150
Verona, VA: VADCLS(VELAP) 460151
Morgantown, WV: WVDHHR 003112M, WVDEP 387

REI Consultants, Inc. - Analytical Report

WO#: 17103512

Date Reported: 11/6/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/25/2017 11:02:00 AM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/27/2017
Lab ID:	17103512-03A	**Matrix:**	Liquid
Client Sample ID:	17208 JAMES WOLFE	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: YT**	
TPH (Diesel Range: C10 - C28)	ND	0.12	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 5:03AM	
TPH (Oil Range: C22 - C36)	ND	0.12	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 5:03AM	
Surr: o-Terphenyl	83.9	NA	17.6-135	NA	%Rec	11/01/17 2:49PM	11/03/17 5:03AM	
DISSOLVED GASES				**Method: GC-FID**			**Analyst: YT**	
Methane	ND	5.00	10.0	NA	µg/L		11/01/17 4:14PM	
Ethane	ND	7.50	15.0	NA	µg/L		11/01/17 4:14PM	
Propane	ND	10.0	20.0	NA	µg/L		11/01/17 4:14PM	
Butane	ND	12.5	25.0	NA	µg/L		11/01/17 4:14PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: CB**	
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA	mg/L	10/30/17 9:43AM	11/01/17 10:55PM	PA/VA
Surr: 2,5-Dibromotoluene	68.3	NA	53.5-143	NA	%Rec	10/30/17 9:43AM	11/01/17 10:55PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**			**Analyst: CB**	
Benzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:55PM	
Toluene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:55PM	
Ethylbenzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:55PM	
m,p-Xylene	ND	1.00	2.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:55PM	
o-Xylene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:55PM	
Surr: 1,1,1-Trifluorotoluene	105	NA	57.1-139	NA	%Rec	10/30/17 9:43AM	11/01/17 10:55PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JAMES WOLFE
GREER-SWD

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-25-17 1102

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-3

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FIELD pH	7.0	units			10-25-17 1102	LG
FIELD TEMP	18.7	°C			10-25-17 1102	LG
FIELD COND	97	µmhos			10-25-17 1102	LG
pH O	7.0	units	SM 22nd 4500 H B	.1	10-26-17 1312	KH
TDS	44 J	mg/L	SM22nd 2540 C	4	10-26-17 1203	MRS
SO_4	6.98 J	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-26-17 2229	DC
Cl^-	17.1	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-26-17 1229	DC
MBAS	.01 J	mg/L	SM22nd 5540C	.01	10-25-17 2332	SW
Na	6.34		EPA 200.7 Rev 4.4-1994	.03	10-30-17 0545	DB
Al	U	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-27-17 1521	MM
Ba	.050	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Fe	.29	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
Mn	.016 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Ca	4.37	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-30-17 0545	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas W Bennett

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JAMES WOLFE
GREER-SWD

SAMPLED BY: L. GARLITZ

LOG NO: W747-17

DATE/TIME SAMPLED: 10-25-17 1102

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-3

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	ABSENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM

*Client Provided
**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.
Microbiological analysis results will be discarded after 5 years
Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"
Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas W Bennett

REI Consultants, Inc. - Analytical Report

WO#: 17103512

Date Reported: 11/6/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/25/2017 1:20:00 PM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/27/2017
Lab ID:	17103512-02A	**Matrix:**	Liquid
Client Sample ID:	17207 JEFF RUSHFORD BARN	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: YT**	
TPH (Diesel Range: C10 - C28)	ND	0.13	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 4:30AM	
TPH (Oil Range: C22 - C36)	ND	0.13	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 4:30AM	
Surr: o-Terphenyl	94.4	NA	17.6-135	NA	%Rec	11/01/17 2:49PM	11/03/17 4:30AM	
DISSOLVED GASES				**Method: GC-FID**			**Analyst: YT**	
Methane	ND	5.00	10.0	NA	µg/L		11/01/17 4:08PM	
Ethane	ND	7.50	15.0	NA	µg/L		11/01/17 4:08PM	
Propane	ND	10.0	20.0	NA	µg/L		11/01/17 4:08PM	
Butane	ND	12.5	25.0	NA	µg/L		11/01/17 4:08PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: CB**	
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA	mg/L	10/30/17 9:43AM	11/01/17 10:22PM	PA/VA
Surr: 2,5-Dibromotoluene	72.5	NA	53.5-143	NA	%Rec	10/30/17 9:43AM	11/01/17 10:22PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**			**Analyst: CB**	
Benzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:22PM	
Toluene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:22PM	
Ethylbenzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:22PM	
m,p-Xylene	ND	1.00	2.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:22PM	
o-Xylene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 10:22PM	
Surr: 1,1,1-Trifluorotoluene	99.3	NA	57.1-139	NA	%Rec	10/30/17 9:43AM	11/01/17 10:22PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JEFF RUSHFORD BARN
GREER-SWD

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-25-17 1320

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-2

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FIELD pH	6.5	units			10-25-17 1320	LG
FIELD TEMP	13.9	°C			10-25-17 1320	LG
FIELD COND	43	µmhos			10-25-17 1320	LG
pH O	7.4	units	SM 22nd 4500 H B	.1	10-26-17 1312	KH
TDS	34 J	mg/L	SM22nd 2540 C	4	10-26-17 1203	MRS
SO_4	1.98 J	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-26-17 2229	DC
Cl^-	6.08	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-26-17 1229	DC
MBAS	U	mg/L	SM22nd 5540C	.01	10-25-17 2332	SW
Na	1.38		EPA 200.7 Rev 4.4-1994	.03	10-30-17 0545	DB
Al	.04 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-27-17 1521	MM
Ba	.015 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Fe	.04 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
Mn	.005 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Ca	2.47	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-30-17 0545	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas A. Bennett

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JEFF RUSHFORD BARN GREER-SWD

SAMPLED BY: L. GARLITZ

LOG NO: W745-17

DATE/TIME SAMPLED: 10-25-17 1320

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-2

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	PRESENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM
E Coli	PRESENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Microbiological analysis results will be discarded after 5 years

Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas W Bennett

REI Consultants, Inc. - Analytical Report

WO#: 17103512

Date Reported: 11/6/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/25/2017 1:10:00 PM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/27/2017
Lab ID:	17103512-01A	**Matrix:**	Liquid
Client Sample ID:	17206 JEFF RUSHFORD HOUSE	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: YT**	
TPH (Diesel Range: C10 - C28)	ND	0.12	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 3:57AM	
TPH (Oil Range: C22 - C36)	ND	0.12	0.25	NA	mg/L	11/01/17 2:49PM	11/03/17 3:57AM	
Surr: o-Terphenyl	19.2	NA	17.6-135	NA	%Rec	11/01/17 2:49PM	11/03/17 3:57AM	
DISSOLVED GASES				**Method: GC-FID**			**Analyst: YT**	
Methane	ND	5.00	10.0	NA	µg/L		11/01/17 4:02PM	
Ethane	ND	7.50	15.0	NA	µg/L		11/01/17 4:02PM	
Propane	ND	10.0	20.0	NA	µg/L		11/01/17 4:02PM	
Butane	ND	12.5	25.0	NA	µg/L		11/01/17 4:02PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: CB**	
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA	mg/L	10/30/17 9:43AM	11/01/17 9:50PM	PA/VA
Surr: 2,5-Dibromotoluene	70.0	NA	53.5-143	NA	%Rec	10/30/17 9:43AM	11/01/17 9:50PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**			**Analyst: CB**	
Benzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 9:50PM	
Toluene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 9:50PM	
Ethylbenzene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 9:50PM	
m,p-Xylene	ND	1.00	2.00	NA	µg/L	10/30/17 9:43AM	11/01/17 9:50PM	
o-Xylene	ND	0.500	1.00	NA	µg/L	10/30/17 9:43AM	11/01/17 9:50PM	
Surr: 1,1,1-Trifluorotoluene	100	NA	57.1-139	NA	%Rec	10/30/17 9:43AM	11/01/17 9:50PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JEFF RUSHFORD HOUSE
GREER-SWD

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-25-17 1310

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FIELD pH	6.0	units			10-25-17 1310	LG
FIELD TEMP	15.3	°C			10-25-17 1310	LG
FIELD COND	61	µmhos			10-25-17 1310	LG
pH O	8.0	units	SM 22nd 4500 H B	.1	10-26-17 1312	KH
TDS	38 J	mg/L	SM22nd 2540 C	4	10-26-17 1203	MRS
SO_4	2.84 J	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-26-17 2229	DC
Cl^-	8.87	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-26-17 1229	DC
MBAS	U	mg/L	SM22nd 5540C	.01	10-25-17 2332	SW
Na	2.78		EPA 200.7 Rev 4.4-1994	.03	10-30-17 0545	DB
Al	.02 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-27-17 1521	MM
Ba	.021 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Fe	U	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-30-17 0545	DB
Mn	.003 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-30-17 0545	DB
Ca	2.09	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-30-17 0545	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
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T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Dwight W Beach

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: JEFF RUSHFORD HOUSE GREER-SWD

SAMPLED BY: L. GARLITZ

LOG NO: W744-17

DATE/TIME SAMPLED: 10-25-17 1310

DATE/TIME RECEIVED: 10-25-17 1445

LABORATORY ID: HG 171025-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	ABSENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	10-25-17 1520	LM

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Microbiological analysis results will be discarded after 5 years

Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"

Data Qualifiers

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T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas W Burns

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304)255-2500
Website: www.reiclabs.com

Improving the environment, one client at a time...

Sample Receipt Checklist H.G. ENERGY, LLC.

Client Name:	STU001			Work Order Number:	17103512
RCPNo:	1	Date and Time Received:	10/27/2017 7:07:00 PM	Received by:	Randy Moore
Completed By:	Megan Ruane		Reviewed By:	Jimmy Suttle	
Completed Date:	10/27/2017 7:13:20 PM		Reviewed Date:	10/30/2017 8:08 AM	

Carrier Name: REIC

1.	Chain of custody present?	Yes [x]	No [ ]	
2.	Chain of custody signed when relinquished and received?	Yes [x]	No [ ]	
3.	Are matrices correctly identified on Chain of custody?	Yes [x]	No [ ]	
4.	Is it clear what analyses were requested?	Yes [x]	No [ ]	
5.	Custody seals intact?	Yes [ ]	No [ ]	Not Present [x]
6.	Samples in proper container type and preservative?	Yes [x]	No [ ]	
7.	Were correct preservatives noted on COC?	Yes [x]	No [ ]	NA [ ]
8.	Sample containers intact?	Yes [x]	No [ ]	
9.	Sufficient sample volume for indicated test?	Yes [x]	No [ ]	
10.	Were container labels complete?	Yes [x]	No [ ]	
11.	All samples received within holding time?	Yes [x]	No [ ]	
12.	Was an attempt made to cool the samples?	Yes [x]	No [ ]	NA [ ]
13.	Sample Temp. taken and recorded upon receipt?	Yes [x]	No [ ]	To 3.1 °C
14.	Water - Were bubbles absent in VOC vials?	Yes [x]	No [ ]	No Vials [ ]
15.	Are Samples considered acceptable?	Yes [x]	No [ ]	
16.	COC filled out properly?	Yes [x]	No [ ]	

Client Notification/Response

Client Name: STU001 Work Order Number: 17103512

Comment:

Client Contacted: Yes [ ] No [ ] NA [x] Person Contacted:

Contact Mode: Phone [ ] Fax: [ ] Email: [ ] In Person: [ ]

Date Contacted: Contacted By:

Regarding:

Client Instructions:

Corrective Action:

CHAIN OF CUSTODY RECORD

17103512

STURM ENVIRONMENTAL SERVICES
STU001
Jimmy Suttle

EIC

Research Environmental & Industrial Consultants, Inc.
MAIN LABORATORY & CORPORATE HEADQUARTERS:
PO Box 286 • 713 Industrial Park Rd, Beaver, WV 25813
800-999-0105 • 304-255-2500 • 304-255-2572 fax • www.reiclabs.com

MID OHIO VALLEY Service Center
101 17th Street
Ashland, KY 41101
606-393-5027

SHENANDOAH Service Center
1557 Commerce Road, Ste 201
Verona, VA 24482
540-248-0183

ROANOKE Service Center
3029-C Peters Creek Rd
Roanoke, VA 24019
540-777-1276

MORGANTOWN Service Center
16 Commerce Drive
Westover, WV 26501
304-241-5861

Client: Sturm Environmental
PO #: 7760
Contact Person: Kim
Phone: 304 623-6349
QUOTE #:
Fax:
Email:
Address: on file
City:
State: Zip:
Billing Address (if different):
City:
State: Zip:
Site ID & State:
Project ID:
Sampler: L. Gooch ...

TURNAROUND TIME
X NORMAL
RUSH TURNAROUND*: 5 DAY | 3 DAY | 2 DAY | 1 DAY
*Rush work needs prior laboratory approval and will incur additional charges.

Send Results Via: Email / Fax

All analytical requests are subject to REIC's Standard Terms and Conditions.

ANALYSIS & METHOD REQUESTED:
1. TPH-DRO/GRO
2. BTEX
3. Dissolved: Propane
4. " : Butane
5. " : Methane
6. " : Ethane

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab	TPH	BTEX	Propane	Butane	Methane	Ethane
ENTER PRESERVATIVE CODE					2 / 1	1	2	2	2	6
17206	1-5 ... / 6 VIAls	10-25-17 1510	L	Grab	X	X	X	X	X	X
17207		1320			X	X	X	X	X	X
17208		1102			X	X	X	X	X	X

Correction ER

COMMENTS:

CUSTODY SEALS [ ] Y [✓] N

Temperature at arrival 3.1 °C ICED? Y ✓ N
Containers provided by: [✓] REIC [ ] Client
Delivered by: [ ] Client [✓] REIC [ ] UPS [ ] FedEx [ ] USPS Other

Relinquished: [signature] 10-27-17 1252
Received: Kimberly C. Moore 10-27-17 1252
Megan A. Rhoane 10/27/17 1550

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

Jeff & Patty Rushford
PO Box 907
Dellslow, WV 26531-0907

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWP
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
___ Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR:						FREQUENCY					# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
JEFF RUSHFORD HOUSE (W)					10/25/17	1310 PM																										6.0		61			15.3
JEFF RUSHFORD BARN (W)					10/25/17	1320 PM																										6.5		43			13.9

Comments

Recor is retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: < 6
Bottles Preserved? Y N

Relinquished by:	Date	Time	Received by:	Date	Time
	10-25-17	1445		10/25/17	1445
Relinquished by:	Date	Time	Received by:	Date	Time

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
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FAX: 304-623-6552

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610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greens SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: [ ] Standard [ ] RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR:								FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
JAMES WOLFE					10/25/17	1102 AM																									7.0		97			18.7

Comments

Record is retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: <6
Bottles Preserved? Y N

Relinquished by:	Date	Time	Received by:	Date	Time
	10-25-17	1445		10/25/17	1445
Relinquished by:	Date	Time	Received by:	Date	Time

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
510 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Green SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard ___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: 1 Liter Glass	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
JAMES WOLFE					10/25/17	1102 AM	X	X					X	X	X						X		11	7.0		97			18.7

Comments

Records retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: <6
Bottles Preserved? Y N

Relinquished by:	Date	Time	Received by:	Date	Time
	10-25-17	1445		10/25/17	1445
Relinquished by:	Date	Time	Received by:	Date	Time

Collier + # 83817

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

Jeff & Patty Rushford
PO Box 907
Dellslow, WV 26531-0907

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
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FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWB
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) Please Check One
___ Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE DATE	TIME	PRESERVATIVE Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: mg Fe	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
JEFF RUSHFORD HOUSE (W)	—	1			10/25/17	1310 PM	X	X					X	X	X						X		11	6.0		61			15.3
JEFF RUSHFORD BARN (W)	—	2			10/25/17	1320 PM	X	X					X	X	X						X		11	6.5		43			13.9

Comments

Records retained for 5 years

Relinquished by:	Date	Time	Received by:	Date	Time
	10-25-17	1445	K. Kuhl	10/25/17	1445
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: < 6
Bottles Preserved? Y N

Collect # 1 - 84017
2 - 84317

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304) 255-2500
Website: www.reiclabs.com

Improving the environment, one client at a time...

3029-C Peters Creek Road
Roanoke, VA 24019
TEL: 540.777.1276

1557 Commerce Road, Suite 201
Verona, VA 24482
TEL: 540.248.0183

16 Commerce Drive
Westover, WV 26501
TEL: 304.241.5861

Friday, October 20, 2017

Kim Krehel
STURM ENVIRONMENTAL SERVICES
P O BOX 650
BRIDGEPORT, WV 26330

TEL: (304) 623-6549
FAX: (304) 623-6552

RE: H.G. ENERGY, LLC.
Work Order #: 17101725

Dear Kim Krehel:

REI Consultants, Inc. received 1 sample(s) on 10/12/2017 for the analyses presented in the following report.

Sincerely,

Jimmy Suttle
Project Manager
(304) 250-6234

REI Consultants, Inc. - Case Narrative

WO#: 17101725

Date Reported: 10/20/2017
Original

Client: STURM ENVIRONMENTAL SERVICES

Project: H.G. ENERGY, LLC.

The analytical results presented in this report were produced using documented laboratory SOPs that incorporate appropriate quality control procedures as described in the applicable methods. Verification of required sample preservation (as required) is recorded on associated laboratory logs. Any deviation from compliance or method modification is identified within the body of this report by a qualifier footnote which is defined at the bottom of this page.

All sample results for solid samples are reported on an "as-received" wet weight basis unless otherwise noted.

Results reported for sums of individual parameters, such as TTHM and HAA5, may vary slightly from the sum of the individual parameter results, due to rounding of individual results, as required by EPA.

The test results in this report meet all NELAP and/or VELAP requirements for parameters clearly designated as PA, VA, PA/VA, or VELAP in the column labeled NELAP.

Please note if the sample collection time is not provided on the Chain of Custody, the default recording will be 0:00:00. This may cause some tests to be apparently analyzed out of hold.

All tests performed by REIC Service Centers are designated by an annotation on the test code. All other tests were performed by REIC's Main Laboratory in Beaver, WV.

This report may not be reproduced, except in full, without the written approval of REIC.

DEFINITIONS:
MCL: Maximum Contaminant Level
MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.
Mg/Kg or mg/L: Units of part per million (PPM) - milligram per Kilogram (weight/weight) or milligram per Liter (weight/volume).
NA: Not Applicable
ND: Not Detected at the PQL or MDL
PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.
Qual: Qualifier that applies to the analyte reported.
TIC: Tentatively Identified Compound, Estimated Concentration denoted by "J" qualifier.
Ug/Kg or ug/L: Units of part per billion (PPB) - microgram per kilogram (weight/weight) or microgram per liter (weight/volume).

QUALIFIERS:
X: Reported value exceeds required MCL
B: Analyte detected in the associated Method Blank at a concentration > 1/2 the PQL
E: Analyte concentration reported that exceeds the upper calibration standard. Greater uncertainty is associated with this result and data should be considered estimated.
H: Holding time for preparation or analysis has been exceeded.
J: Analyte concentration is reported, and is less than the PQL and greater than or equal to the MDL. The result reported is an estimate.
S: % REC (% recovery) exceeds control limits

CERTIFICATIONS:
Beaver, WV: WVDHHR 00412CM, WVDEP 060, VADCLS 00281, KYDEP 90039, NCDWQ 466, PADEP 68-00839, VADCLS(VELAP) 460148
Bioassay (Beaver, WV): WVDEP 060, VADCLS(VELAP) 460148, PADEP 68-00839
Roanoke, VA: VADCLS(VELAP) 460150
Verona, VA: VADCLS(VELAP) 460151
Morgantown, WV: WVDHHR 003112M, WVDEP 387

REI Consultants, Inc. - Analytical Report

WO#: 17101725

Date Reported: 10/20/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	10/11/2017 11:30:00 AM
Project:	H.G. ENERGY, LLC.	**Date Received:**	10/12/2017
Lab ID:	17101725-01A	**Matrix:**	Liquid
Client Sample ID:	17199 BERNARD CALE	**Site ID:**	

Analysis	Result	MDL	PQL	MCL	Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: YT**	
TPH (Diesel Range: C10 - C28)	ND	0.12	0.25	NA		mg/L	10/18/17 4:24PM	10/19/17 11:25PM	
TPH (Oil Range: C22 - C36)	ND	0.12	0.25	NA		mg/L	10/18/17 4:24PM	10/19/17 11:25PM	
Surr: o-Terphenyl	123	NA	17.6-135	NA		%Rec	10/18/17 4:24PM	10/19/17 11:25PM	
DISSOLVED GASES				**Method: GC-FID**				**Analyst: YT**	
Methane	ND	5.00	10.0	NA		µg/L		10/16/17 5:44PM	
Ethane	ND	7.50	15.0	NA		µg/L		10/16/17 5:44PM	
Propane	ND	10.0	20.0	NA		µg/L		10/16/17 5:44PM	
Butane	ND	12.5	25.0	NA		µg/L		10/16/17 5:44PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**				**Analyst: CB**	
TPH (Gasoline Range: C6 - C10)	ND	0.250	0.500	NA		mg/L	10/18/17 7:50AM	10/18/17 2:20PM	PA/VA
Surr: 2,5-Dibromotoluene	17.7	NA	53.5-143	NA	S	%Rec	10/18/17 7:50AM	10/18/17 2:20PM	
VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**				**Analyst: CB**	
Benzene	ND	0.500	1.00	NA		µg/L	10/18/17 7:50AM	10/18/17 2:20PM	
Toluene	ND	0.500	1.00	NA		µg/L	10/18/17 7:50AM	10/18/17 2:20PM	
Ethylbenzene	ND	0.500	1.00	NA		µg/L	10/18/17 7:50AM	10/18/17 2:20PM	
m,p-Xylene	ND	1.00	2.00	NA		µg/L	10/18/17 7:50AM	10/18/17 2:20PM	
o-Xylene	ND	0.500	1.00	NA		µg/L	10/18/17 7:50AM	10/18/17 2:20PM	
Surr: 1,1,1-Trifluorotoluene	84.1	NA	57.1-139	NA		%Rec	10/18/17 7:50AM	10/18/17 2:20PM	

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: BERNARD CALE
GREER SWD

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 10-11-17 1130

DATE/TIME RECEIVED: 10-11-17 1420

LABORATORY ID: HG 171011-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FLOW	N/A	gpm			10-11-17 1130	LG
FIELD pH	6.1	units			10-11-17 1130	LG
FIELD TEMP	21.3	°C			10-11-17 1130	LG
FIELD COND	558	µmhos			10-11-17 1130	LG
pH O	4.7	units	SM 22nd 4500 H B	.1	10-12-17 1112	KH
TDS	368 J	mg/L	SM22nd 2540 C	4	10-12-17 1136	MRS
SO_4	2.48	mg/L	EPA 300.0 Rev 2.1-1993	1.0	10-13-17 1630	DC
Cl^-	197.	mg/L	EPA 300.0 Rev 2.1-1993	.50	10-13-17 1641	DC
MBAS	U	mg/L	SM22nd 5540C	.01	10-12-17 1253	SW
Na	65.3	mg/L	EPA 200.7 Rev 4.4-1994	.03	10-20-17 0556	DB
Al	.51	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-14-17 0913	DB
As	U	mg/L	SM22nd 3113 B	.0005	10-17-17 1157	RC
Ba	.366	mg/L	EPA 200.7 Rev 4.4-1994	.002	10-14-17 0913	DB
Al	.03 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-14-17 0913	DB
Mn	.369	mg/L	EPA 200.7 Rev 4.4-1994	.02	10-14-17 0913	DB
Ca	21.0	mg/L	EPA 200.7 Rev 4.4-1994	.10	10-14-17 0913	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas W Bennett

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: BERNARD CALE
GREER SWD

SAMPLED BY: L. GARLITZ

LOG NO: W714-17

DATE/TIME SAMPLED: 10-11-17 1130

DATE/TIME RECEIVED: 10-11-17 1420

LABORATORY ID: HG 171011-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	ABSENT	P/A (Cfu)	9223 Colilert	1	10-11-17 1440	LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	10-11-17 1440	LM

*Client Provided
**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.
Microbiological analysis results will be discarded after 5 years
Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"
Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
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C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas M Bennett

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: Greer SWD
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: Xam File	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
BENARD CALE					10/11/17	1130 AM	X	X			X		X	X			X				X		5	6.1	NA	558			21.3

Comments

Records retained for 11 years

Laboratory Comments:
Temperature Upon Receipt: <6
Bottles Preserved? Y N

Collector # 660 17

Relinquished by:	Date	Time	Received by:	Date	Time
	10-11-17	1420		10/11/17	1420
Relinquished by:	Date	Time	Received by:	Date	Time

REIC
Improving the environment, one client at a time...

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304)255-2500
Website: www.reiclabs.com

Sample Receipt Checklist H.G. ENERGY, LLC.

Client Name:	STU001			Work Order Number:	17101725
RCPNo:	1	Date and Time Received:	10/12/2017 5:40:00 PM	Received by:	William Myers
Completed By:	Megan Ruane		Reviewed By:	Jimmy Suttle	
Completed Date:	10/13/2017 11:43:48 AM		Reviewed Date:	10/13/2017 11:55 AM	

Carrier Name: REIC

1.	Chain of custody present?	Yes [x]	No [ ]	
2.	Chain of custody signed when relinquished and received?	Yes [x]	No [ ]	
3.	Are matrices correctly identified on Chain of custody?	Yes [x]	No [ ]	
4.	Is it clear what analyses were requested?	Yes [x]	No [ ]	
5.	Custody seals intact?	Yes [ ]	No [ ]	Not Present [x]
6.	Samples in proper container type and preservative?	Yes [x]	No [ ]	
7.	Were correct preservatives noted on COC?	Yes [x]	No [ ]	NA [ ]
8.	Sample containers intact?	Yes [x]	No [ ]	
9.	Sufficient sample volume for indicated test?	Yes [x]	No [ ]	
10.	Were container labels complete?	Yes [x]	No [ ]	
11.	All samples received within holding time?	Yes [x]	No [ ]	
12.	Was an attempt made to cool the samples?	Yes [x]	No [ ]	NA [ ]
13.	Sample Temp. taken and recorded upon receipt?	Yes [x]	No [ ]	To 0 °C
14.	Water - Were bubbles absent in VOC vials?	Yes [x]	No [ ]	No Vials [ ]
15.	Are Samples considered acceptable?	Yes [x]	No [ ]	
16.	COC filled out properly?	Yes [x]	No [ ]	

Client Notification/Response

Client Name: STU001 Work Order Number: 17101725

Comment:

Client Contacted: Yes [ ] No [ ] NA [x] Person Contacted:

Contact Mode: Phone [ ] Fax: [ ] Email: [ ] In Person: [ ]

Date Contacted: Contacted By:

Regarding:

Client Instructions:

Corrective Action:

DBPix Evaluation

CHAIN OF CUSTODY RECORD

17101725

STURM ENVIRONMENTAL SERVICES
STU001
Jimmy Suttle

EIC

Research Environmental & Industrial Consultants, Inc.

MAIN LABORATORY & CORPORATE HEADQUARTERS:
P.O. Box 286 • 225 Industrial Park Rd, Beaver, WV 25813
800 999-0105 • 304 255-2500 • 304 255-2572 fax • www.reiclabs.com

MID-OHIO VALLEY Service Center	SHENANDOAH Service Center	ROANOKE Service Center	MORGANTOWN Service Center
101 17th Street	1557 Commerce Rd. Ste 201	3029 C Peters Creek Rd	16 Commerce Drive
Ashland, KY 41101	Verona, VA 24482	Roanoke, VA 24019	Westover, WV 26501
606 393-5027	540 248 0183	540 777 1276	304 241 5861

Client: Sturm Environmental
Contact Person: Kim
QUOTE #:
Fax:
Address: Bl. [illegible]
Billing Address (if different):
City:
State:
Zip:
Site ID & State:
Project ID:
PO #: 7484
Phone: 304 623 6547
Email:
Sampler: [illegible]

TURNAROUND TIME
✓ NORMAL
RUSH TURNAROUND*: 5 DAY, 3 DAY, 2 DAY, 1 DAY
*Rush work needs prior laboratory approval and will incur additional charges

Send Results Via: Email, Fax

All analytical requests are subject to REIC's Standard Terms and Conditions.

ANALYSIS & METHOD REQUESTED: [illegible] Bret [illegible] Gases

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab			
					0	1	0
					1		
17149	[illegible]	10/11/17 / 1130	[illegible]	G	5	2	3

ENTER PRESERVATIVE CODE

Preservative Codes:
0 None
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide, Sodium Arsenite
6 Sodium Hydroxide, Ascorbic Acid
8 Sodium Bisulfate/Methanol
9 Cat. [illegible] Chloride
10 CRF Bath
11 [illegible]
*Leave blank for unpreserved

COMMENTS:
corrected IR#1

CUSTODY SEALS [ ] Y ✓ N

Temperature at arrival 0.0 ICED? Y — N Containers provided by: ✓ REIC [ ] Client Delivered by: [ ] Client ✓ REIC [ ] UPS [ ] FedEx [ ] USPS Other

[signature] 10/12/17 0940
[signature] 10/12/17 1412
[signature] 10-12-17 1600 → 10-12-17 1740

www.ammara.com

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: CHARLES M^{c}DANIEL GREER-SWD

SAMPLED BY: L. GARLITZ

DATE/TIME SAMPLED: 11-06-17 1220

DATE/TIME RECEIVED: 11-06-17 1400

LABORATORY ID: HG 171106-A1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
FLOW	NA	gpm			11-06-17 1220	LG
FIELD pH	7.0	units			11-06-17 1220	LG
FIELD TEMP	16.1	°C			11-06-17 1220	LG
FIELD COND	41	µmhos			11-06-17 1220	LG
pH O	7.6	units	SM 22nd 4500 H B	.1	11-07-17 0940	KH
TDS	48 J	mg/L	SM22nd 2540 C	4	11-08-17 1035	MRS
SO_4	1.83 J	mg/L	EPA 300.0 Rev 2.1-1993	1.0	11-09-17 0711	DC
Cl^-	4.26	mg/L	EPA 300.0 Rev 2.1-1993	.50	11-09-17 0711	DC
MBAS	U	mg/L	SM22nd 5540C	.01	11-07-17 1114	SW
Na	1.20	mg/L	EPA 200.7 Rev 4.4-1994	.03	11-09-17 0549	DB
Al	U	mg/L	EPA 200.7 Rev 4.4-1994	.02	11-09-17 0549	DB
As	U	mg/L	SM22nd 3113 B	.0005	11-10-17 1857	RC
Ba	.024 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	11-09-17 0549	DB
Fe	.13 J	mg/L	EPA 200.7 Rev 4.4-1994	.02	11-09-17 0549	DB
Mn	.030 J	mg/L	EPA 200.7 Rev 4.4-1994	.002	11-09-17 0549	DB
Ca	4.74	mg/L	EPA 200.7 Rev 4.4-1994	.10	11-09-17 0549	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

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T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

Approved Dwight H Beatty

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: CHARLES M^{C}DANIEL GREER-SWD

SAMPLED BY: L. GARLITZ

LOG NO: W765-17

DATE/TIME SAMPLED: 11-06-17 1220

DATE/TIME RECEIVED: 11-06-17 1400

LABORATORY ID: HG 171106-A1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	ABSENT	P/A (Cfu)	9223 Colilert	1	11-06-17 1530	KC/LM
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	11-06-17 1530	KC/LM

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Microbiological analysis results will be discarded after 5 years

Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
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Narrative:

Approved Douglas W Beuto

CHAIN OF CUSTODY RECORD

STURM ENVIRONMENTAL SERVICES

STURM ENVIRONMENTAL
BRUSHY FORK ROAD
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

MAILING ADDRESSES ARE LISTED BELOW

REPORT TO: Client Name: HG ENERGY
Address:
City/State/Zip:
Contact Person:
Telephone Number:
Email Address:
Sampler Name: (Print) LARRY GARLITZ
Sampler Signature:
Project Name: GREER
Special Reporting: [ ] Email Results [ ] Fax Results

BILL TO: Client Name:
Address:
City/State/Zip:
Contact Person:
Telephone Number: FAX
Email Address:
Purchase Order #:
TURN AROUND TIME: ___ Standard
___ RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: on file	FREQUENCY	# of Bottles	Field pH	Flow (gpm, cfs, mgd) circle one	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
CHARLES McDANIEL					11/6/17	1220 PM	X	X			X		X	X			X				X		13	7.0	NA	41			16.1
RICKY JOHNSON					11/6/17	1245 PM																		CITY	WATER				

Comments

Records retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: 26
Bottles Preserved? Y N
Colilert 80917

Relinquished by:	Date	Time	Received by:	Date	Time
	11/6/2017	14:00	K. Kimbel	11/6/17	1400
Relinquished by:	Date	Time	Received by:	Date	Time

APPENDIX F

APPENDIX F

Area Permit Wells

API #	Well Type (Injection, Production, Observation, Monitoring)	Well Status (Active, Abandoned, Shut-in, Plugged)	Northing (UTM NAD 83 Meters)	Easting (UTM NAD 83 Meters)
NA	NA	NA	NA	NA
Appendix F	Only Applies	to Class 2R	and Class 3S	

Make as many copies as necessary and include page numbers as appropriate.

SECTION 8

GEOLOGIC DATA

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Tables

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SEP 25 2012

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This report has been prepared by URS Corporation for Chesapeake Energy Inc. in response to a request by the West Virginia Department of Environmental Protection Office of Oil and Gas (WVDEP-O&G). In an effort to re-permit the Greer Steel A-1 Underground Injection Control (UIC) well, Chesapeake has been requested by the State to address items 14 and 15 described in the document *Additional Items Required as Part of All Class II and III UIC Permit Applications*, which states:

14. *Conduct a detailed geologic investigation of subsurface features in the vicinity of the injection well. This investigation will assess the likelihood for the presence of subsurface faults, fractures or potential seismically active features. At a minimum, this investigation will draw upon public or privately available geologic information such as*

    - *seismic survey lines,*
    - *well records,*
    - *published academic reports,*
    - *government reports or publications,*
    - *earthquake history,*
    - *geologic maps, or*
    - *other like information*

    to assess the potential that injection of fluids could lead to activation of fault features and increasing the likelihood of earthquakes.

15. *Provide a schematic/model of fluid migration horizontally and/or vertically over time within subsurface formation(s) around the proposed injection well.*

Chesapeake's Greer well injects fluid at depths of 7,889 to 7,969 feet (2,405 to 2,429 m) into the lower chert member of the Onondaga Limestone, which lies below the Marcellus shale and overlies the Oriskany sandstone. To address items 14 and 15, in this report we present the available information to assess the potential that injection of fluids at Greer well could lead to the reactivation of faults in the vicinity of the well, resulting in induced earthquakes.

In this report, the seismotectonic setting and earthquake generation in the central and eastern U.S. (CEUS), and the regional and local historical seismicity are described (Section 2); the local geology and in particular faulting in the vicinity of the Greer well are presented (Section 3); recent seismicity is described, including efforts to detect and locate events recorded at the nearby seismic station in Morgantown, WV (Section 4); the well injection parameters and history are presented (Section 5); and hydrologic and mechanical parameters of the reservoir around the well are detailed and fluid flow away from the well is evaluated (Section 6).

1.1 ACKNOWLEDGMENTS

SEP 25 2012

This study was performed under the direction of Jeff Bull, Gary Gould, Mike Brownell, and John Satterfield of Chesapeake Energy. Chesapeake contributors to the report included Jeff Bull,

James Van Alstine, and Jessica Griffin. The URS efforts were managed by Ivan Wong. URS contributors were Ivan Wong, Eliza Nemser, Judy Zachariasen, Jackie Bott, Fabia Terra, Candace Beauvais, Tom Kwader, and Mike Planert. Our thanks to Melinda Lee for her support.

In this section, the seismotectonic setting and historical seismicity of the region surrounding the Greer well are described.

2.1 SEISMOTECTONIC SETTING

The Greer well is located in Monongalia County, West Virginia, near the border with Preston County, West Virginia, in the central Appalachian region of the CEUS. The seismotectonic setting of the area is a product of multiple episodes of continental rifting and collision. The Proterozoic (ca. 1 billion year) Grenville Orogeny was produced by the collision of the proto-African and South American landmasses against the eastern and southern edges of ancestral North America, known as Laurentia, to form the supercontinent Rodinia. In the late Proterozoic era, Rodinia began to break apart into smaller continents. Rifting along the eastern margin of Laurentia began with an episode of failed rifting between 680 and 720 Ma, synchronous with rifting along the western margin. This was followed by successful rifting on the eastern margin and initiation of the Iapetus Ocean, a proto-Atlantic Ocean between Laurentia and Gondwanaland, between about 620 and 550 Ma (Thomas, 2006; Whitmeyer and Karlstrom, 2007). This rifting episode produced a passive margin along what is now the east coast of the United States.

The Iapetan passive margin was expressed as a zigzagging pattern of promontories and embayments formed by the intersections of northeast-trending rift segments and northwest-striking transform faults (Thomas, 2006; Figure 1). Thomas (1993; 2006) describes the faulting as consistent with low-angle detachment faulting producing a 200-km-wide zone of extended transitional crust marked by low-angle normal faults on the lower plate and a narrower zone of upper-plate transitional crust marked by higher-angle faults; transform faults juxtapose different types of crust. The axis of Iapetan rifting in the central Appalachians was concentrated along the Blue Ridge rift zone, which runs through Virginia and into Tennessee. The Virginia-Tennessee transform fault juxtaposed highly attenuated lower-plate crust of the southern Blue Ridge rift zone from the less attenuated upper-plate crust of the northern Blue Ridge fault zone (Thomas, 1993; Figure 2). In this type of rifted environment, the more attenuated crust subsides more and is generally overlain by thicker syn- and post-rift sediments, which is observed along the Iapetan passive margin in the Blue Ridge area.

Iapetan rifting itself occurred largely outboard of West Virginia, traversing what is now central-eastern Virginia and the Carolinas. However, the rifting was accompanied by extensional tectonic processes that penetrated well inboard of the Iapetan rift system proper, including the development of continental rifts, failed rifts (aulacogens) and consequent graben systems within what is now the CEUS. These aulacogens are present as deep fault-bounded and sedimentary rock-filled basins in the basement underlying the Appalachians (Thomas, 1991). Wheeler (1995) mapped the northwestern limit of Iapetan normal faulting as running essentially along the western border of West Virginia, correlating approximately with the western boundary of the Rome Trough (Figure 3). The Rome Trough is a Paleozoic aulacogen that was delineated by Bond *et al.* (1971), Wheeler (1995) and other investigators based on geological, geophysical, and seismicity data. It extends from eastern Kentucky into central and northern West Virginia and may have formed by reactivation of Proterozoic rift basin faults (Stark, 1997; Drahovzal, 1997). Its northwestern boundary marks both the northwestern limit of the Iapetan rifted margin (IRM) (Wheeler, 1995) and the western limit of Grenville-aged contractional deformation (EPRI/DOE/NRC, 2012).

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Following rifting and establishment of a passive margin, the rifted margin subsided and shallow seas transgressed over the Iapetan coastal plain and deposited Paleozoic marine siliciclastics, such as the Lower Cambrian Chilhowee Group, followed by carbonate and clastic continental shelf and slope sediments over the margin (Hatcher, 2004). In the Cambrian and Ordovician, much of the area was covered by shallow seas and thick accumulations of carbonates were deposited, which are now exposed in the Valley and Ridge province of Virginia and eastern West Virginia. To the east, however, a series of Paleozoic orogenies occurred, emplacing volcanic arcs and exotic terranes onto the edge of the continent. During the Ordovician Taconic orogeny the Taconic terrane met the continent first at the southern then the northern end of Virginia, where Iapetan promontories jutted eastward, and formed large mountains east of West Virginia, whereas the central embayed region was protected and remained relatively undeformed. The Devonian Acadian Orogeny added more terrane to eastern North America and formed more mountain ranges to the east, in areas that now underlie the coastal plain. These orogenies were followed by continued sedimentation of carbonates as well as clastic sediments eroded off the mountains to the east. The seas retreated in Mississippian time, leading to the deposition of continental redbeds over most of West Virginia, followed by subsidence and swamp development that gave rise to extensive development of coal deposits in the latest Pennsylvanian and Permian Periods. These late Paleozoic rocks underlie much of West Virginia and the Appalachian Plateau physiographic province (WVGES, 2011; Figures 4 and 5).

A final episode of collision occurred in the late Paleozoic to early Mesozoic Eras in which the Iapetus Ocean closed and the supercontinent of Pangaea was formed. The closing of the Iapetus Ocean produced the Appalachian or Alleghenian Orogeny along the eastern edge of the continent with the collision of the Gondwana supercontinent and the North American continent (Laurentia). The collision of Gondwana was oblique and occurred gradually, with collision starting in the north and progressing south (Hatcher, 2004; Figure 6). The effects of the Alleghenian orogeny were felt farther inland than those of the earlier Paleozoic orogenies. The east coast of the continent, into West Virginia, was uplifted into a large mountain chain. The edge of Gondwana was thrust up and over the eastern margin of North America and transported westward at least 350 km along low-angle thrust faults rooted in a decollement, primarily the Blue Ridge-Piedmont megathrust, forming a foreland fold-and-thrust belt in western Virginia (Hatcher, 2004). West of the allochthonous terrane, collision manifested as folding and faulting of Paleozoic sedimentary rocks along low-angle thrust faults. The western margin of the deformation is the Allegheny Front, which runs through easternmost West Virginia. Major orogenic activity ended with the Alleghenian orogeny. It was followed by rifting of Pangaea in the early Mesozoic Era and formation of the Atlantic Ocean, turning eastern North America again into a passive margin.

The geologic history of the Central Appalachians is represented in the modern physiographic provinces within the region (Figure 7). Most of West Virginia, including Monongalia and Preston Counties, is located within the Appalachian Plateau physiographic province. This is west of the Allegheny Front and comprises relatively flat-lying Paleozoic rocks outboard of the overthrust sheets of the Alleghenian orogeny (Bollinger and Wheeler, 1988). The northeastern corner of West Virginia, in the Allegheny Mountains, includes a somewhat higher and more deformed subprovince of the Plateau, which registers the effects of deformation in the foreland region of the thrust belt and includes high-amplitude open folds that developed outboard of the Allegheny Front. The Allegheny Front marks the transition from the Appalachian Plateau to the Valley and Ridge Province. The Valley and Ridge Province is characterized by northeast-southwest-trending valleys and ridges and tight, high-amplitude west-vergent folds (Bollinger

and Wheeler, 1988). This province is underlain by the folded and thrusted Paleozoic sediments deformed in the Alleghenian orogeny. East of the Valley and Ridge sequence is the Blue Ridge province that includes the Blue Ridge Mountains and is underlain by faulted and folded allochthonous terrane thrust over the Valley and Ridge Paleozoic rocks in the Alleghenian orogeny. It is composed of a large eroded anticline with exposed Grenville rocks in the core. East of the Blue Ridge province is the Piedmont province of Virginia, which is flat but underlain by assembled Proterozoic and Paleozoic mixed metamorphic and igneous rocks. The province also contains Mesozoic extensional basins formed during the breakup of Pangaea and filled in with Mesozoic sedimentary basin fill. The Coastal Plain lies east of the Piedmont and is also underlain by buried Mesozoic rift basins.

Currently, the CEUS is part of a broad mid-plate compressive stress province that also includes most of Canada (Zoback and Zoback, 1991; Heidbach *et al.*, 2008; Hurd, 2010; Figure 8). Over this large region, the stress field is oriented with a relatively uniform east-northeast direction of maximum horizontal compression. This compression direction corresponds well to the direction of absolute plate motion of the North American Plate, which suggests that a far-field tectonic source such as ridge-push or basal drag at the Mid-Atlantic Ridge may be the primary source of stress in the mid-plate region (Zoback and Zoback, 1991). This stress regime, along with the structural features developed through the geologic history described above controls the occurrence and localization of seismicity in the region (Section 2.2). It is generally agreed, as manifested in recent regional source characterizations for seismic hazard assessments in the eastern U.S., that in contrast to the plate boundary faults that control seismic hazard in the western U.S., seismicity and consequent hazard in the east is largely controlled by pre-existing zones of weakness that are favorably oriented in the modern stress field (Petersen *et al.*, 2008; EPRI/DOE/NRC, 2012, and included references). This includes regions of Mesozoic extension but also those of older extensional episodes such as the IRM (Figures 3 and 5).

West Virginia is located fairly far west of the zones of Mesozoic extension associated with the rifting of Pangaea, but it occupies the western edge of the IRM, whose western margin runs approximately along the northwestern border of the state (Wheeler, 1995). The Rome Trough in western West Virginia, a Cambrian rift basin activated during Iapetan rifting, formed due to west-side-down normal faulting along its southern boundary fault (Figure 3). Its northern boundary corresponds with the Kentucky River fault system, which was active from the Precambrian to at least the late Paleozoic Era and possibly into the Quaternary at a very low slip rate (Van Arsdale, 1986). In addition to the Rome Trough, smaller Iapetan failed rift basin structures such as the Ocoee and Mt. Rogers grabens underlie the Paleozoic sedimentary rocks in Virginia and the Carolinas (Thomas, 1991).

Another major basement structure in the Central Appalachians is the northeast-trending New York-Alabama (NY-AL) lineament, a deep-seated crustal boundary beneath the Appalachian basin that manifests as a magnetic anomaly (King and Zietz, 1978; Steltenpohl *et al.*, 2010) (Figure 9). It extends through the basement along the full length of the Appalachians and runs through the center of West Virginia and Preston County, about 20 km east of the Greer well (Figure 9). The NY-AL lineament has been interpreted as a Grenville-aged suture zone (Thomas, 2006) that was active in the late Precambrian as a large crustal-scale dextral fault (King and Zietz, 1978; Steptenpohl *et al.*, 2010). As with many Grenville-aged structures, it may have been reactivated in any of the several tectonic episodes that affected the CEUS in Paleozoic time. It has offset the Grenville front and Amish anomaly mapped by Culotta *et al.* (1990) by ca. 220 km (Steltenpohl *et al.*, 2010). Within West Virginia, it also accommodated dip-slip displacement

during the formation of Cambrian Iapetan rift basins (Steltenpohl *et al.*, 2010). The lineament corresponds to Iapetan rift basin normal faults in places; the Rome Trough runs parallel to the lineament for 250 km and converges with it in southern West Virginia.

The Amish Anomaly is another north-northeast-trending linear magnetic anomaly that is described in the literature and defined on the basis of aeromagnetic data (Steltenpohl *et al.*, 2010; Culotta *et al.*, 1990) (Figure 9). The Amish Anomaly corresponds to an aeromagnetic low that appears to have been displaced and truncated by the NY-AL lineament (Steltenpohl *et al.*, 2010). The Amish Anomaly is considered to represent a belt of metasedimentary rocks with relatively low magnetism, based on borehole data recovered in West Virginia by King *et al.* (1998). Culotta *et al.* (1990) suggest that the Precambrian Amish Anomaly is spatially associated with the Coshocton zone, an approximately 100-km wide west-dipping collision zone to the west of the Amish Anomaly that has been imaged in deep seismic reflection profiles. The Amish Anomaly is more than 70 km west of the Greer well (Figure 9).

The Valley and Ridge Province of West Virginia and Virginia comprises Paleozoic rocks folded, faulted and transported westward during the Alleghenian orogeny. These rocks that appear at the surface overlie a detachment and beneath that, undeformed Paleozoic rocks and underlying Precambrian basement (Cook *et al.*, 1979; McBride *et al.*, 2005). The structures in the rocks below the detachment, which likely include buried Iapetan normal faults, are therefore likely to be unrelated to the structures within the overthrust sheet. The eastern margin of the sub-detachment Paleozoic terranes corresponds to the Piedmont gravity anomaly gradient associated with a transition between thicker crust to the west and thinner crust to the east, and may also be the eastern limit of Iapetan normal faults (EPRI/DOE/NRC, 2012; Bollinger and Wheeler, 1998; Figure 10).

In a recent comprehensive source characterization model for seismic hazard assessments for nuclear facilities in the CEUS, EPRI/DOE/NRC (2012) have identified seismic source zones based on their seismotectonic characteristics and capacity for affecting seismic hazard (referred to hereafter as 2012 CEUS seismic source characterization [SSC]). West Virginia has been included in their Paleozoic extended zone (PEZ), and alternatively, partially within the Midcontinent-Craton zone (MidC) (Figure 10). The basis for segregating the PEZ from the craton is based on the inference that Mesozoic extended crust may localize seismicity and sustain higher magnitude earthquakes, and that Iapetan rift structures may have been reactivated in the Mesozoic, as observed in Saint Lawrence rift region, and/or be likely to localize future seismicity (Figure 5). The PEZ is distinguished from the region along the eastern seaboard that clearly underwent Mesozoic extension because reactivation of the Iapetan structures in the Mesozoic is uncertain farther west in the Appalachians. The PEZ, therefore, represents a region that experienced Iapetan normal faulting and whose Iapetan structures, largely hidden beneath the detachment and thrust sheets of the Valley and Ridge and Blue Ridge provinces, may have been reactivated during Mesozoic extension. The eastern edge of the PEZ corresponds to the Piedmont gravity anomaly gradient and the presumed eastern limit of Iapetan normal faulting (Figure 10). The western boundary has two alternatives, either along the NY-AL lineament or farther west along the Rome Trough, based on differences in the amount of Iapetan extension and uncertainty of Mesozoic reactivation. Adopting the western alternative (PEZ-W) leads to essentially all of West Virginia being included in the PEZ, whereas the eastern alternative (PEZ-N) places the eastern part of the state in the PEZ and the western in the stable craton (MidC) zone.

Several zones of concentrated seismicity occur near West Virginia (Figure 11). In southwest Virginia, near the border, the Giles County, Virginia seismic zone (GCSZ) comprises a 40-km-long, northeast-striking, southeast-dipping tabular zone of seismicity at depths of 5 to 25 km (Bollinger and Wheeler, 1983; 1988). The orientation of the zone is rotated about 20 degrees clockwise from the orientation of the overlying Valley and Ridge structures, suggesting the seismicity might be occurring on reactivated Iapetan structures beneath the detachment and unconnected to surface structures. The seismic zone has been speculatively correlated with possible differential uplift of Tertiary and younger fluvial terraces and with surficial faulting features in the seismic zone (e.g., Law *et al.*, 1993; Robinson *et al.*, 1993); however, solution collapse and landsliding have also been proposed as causes of the faulting (Law *et al.*, 1994).

East of the GCSZ lies the Central Virginia seismic zone (Figure 11). The Central Virginia seismic zone was the source of the August 2011 **M** 5.8 Mineral earthquake (e.g., Wong *et al.*, 2012). The Eastern Tennessee seismic zone (ETSZ) is a pronounced 300-km-long swath of elevated seismicity in the Valley and Ridge and Blue Ridge provinces south of West Virginia (Johnston *et al.*, 1985; Steltenpohl *et al.*, 2010). Seismicity in the ETSZ is spatially correlated with potential field anomalies including the NY-AL lineament. Johnston *et al.* (1985), who analyzed seismicity and focal mechanisms in the ETSZ, observed that seismicity in Tennessee is concentrated between the NY-AL lineament and the Clingman and Ocoee lineaments (located about 30 to 60 km to the east; Figure 9). They state that the lineaments themselves are not seismogenic but bound a weaker, more deformable block of crust that hosts the seismicity cluster. Seismicity occurs at depths between 3 and 29 km, is concentrated between 9 and 15 km, and is largely restricted to the sub-detachment basement. The GCSZ also lies between the same sets of lineaments, although much closer to the Ocoee-Clingman lineament than the NY-AL lineament. Johnston *et al.* (1985) state that GCSZ seismicity is probably concentrated on a NNE-striking sub-detachment reactivated Iapetan normal fault and suggest a similar model to explain the ETSZ seismicity. In West Virginia, the NY-AL lineament is not associated with seismicity.

The most intense seismicity in the ETSZ coincides with the now offset southern continuation of the Amish Anomaly, which trends more northerly than the NY-AL lineament and, on the northwest side of the lineament, runs along western border of WV. The Amish Anomaly represents a belt of metasedimentary rocks in West Virginia, which Chapman *et al.* (1997) propose is correlative with the basement of the Ocoee block SE of the lineament in Tennessee. The magnetic grain of the Ocoee block and/or deformational anisotropies from any of the various tectonic events the area has experienced could control the pattern of seismicity.

Steltenpohl *et al.* (2010) concur with Powell *et al.* (1994) that the regional stresses are consistent with reactivation of the NY-AL lineament right-lateral fault and are concentrating seismicity closer to the lineament, which may reflect the possible emergence of a new throughgoing fault. Johnston *et al.* (1985), by contrast, do not think there is a single throughgoing structure through the Appalachian basement. Their interpretation suggests that seismicity in the ETSZ is controlled by the weak crust on the southeast side of the NY-AL lineament rather than with the lineament itself, and that it is analogous to the sub-detachment seismicity in the GCSZ, which is not correlated with the lineament.

2.2 EARTHQUAKE GENERATION IN THE CEUS

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The eastern United States is far from an active plate boundary yet it has measureable earthquake activity, including concentrations of seismicity in areas of no mapped active faults. As noted

above, the CEUS has undergone multiple stages of rifting and collision, which have left their structural imprint on the crust. It has been observed that several of the concentrations of seismicity are spatially correlated with regions of older faulting, especially Mesozoic and older rift structures. For example, the Reelfoot Rift in Missouri, Arkansas, Tennessee, and Kentucky is part of an intracratonic rift zone formed during late Proterozoic Iapetan rifting and reactivated in the Paleozoic and Mesozoic Eras, and it is the locus of concentrated historical seismicity as well as Holocene faulting in the New Madrid seismic zone (Johnston and Shedlock, 1992; Kolata and Nelson, 1991). Similarly, the Saint Lawrence rift zone originated with Iapetan rifting and was reactivated during the Paleozoic and Mesozoic Eras (Tremblay and Lemieux, 2011). It is associated with concentrated seismicity and contains the Charlevoix seismic zone, which has been the source of several historical **M** 6 earthquakes as well as paleoseismic events (Tuttle and Atkinson, 2010). Numerous other such examples of the correlation between older extension and modern seismicity occur throughout the region.

In the absence of mapped active faults that clearly accommodate regional stresses, as in the faults of western North America's active plate margin, characterization of future seismicity in the CEUS is based largely on seismotectonic characterization of regions, such as regions of older rifting, and on the location of historical seismicity. In light of the correlation of concentrated seismicity with Iapetan and/ or Mesozoic rift zones documented in several locations, models of earthquake generation in the CEUS often identify pre-existing faults or zones of structural weakness that are favorably oriented in the modern stress field as localizers of future seismicity (e.g., Petersen *et al.*, 2008; EPRI/DOE/NRC, 2012). Throughout the eastern U.S., the stress field is characterized by a relatively uniform east-northeast direction of maximum horizontal compression (Zoback and Zoback, 1991; Heidbach *et al.*, 2008; Hurd, 2010; Figure 8). In this stress field, northeast-striking extensional structures that formed along or parallel to the Iapetan and/or Atlantic rift zones are well oriented to accommodate the regional stress through reactivation of normal faults as strike-slip or oblique-slip faults (Wheeler, 1995). The largely strike-slip focal mechanisms of earthquakes in the eastern U.S. bear out this assessment (Adams *et al.*, 1995; Zoback, 1992).

As described in Section 2.1, the 2012 CEUS SSC model, along with the 2008 USGS National Hazard Map model (Petersen *et al.*, 2008), uses the region of Iapetan and/or Mesozoic rifting to delineate zones of likely future earthquake occurrence as well as the magnitude of those earthquakes (Figures 3, 5, and 10). Those models include West Virginia in the region of Iapetan rifting, with the former model further distinguishing it also on the basis of uncertain Mesozoic reactivation of those faults. The USGS model also includes a special zone for the ETSZ, located to the southwest and along strike with West Virginia, to reflect the local concentration in seismicity and possible differences in magnitude and recurrence for earthquakes in that region. The 2012 CEUS SSC model, however, does not call out the zone as a repeated large magnitude event (RLME) source. Neither the USGS nor the 2012 CEUS SSC model includes the GCSZ, as a special source zone, reflecting a lack of confidence that the zone's seismic characteristics differ markedly in recurrence or magnitude from the surrounding region.

In addition to models based on seismotectonic setting and geologic structure, historical seismicity, which shows clusters of seismicity in some areas, can also help define likely locations of future earthquake occurrence. Kafka (2002) for example, concluded based on a statistical analysis of seismicity that future earthquakes in the CEUS are significantly more likely to occur in regions delineated by historical seismicity clusters. Given that, as noted above, seismicity clusters in the CEUS are commonly associated with identifiable seismotectonic environments

and/or favorably oriented pre-existing structures, using seismicity and using seismotectonic setting to identify locations of future earthquake activity will commonly yield similar results.

2.3 HISTORICAL SEISMICITY AND RECURRENCE

The historical earthquake record in West Virginia dates back to 1824. Only 62 known and recorded earthquakes have occurred in the state from 1824 to present (Figure 12), although seismographic coverage of the state has been sparse even up to present (Figure 13). The instrumental record for the region began in earnest in the late 1970's with the earthquakes recorded by the Southeast U.S. Seismic Network (Figure 13).

There have only been eight instrumentally located earthquakes within 100 km of the Greer well, not including the events discussed in Section 4 (Figure 12). A total of four earthquakes have been reported felt in Morgantown and all have been assigned the same location 6.2 km west of the Greer well (Figure 12). This location is probably uncertain by at least 10 km. These earthquakes include events on 7 and 13 March 1957, 12 September 1972 (**M** 2.5) and 6 May 1976 (**M** 2.7) (Figure 12). We are unsure of why all four events have been assigned the same location. The 1957 earthquakes would have had few seismic stations recording them. The 1976 earthquake was felt at a Modified Mercalli (MM) intensity IV level. All events were recorded by the Morgantown seismograph.

The largest earthquake within 100 km of the site was a **M** 4.2 event on 15 July 1824 (Figure 12); this event is described in more detail in Section 2.3.1. A **M** 3.7 earthquake occurred on 8 December 1896, 47 km north-northeast of the site, and a **M** 3.2 event occurred on 8 October 1965, 55 km north of the site (Figure 12). Hence there appears to be at least a comparatively moderate level of seismicity occurring in the Morgantown area that is probably more widespread in West Virginia than is indicated by the historical record. The recordings of the Morgantown seismic station support this observation (Section 4).

2.3.1 1824 Earthquake

On 15 July 1824, a **M** 4.2 earthquake occurred 59 km west of the Greer injection well (Figure 12). This is the first known earthquake in West Virginia although given its large location uncertainty of probably tens of kilometers, it could have occurred in Pennsylvania or Ohio (Figure 12). MacCarthy (1964) reports that this event was confined ~~–~~largely to West Virginia and Ohio". In West Virginia, it was reported in the towns of Weston, Clarksburg, and Wheeling.

2.3.2 1853 Earthquake

The largest earthquake observed in West Virginia occurred on 2 May 1853 (Figure 12). Stover and Coffman (1993) place this earthquake on the West Virginia/Virginia border at a latitude of 38.5°N and a longitude of 79.5°W. They report a MM V (Table 1), a felt area magnitude (Mfa) 4.6, and a felt area of 159,000 km^2. The NCEER-91 (National Center for Earthquake Engineering Research) catalog uses the same location as Stover and Coffman (1993) but they report a MM VI, a Mfa 4.4, and a felt area of 179,872 km^2. The magnitude uncertainty is 0.3, and the location uncertainty is about 50 km (Figure 14). In developing the earthquake catalog to use in the 2008 National Seismic Hazard Maps, the USGS relied heavily on the NCEER-91 catalog for the CEUS. The USGS catalog uses the same location described above, and assumes that the Mfa is equivalent to mblg, and thus used a mblg 4.4.

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Recently, EPRI/DOE/NRC developed a new seismic source characterization (SSC) for the CEUS (Section 2). In support of this work, a new comprehensive earthquake catalog for the CEUS was compiled. This catalog utilized several new studies, including an analysis by Jeff Munsey of the Tennessee Valley Authority (TVA). Munsey relocated events using the Bakun and Wentworth (1997) technique and felt reports extracted from newspaper archives for the region of Kentucky, Tennessee and adjoining areas (Figure 15). Munsey relocated the 1853 earthquake to the west, near Braxton County, at a latitude of 38.47°N and a longitude of 80.56°W, with a **M** 5.16, a magnitude uncertainty of 0.5 and a location uncertainty of 34 km (Figure 14).

2.3.3 Seismicity Catalog for Calculating Recurrence

A historical earthquake catalog was compiled for a large region surrounding the site as shown in Figure 12. This catalog includes the data from the new EPRI/DOE/NRC CEUS earthquake catalog for the time period of 1568 to 2008 (EPRI, 2012). The development of this catalog involved several steps, including: catalog compilation using original source catalogs as much as possible rather than existing compiled catalogs; assessment of a uniform size measure to apply to each earthquake; and the identification of dependent events. Data was compiled from continental scale catalogs (i.e., USGS) and regional catalogs, including the Southeastern United States catalog of Virginia Tech. A major component of the development of the catalog was the determination of a uniform moment magnitude, thus the catalog reports all events in moment magnitude. To update the catalog from 2009-present, the Advanced National Seismic System catalog was used. This catalog includes data from the USGS NEIC Preliminary Determination of Epicenters (PDE), as well as regional network catalog data. The magnitudes were converted to moment magnitude using the methodology described in EPRI (2012). All known events are included in this catalog, but due to inconsistent station coverage (in time and space), a minimum magnitude threshold was not maintained throughout. There are 270 earthquakes shown on Figure 12.

The catalog can be divided into two time periods: the pre-instrumental period from 1775 through the early 1960's and the instrumental period from then to the present. Because these earthquakes occurred prior to national seismographic coverage, the locations, depths, origin times and magnitudes can be highly uncertain and are usually based on anecdotal information described by those who experienced the earthquake. The instrumental period essentially began with the operation of the first global network called the Worldwide Standardized Seismographic Network (WWSSN) in the 1960's. One station at Morgantown was installed in 1950 and was the only station in the state until a few seismograph stations from the Long Range Seismic Network were installed between 1962 and 1966 in West Virginia. Three additional stations at Princeton, Hinton and Green Bank were installed in the late 1970's of which only Green Bank is still operational. In 1991 another station was installed at Mont Chateau in Morgantown by the West Virginia Geological and Economic Survey and this broadband station is part of the USGS NEIC network (Figure 13). A few seismograph stations in the neighboring states of Ohio, Pennsylvania and Virginia were operational in the early 1900's though it was not until the 1970's and 1980's that coverage expanded enough in the states of Ohio, Virginia, Kentucky and Tennessee to contribute significantly to instrumental locations of earthquakes in West Virginia.

The Virginia Tech Seismological Observatory operates 6 seismographic stations in Virginia and there are three other stations in the state (Figure 13). These stations are useful in monitoring the seismicity in West Virginia.

2.3.4 Spatial Distribution of Earthquakes

To evaluate the recurrence of earthquakes within the region around the site, the distribution of historical and instrumental earthquakes was examined to determine distinct seismotectonic provinces. Most of West Virginia lies to the west of a more seismically active zone along the Appalachian Mountains. This area of increased seismicity has been included in hazard analyses in the CEUS but its northern and southern extent varies between studies. In the National Seismic Hazard Maps, the ETSZ was based on the density of seismicity in this region compared to surrounding regions (Petersen *et al.*, 2008). However, other investigators have extended this zone both to the north and south to include other parts of the Appalachian Mountain Chain. Bollinger *et al.* (1991) distinguished a zone (named the Appalachian Highlands) based on a diffuse distribution of seismicity from the Virginia-West Virginia border southwestward into central Alabama which includes the northeasterly trending lineations in eastern Tennessee and Giles County, Virginia. The Appalachian Highlands zone includes just a small amount of northeastern West Virginia. The focal depths are generally between 5 and 25 km in this zone and faulting is predominantly strike-slip motion on steeply dipping planes. The earthquakes are thought to be occurring on reactivated faults that formed during extensional stress during Eocambrian times.

As discussed in Section 2.1, the PEZ described in the 2012 CEUS SSC encompasses the East Tennessee Seismic Zone and much of the Appalachian Highlands as defined by the USGS and Bollinger *et al.* (1991). The seismotectonic zones in that study were modeled after two independent studies: the EPRI (1988) SSC study and the Lawrence Livermore National Laboratory SSC model (Bernreuter *et al.*, 1989). As described in Section 2.1, a narrow version of the zone (PEZ-N) includes the southeastern half of West Virginia and a wider version (PEZ-W) includes all of West Virginia. This zone is part of the Iapetus rifted margin characterized by Wheeler (1995), which encompasses continental crust that was extended during Paleozoic rifting and opening of the Iapetus Ocean. Favorably-oriented faults from the old margin (below the detachment surface) are now reactivated under a compressional stress field particularly in Eastern Tennessee and Giles County, Virginia. The eastern margin of the zone is defined by a gravity anomaly gradient, which is inferred to represent thinning of the crust. The preferred model of the PEZ in the 2012 CEUS SSC is PEZ-N whose western edge is defined by the Birmingham basement fault system in Alabama and the NY-AL lineament to the northeast; the site would be included within this zone.

In this study we have chosen to define the Appalachian Highlands seismic zone similarly to that delineated by Bollinger *et al.* (1991) due to the very low rates of seismicity experienced in central West Virginia. The earthquakes within the Appalachian Highlands seismic zone were removed from the catalog prior to calculating recurrence. The majority of West Virginia, including the site, lies within the stable Midcontinent or Plateau zone of Bollinger *et al.* (1991) and is characterized by reduced rates of seismicity (Figure 16). Since this zone has such low levels of seismicity, the earthquake catalog was extended westward into Kentucky and Ohio (as far as 84.825°W) to increase the robustness of the recurrence calculations (Figure 16).

2.3.5 Recurrence

Plateau Zone

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Crustal background or random earthquakes are those events that can occur without an apparent association with a known or identified tectonic feature. Within the Plateau zone surrounding the

site, seismicity is distributed diffusely with no clear relationships with any geologic structures (Figure 16). These faults are often called "blind" or "buried" faults.

Earthquake recurrence was calculated for the Plateau zone using the catalog of earthquakes compiled for West Virginia. We also calculated recurrence for an extended Plateau zone (extended westward into Kentucky and western Ohio; Figure 16) since the number of independent earthquakes within and surrounding West Virginia appeared to be inadequate for reliable estimates of recurrence.

Within the Plateau zone catalog, a range of different magnitude types (m_{bLg}, M_C, M_D, and **M** based on felt area, etc.) have been used by various agencies when listing earthquakes. We have attempted to normalize the magnitudes in the catalog by converting magnitudes for all events in the catalog to **M**. Relations between m_{bLg} and M_C and **M** have been established for the CEUS by Atkinson and Boore (1995) and Johnston (1996) which are also used in this study. The two relations are:

$\mathbf{M} = -0.39 + m_{bLg} * 0.98$ for $m_{bLg} \leq 5.5$ (Atkinson and Boore, 1995)

$\mathbf{M} = 2.715 - 0.277 * m_{bLg} + 0.127 * m_{bLg}^2$ for $m_{bLg} > 5.5$ (Atkinson and Boore, 1995)

$\mathbf{M} = 1.14 + 0.24 * m_{bLg} + 0.0933 * m_{bLg}^2$ (Johnston, 1996)

In this study we use both relations to calculate **M** and then average the two estimates in a similar manner to that of the USGS when computing the National Seismic Hazard Maps (Petersen *et al.*, 2008). We assume that M_C and M_D have been calibrated to m_{bLg} and so are equivalent and can thus be converted to **M** using the same equations.

Because both seismographic coverage and historical reporting of earthquakes are not uniform with time across this part of the southeastern U.S., completeness periods were determined for each magnitude increment and incorporated into the recurrence calculations. These were based on the history of seismographic coverage in the region and population density with time for the pre-instrumental period. We have used completeness information (including Stepp plots) compiled in the 2012 CEUS SSC report (EPRI/DOE/NRC, 2011) to help determine completeness intervals for uniform magnitude increments as shown in Figure 17. Our magnitude increments are slightly different than those used in the 2012 CEUS SSC report and we only used completeness intervals that we believe to be 100% completely reported. The 2012 CEUS SSC report includes variable percentages of completeness such that the catalog for one region is, for example, believed to be 100% for **M** 2.9 to 3.6 for 1975 to date, but only 83.5% complete from 1950 to 1975 and 63.6% complete for 1910 to 1950, etc.

The recurrence relationships were estimated following the maximum likelihood procedure developed by Weichert (1980) and estimated completeness intervals for the region. The relationships are in the form of the truncated exponential distribution for the occurrence of independent earthquakes. Dependent events, foreshocks, aftershocks, or smaller events within an earthquake swarm (the largest event is assumed to be a mainshock), were identified using empirical criteria for the size in time and space of foreshock-mainshock-aftershock sequences from the procedure adopted from Youngs *et al.* (2000). If an event was identified as dependent by two of the three criteria, it was deleted from the catalog. The resulting catalog for independent events was then used to develop the recurrence relationships.

Earthquakes were placed into 0.5 M unit bins. The number of earthquakes was normalized on an annual basis and per unit area (km^2). The resulting recurrence relationships, assuming the usual form of the Gutenberg-Richter relationship of log N = a - *b*M, are shown on Figures 18 and 19. For the recurrence of the Plateau zone, 18 independent earthquakes (M 2.5 to 5.2) were used to establish a *b*-value of 0.96 (Figure 18). The earthquake recurrence is not well constrained. Predicted recurrence intervals for M 3.0 and 4.0 earthquake and greater in the Plateau zone of West Virginia are 13 and 122 years, respectively. For the extended Plateau zone in West Virginia, 40 independent earthquakes (M 2.5 to 5.2) were used to establish a *b*-value of 0.84 (Figure 19). Using these values, predicted recurrence intervals for M 3.0 and 4.0 events and greater are 9 and 64 years, respectively. Based on either of the two sets of recurrence calculations, the seismicity rates are low in West Virginia. For comparison, the recurrence intervals for M 3 and 4 in the Central Virginia seismic zone are 5 and 22 years, respectively (Bollinger *et al.*, 1989).

The 2012 CEUS SSC computed regional *b*-values of between 0.99 and 1.02 for all of the CEUS. Our estimates appear reasonable when compared to those computed by others using a much larger database.

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The following describes the local structural and stratigraphic setting of the site including a description of local faulting.

3.1 STRATIGRAPHIC SETTING

The Greer well was drilled to a total depth (TD) of 8,185 ft (2,495 m) MD (-6,117 ft [-1,864 m] TVDSS). As shown in Figure 20, the well penetrated the regionally extensive Middle Devonian Oriskany Sandstone at 8,069 ft (2,459 m) MD (-6,001 ft [-1,829 m] TVDSS) and drilled 116 ft (35 m) in the formation to TD. Overlying the Oriskany is the Onondaga Limestone, a 183-ft (56-m) thick cherty fossiliferous packstone that grades into an impure calcitic to dolomitic chert at its base. This lower cherty interval is also known as the Huntersville chert in other parts of the basin. The top of the Onondaga is at 7,886 ft (2,404 m) MD (-5,818 ft [-1,773 m] TVDSS) and the well was perforated in the lower chert interval between 7,889 ft (2,405 m) and 7,969 ft (2,429 m) MD (-5,821 ft [-1,774 m] and -5,901 ft [-1,799 m] TVDSS).

Above the Onondaga is the Middle Devonian Marcellus Shale. At the well locality, the Marcellus Shale is roughly 288 ft (88 m) thick with scattered carbonate stringers throughout. The top of the Marcellus is at roughly 7,598 ft (2,316 m) MD (-5,530 ft [-1,686 m] TVDSS). Overlying the Marcellus is 251 ft (77 m) of Hamilton Shale, a dominantly non-organic, clayey mudstone, followed by the Tully Limestone, a 77-ft- (23-m-) thick fossiliferous wackestone to calcimudstone with its top at 7,270 ft (2,216 m) MD (-5,202 ft [-1,586 m] TVDSS). Overlying the Tully Limestone is the thin Upper Devonian Genesee Shale grading into relatively undifferentiated Upper Devonian non-organic shales and scattered thin sandy shale lenses. The well was not logged from 7,098 ft (2,163 m) to 4,191 ft (1,277 m) MD (-5,030 ft [-1,533 m] to -2,123 ft [-647 m] TVDSS), but using a nearby offset roughly 3,000 ft (914 m) away, the estimated formation tops within this undifferentiated shale section are: the Middlesex Shale (6,958 ft [2,121 m] MD, -4,890 ft [-1,490 m] TVDSS), Cashaqua Shale (6,498 ft [1,981 m] MD, -4,430 ft [-1,350 m] TVDSS) Rhinestreet Shale (4,618 ft [1,408 m] MD, -2,550 ft [-777 m] TVDSS), Angola Shale (4,338 ft [1,322 m] MD, -2,270 ft [-692 m] TVDSS), Java Formation (4,013 ft [1,223 m] MD, -1,945 ft [-593 m] TVDSS), and Brallier Formation (3,742 ft [1,141 m] MD, -1,674 ft [-510 m] TVDSS).

Above the Brallier Formation, the well is in primarily shale to sandy shale as part of the Upper Devonian Greenland Gap Formation to roughly 1,848 ft (563 m) MD (220 ft [67 m] TVDSS), above which is the predominantly more sandy intervals of the Upper Devonian Hampshire Formation (1,258 ft [383 m] MD, 810 ft [247 m] TVDSS) and Lower Mississippian Berea sandstone (1,049 ft [320 m] MD, 1,019 ft [311 m] TVDSS), where the log recording stops.

3.2 STRUCTURAL SETTING

The Greer well was drilled in 1968 in the Chestnut Ridge anticline of north-central West Virginia (Monongalia and Preston counties) as part of the South Burns Chapel field. Approximately 44 miles (70 km) northwest of the Allegheny Overthrust, the Chestnut Ridge anticline is a regional feature of the Appalachian Fold belt. The anticline's western limb creates the Intra-Plateau Front, a roughly 100-mile (160 km) topographic high that separates the high relief, open folds (> 1,000 ft [> 205 m] of relief) of the Allegheny Mountains in the east from the lowlands and low folds of the Pittsburg Plateau to the west (Shumaker, 2002).

The USGS has recently published regional northwest-southeast cross sections through the Appalachian Basin in the vicinity of the Greer well (Ryder *et al.*, 2009; 2012) (Figure 21).

Cross-section C-C' (Ryder *et al.*, 2012) passes through the Chestnut Ridge anticline approximately 34 km northeast of Greer well, where the geologic interpretation of the anticline is constrained by well data (well #8) (Figure 22); cross-section D-D' (Ryder *et al.*, 2009) passes through the Chestnut Ridge anticline approximately 24 km southwest of Greer well, where the geologic interpretation of the anticline is also constrained by well data (well #10) (Figure 23). Only the southeastern portions of cross-sections C-C' and D-D' are shown on Figures 22 and 23. Note that whereas these regional cross-sections are not representative of the particular stratigraphy and structure along the Chestnut Ridge anticline at the location of the Greer well, these sections illustrate the character of the anticlinal structure and highlight the higher structural relief and intensity of deformation to the northeast of the Greer well (cross-section C-C'; Figure 22) relative to the more subdued structural relief and less intense deformation to the southwest of the well (cross-section D-D'; Figure 23).

Formation of the Chestnut Ridge anticline was driven by the Pennsylvanian Allegheny thrust and defined primarily through two decollement events: an older event within the Ordovician Martinsburg-Reedsville Shale and a younger event within the evaporate beds of the Silurian Salina Group (Figures 22 and 23). Whereas the Greer well did not penetrate below the Oriskany sandstone, it is possible to estimate the depths of the two decollements below the well by interpolating between the depths represented on cross-sections C-C' and D-D' (Figures 22 and 23), using a weighted average based on the relative distance from the well to those lines. Using this method, the Salina decollement is inferred to be at approximately 8,990 ft (2,740 m) MD (-6,920 ft [-2,109 m] TVDSS) below the Greer well. The Martinsburg-Reedsville shale decollement is inferred to be at a depth of approximately 13,730 ft (4,180 m) MD (-11,660 ft [-3,554 m] TVDSS) below the Greer well. The structural folds generated by the initial decollement in the Martinsburg-Reedsville Shale likely controlled the placement of the folds created by the younger overlying Salina decollement (Gwinn, 1964). The decollement events generated a series of faulted folds within the core of the anticline, extending from the Helderburg Limestone directly overlying the Salina Group up through the Onondaga, Marcellus and Tully formations and dying out into the Upper Devonian Shales (Shumaker, 2002) (Figures 22 and 23). From log correlations, deformation within the Upper Devonian appears to rapidly diminish above the Tully Limestone and marker beds within the Upper Devonian form a comparatively smooth, broad fold profile that extends upwards to surface and near-surface rocks (Shumaker, 2002) (Figures 22 and 23).

The Chestnut Ridge anticline is a deeply-rooted structure, suggesting that its evolution was influenced by basement tectonics (Scanlin and Engelder, 2003; Ryder *et al.*, 2012). Both Scanlin and Engelder (2003) and Ryder *et al.* (2012) propose a two-stage origin for the Chestnut Ridge anticline, wherein the first stage resulted from the reactivation in a reverse sense of a (steeply-dipping) Rome Trough-related basement fault, and the second stage involved the thin-skinned decollement-style deformation. However, it is important to note that although thin-skinned deformation in the core of the Chestnut Ridge anticline is probably spatially controlled by the location of a reactivated basement fault, no recurrent fault movement on the basement fault has been documented (Scanlin and Engelder, 2003; Ryder *et al.*, 2012).

The proximity of the Chestnut Ridge anticline to the eastern boundary fault of the Rome Trough is interpreted to vary along strike of the anticlinal crest (Figure 24). At the latitude of cross-section C-C' (~34 km northwest of the Greer well along strike of the anticline), Ryder *et al.* (2012) place the eastern margin of the Rome Trough approximately 32 km to the east of the Chestnut Ridge anticline, beneath the Laurel Hill anticline (Figure 22). In contrast, Scanlin and

Engelder (2003) place the eastern boundary fault directly beneath the Chestnut Ridge anticline at this latitude (Ryder *et al.*, 2012). At the latitude of cross-section D-D' (~24 km southwest of the Greer well along strike of the anticline), Ryder *et al.* (2009) place the eastern margin of the Rome Trough approximately 10 km to the east of the Chestnut Ridge anticline (Figure 23). Based on interpolation using a weighted average that accounts for the distance between the Greer well and cross-sections C-C' and D-D', it can be estimated that the distance between the eastern boundary fault of the Rome Trough and the Chestnut Ridge anticline at the latitude of the Greer well is approximately 19 km.

Whereas the basement faults within the Rome Trough generally affect Ordovician and older strata, the eastern boundary fault is significant in that it is interpreted to cut farther upsection. Along cross-section C-C', Ryder *et al.* (2012) interpret the boundary fault to propagate upsection as far as the Silurian Wills Creek Formation directly below the Salina Group (Figure 22). Along cross-section D-D', Ryder *et al.* (2009) indicate that the boundary fault may cut up to the Salina detachment; this interpretation is dashed (inferred) and must be considered highly speculative as it is not constrained by deep drill hole data (Figure 23). In their northwest-southeast trending interpreted regional seismic line B-B', which passes through the Chestnut Ridge anticline only about 1 km southwest of the Greer well (Figure 24), Kulander and Ryder (2005) interpret a fault beneath the anticline from the top of the Grenvillian basement up into the Upper Devonian Elk Group (Figure 25).

Figure 26, an Onondaga structure map, shows the location of the faults closest to the Greer well at the structural level of the Onondaga. Figure 27 shows the same structural interpretation superimposed on an isopach map of the Onondaga and Oriskany Formations. The Greer well appears to cut through a reverse fault within the Marcellus section at roughly 7,838 ft (2,389 m) MD (-5,770 ft [-1,759 m] TVDSS), 51 ft (16 m) above the top of the perforated interval. This fault resulted in significant structural thickening of the shale at the well: the Marcellus in the Greer well is 288 ft (88 m) thick (Figure 20), whereas the general average thickness of the Marcellus in the surrounding wells is closer to 110 ft (34 m). From 2D seismic data, the fault has been interpreted to have started in the Ordorician Martinsburg-Reedsville shale as part of the decollement surface at approximately 13,730 ft (4,180 m) MD (-11,660 ft [-3,554 m] TVDSS) and extend into the Upper Devonian shales where it dies at roughly 6,068 ft (1,850 m) MD (-4,000 ft [-1,219 m] TVDSS). However, this interpretation is somewhat suspect due to the very poor coherency of the 2D seismic data. Due to the rough topography and strong refraction statics, the seismic data in this area is generally of very poor quality over the anticline, and it is difficult to clearly ascertain displacement and lateral (along-strike) extent of faults within the data noise.

In situ data on the magnitudes and orientations of the principal stresses at the Greer well are not available. Regional stress data indicates that the regional stress field is characterized by an east-northwest direction of the maximum horizontal compressive stress (S_H), as discussed in Sections 2.1 and 2.2. Northeast-trending faults, including the faults in the immediate vicinity of the Greer well, are favorably oriented to slip in this current stress field.

In order to evaluate seismicity in the vicinity of the Greer well that may be occurring below the level of detection of current seismic networks, continuous data recorded from the USGS MCWV seismic station located in Morgantown was analyzed by Seismik to detect and possibly locate earthquakes occurring near the station.

4.1 STA/LTA EVENT DETECTION

Continuous data recorded by the US.MCWV station was used as input to the STA/LTA (short-term average/long-term average) detection. The STA/LTA detection algorithm works by scanning the continuous data recorded by a seismic station and outputting a detected _event' anytime a short-term portion of the data (STA) goes above the long-term noise level (LTA). The continuous data, detailed parameters, and other station information are available for download or viewing at the IRIS (Incorporated Research Institutions for Seismology) website.

The MCWV station was installed in March 1991. However, due to large gaps in the data and the possibility of large parameter changes in the sensitivity of the station, analysis was performed only for data recorded after September 1995. Each output _event' of the detection was visually inspected to verify that the recorded waveform was that of an earthquake. For each detected earthquake, the arrival times of the S- and P-wave phases were manually picked. As the final selection criteria, events with hypocenters within 20 km of the MCWV station would be expected to have a delay time between the S- and P-wave arrivals of no greater than 4 sec. Figure 28 shows an example of two accepted earthquake waveforms as well as the picked S- and P-wave arrival times.

Between September 1995 and present, 602 earthquake waveforms with S-P times of less than 4 sec were detected. Figure 29 shows the number of events detected per month as well as any reported changes in instrument sensitivity or gaps in the recorded data. While the greatest number of events was detected between 2010 and 2011, this is also the time period when the sensitivity of the station was greatest, and the ability to detect greater numbers of smaller events is increased. There are also two large time gaps, one in 2009 and one in 2010, when no events could be detected.

Figure 30 shows the distribution of measured S-P times. The values range from 1 to 4 sec, which roughly corresponds to a range of hypocentral distances from 5 to 24 km from the MCWV station. The majority of the measured delays are around 2 sec, which corresponds to a hypocentral distance of around 11 km from the MCWV station.

4.2 MAGNITUDE ESTIMATION

The data record for the MCWV station includes no reported events, and a large number of the events detected were not recorded on any additional stations. To calculate an approximate magnitude of the detected events the equation from Herrmann and Nuttli (1982) was used.

$$m_{bLg} = 3.81 + 0.83\log(\Delta) + y(\Delta - 0.09)\log(e) + \log(A)$$

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Where m_{bLg} is the body wave magnitude of the event, Δ is the epicentral distance in degrees (in this case taken from S-P times), y quantifies how amplitude attenuates with distance (in deg^{-1}), and A is the measured amplitude of the event at the MCWV station (in microns). This was corrected to Richter local magnitude using a generalized formula for shallow events with magnitudes around m_{bLg} 2.0,

$$M_L = \frac{5}{3.5} * (m_{bLg} - 1.5)$$

and Figure 31 shows the M_L of each event plotted as a function of time. The calculated magnitudes were found to range from M_L 0.0 to 2.6 and show little to no pattern or variation with time. Figure 31 also illustrates the increased number of smaller events detected after 2010 that may be due to the increased sensitivity of the MCWV station. The sudden decrease of the magnitude of the detected events in February through April 2000 may be representative of the true nature of the detected events, or may be an artifact of an unreported change in the station parameters.

For three more recent, larger events detected on 7 to 9 February 2011, the same amplitude calculation was performed for the records of these events at the PE.UPAO and TA.O56A seismic stations located 95 km to the north and 130 km to the northeast of the MCWV station, respectively. The calculated magnitudes at the UPAO station were, on average, smaller by 0.3 than those calculated at the MCWV station, so the estimated uncertainty of the magnitudes presented here (Figures 31 and 32) is around ± 0.3 magnitude unit.

Figure 32 shows the distribution of event magnitudes for all of the detected events on a logarithmic scale. Using this scale, the distribution is observed to decay linearly as magnitude decreases but only for events smaller than M_L 1.4. This indicates that M_L 1.4 is the minimum magnitude for which the catalog can be assumed complete. Figure 33 shows the number of events detected per month with M_L>1.4. Where the catalog is complete and the effect of increased station sensitivity is largely removed, no recent increase in the number of detected events is observed.

4.3 EVENT LOCATIONS

Six events detected at the MCWV station during the first half of 2011 (Table 2) between M_L 1.4 and 2.0 were also recorded in the data of two additional regional seismic stations: PE.UPAO and TA.O56A (Figure 34). P- and S-wave arrival times measured at these three stations (Figure 35) as well as a local velocity model determined by Fnais (2004) (Figure 36) were used to locate these six events. The methodology used here for event location is performed by finding the event hypocenter where the measured P- and S-wave arrival times best match the theoretical arrival times calculated within the given velocity model. The calculated locations are given in Table 2.

Figure 37 shows the locations determined for all six events. It was found that five of the events had epicenters between 3 and 10 km to the east and southeast of the MCWV station. One event detected on 7 February 2011 was found to have an epicenter around 10 km to the south-southwest of the MCWV station and in the same area as the epicenter of the earthquake reported in the area in 1976 (Section 2.3; Figure 37). All the event depths were found to be between 12 and 14 km. However, the distance of the regional stations used in these locations makes determining accurate depths difficult. The uncertainty in the epicentral locations, based on possible pick error and velocity model uncertainty, was found to be around 14 km on average (Figure 37).

While few earthquakes have been reported in the area near Morgantown in the last 100 years, the data from the MCWV seismic station located in Morgantown includes records of 602 events that

have occurred within 20 km of the station since 1995. This seismicity is of relatively low magnitude with values in the range of M_L 0 to 2.6.

The lack of seismic coverage in both time and space make accurate event locations difficult and no distinct spatial pattern was observable in the hypocenters of the six events that were located. However, one of the located events was found to have an epicenter in the same area as the reported Morgantown earthquakes (Figure 37). Whether or not this could imply a possible relationship with past seismicity from 36 years ago, it is clear that ongoing seismicity has been present in this area for many years.

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The Greer well, API # 47-061-0317, is located at N 39.58985, W 79.82913 in Monongalia County. The well was drilled to a total depth of 8,185 ft (2,495 m) MD (-6,117 ft [-1,864 m] TVDSS). The well was completed in the Oriskany sandstone with perforations from 7,889 ft (2,405 m) to 7,969 ft (2,429 m) MD (-5,821 ft [-1,774 m] and -5,901 ft [-1,799 m] TVDSS). Figure 38 shows the well-bore schematic, which summarizes the drilling, completion and current downhole equipment for the well.

The well was originally a producing well, with poor results with regard to producing natural gas, and a decision was made to convert the well into a UIC Class II injection well. The step-rate injection test was conducted on 4 December 2006. A total of 510 bbls of freshwater were injected over the course of ~4 hours. The initial injection rate was recorded at 0.5 BPM, with incremental increases in rate to a 3.65 BPM max injection rate. The maximum pressure recorded prior to parting the formation during the step-rate test was 2,980 psi. The graph recording the step-rate tests is shown in Figure 39.

In August 2007, a permit application was submitted to operate the well as a UIC Class II injection well in accordance with the WVDEP-O&G rules and regulations. In November 2007, the WVDEP-O&G issued an operating permit as follows:

- Maximum injection pressure: 2,682 psi (pounds per square inch)

Injection operations began on 10 January 2008. The following table presents annual operating parameters.

	Average	Maximum	Minimum
2008 rate (gallons/minute)	10.0	20.9	0
2008 maximum daily injection pressure (psi)	1,191	2,100	0
2009 rate (gallons/minute)	8.6	23.8	0
2009 maximum daily injection pressure (psi)	1,616	2,140	1,020
2010 rate (gallons/minute)	7.6	21.5	0
2010 maximum daily injection pressure (psi)	1,783	2,350	0
2011 rate (gallons/minute)	8.9	19.7	0
2011 maximum daily injection pressure (psi)	2,063	2,480	1,550
2012 through 6/30/12 rate (gallons/minute)	8.1	19.4	0
2012 through 6/30/12 maximum daily injection pressure (psi)	1,905	2,460	0

Figure 40 shows annual graphs of the injection volume (bbls/day), injection pressure (psig) and the shut-in pressure. Daily injection volume ranged from zero to 640 bbls/day. Accumulated volume through 30 June 2012 is 275,980 bbls.

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To address item 15 of the WVDEP-O&G requirements on the migration of injectate (see Section 1), this section describes a model developed to numerically simulate the fluid migration caused by injection into the Greer well into the lower chert interval of the Onondaga Limestone. An evaluation of the fluid migration is useful to illustrate the reservoir structure and the stratigraphic units that impact the direction, rate, and pattern of fluid (and corresponding pore pressure) migration.

Because of the faulting in the direct vicinity of the Greer well and the impact of the pre-existing faults and associated fractures on fluid flow, it is not appropriate in this case to conduct the analysis using a modified analytical solution based on the EPA document *Radius of Pressure Influence of Injection Wells* (Warner *et al.*, 1979). Instead, consistent with published studies of fluid-injection induced seismicity that include modeling (e.g., Raleigh *et al.*, 1976; Hsieh and Bredehoeft, 1981; Davis and Pennington, 1989), we employ a continuum model and incorporate structural anisotropy and hydraulic conductivity variation to model faults and associated fractured regions. The main objective of the modeling effort is to estimate the horizontal and vertical distance that the injected fluid has migrated since the initiation of injection.

6.1 GEOLOGY AND CONCEPTUAL MODEL

A review of the geological characteristics of the strata at the Greer well indicates the thickness of the injection zone in the Onondaga Limestone is limited to 80 feet (24 m). A summary of the formations present above and below the Onondaga Limestone is shown in Table 3. The low porosity and permeability of the Tully Limestone indicate that this formation serves as a competent upper confining unit.

6.2 MODEL DESIGN

Visual MODFLOW v. 2011.1 (Schlumberger Water Services), which incorporates the USGS code of MODFLOW 2005 (Harbaugh, 2005), was used for the flow simulations. The MODFLOW code simulates flow over the modeling domain represented by a modeling grid. Head and flux are solved within each grid cell by applying a finite-difference numerical method.

Because this simulation involves a fully confined system at significant depth (over 6,000 feet [1,829 m] below land surface [ft bls]), a "box model" was used for the evaluation. The lateral extent of the model was selected to minimize the possibility of artificial boundary influences. The final model developed for this analysis is a 3D representation of the Onondaga Limestone (the targeted injection zone) and units above and below.

The model was constructed to represent fluid flow migration associated with the Greer injection well, summarized as follows:

1. A 13-layer flow model was created for the simulation, with five layers used to represent flow in the Onondaga and the adjacent Oriskany, Marcellus, Hamilton, and Tully formations.
2. Monthly averages of injection rates for the period of record were used in the model.
3. The model includes higher conductivity zones to represent faults in the vicinity of the injection well.

6.2.1 Model Grid

The model grid is non-uniform, with the cell dimensions adjusted such that the spatial center contains the injection well (Figure 41). The grid dimensions are 281 rows by 331 columns; the total modeled area covers an area of 75,387 ft (22,978 m) (N-S) by 102,455 ft (31,228 m) (W-E), or approximately 277 square miles. The cell size gradually increases away from the well from a minimum cell size of 203 ft (62 m) by 196 ft (60 m) at the well to a maximum cell size 834 ft (254 m) by 610 ft (186 m).

6.2.2 Structural Model

The structural input for the model is based primarily on the data presented in Figure 26 (the Onondaga structure map, which incorporates well data and 2D seismic data). The model was further developed using the assumptions listed below, which were informed by published data presented in Section 3.2 (sources include Ryder *et al.*, 2009; Ryder *et al.*, 2012; Kulander and Ryder, 2005). These assumptions were guided by main four goals: (1) to be consistent with the available (reliable) data, (2) to be geologically reasonable, (3) to simplify the model, and (4) to generate conservative results. Figure 42 is a modified version of the Onondaga structure map (Figure 26) that shows fault labels and indicates the location of the cross-section line X-X' (Figure 43). Figure 43 schematically depicts the depth dimension of the structural model along the cross-section line X-X'. The structural model presented in Figure 43 is based on the following assumptions:

1. The interpreted locations of the faults represented on the Onondaga structure map (drawn where the Onondaga appears to be offset; Figure 42) are assumed to be accurate and are adopted in this model.

2. The faults represented on the Onondaga structure map that do not appear on cross-section line X-X' are omitted from the model, with the exception of fault A' (Figure 42).

3. Most faults represented on the Onondaga structure map (Figure 42) (fault A', fault B', fault C', fault D', fault E', fault G', fault H', fault I', and fault J') are assumed to be vertical due to a lack of reliable data on fault dip direction.

4. The fault (fault F') that intersects the Greer well at -5,770 ft TVDSS (Figure 42) is assigned a dip of 80°W because the well data indicates that the fault intersects the (vertical) well only once, in the Marcellus. Fault F is assigned a (north)westerly dip because it is assumed to be a reverse fault, and the west side has moved up relative to the east side (Figure 42). The dip of 80° (close to vertical) is assigned due to a lack of reliable data on fault dip direction.

5. All faults represented on the structure map (Figure 42) (faults A-J) are assumed to start at the Martinsburg-Reedsville decollement (-11,660 ft TVDSS) and die out in the upper Devonian shales (-4,000 ft TVDSS). This depth range estimation is based on interpreted 2D seismic data that crosses the Chestnut Ridge anticline at the location of the Greer well (see discussion in Section 3.2).

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6. There are two major (regional) decollement faults included in the model: a shallower one in the Silurian Salina Group at -6,920 ft TVDSS (fault K'), and a deeper one in the Ordovician Martinsburg-Reedsville Shale at -11,660 ft TVDSS (fault L') (Figure 43). The estimated depths of these decollement faults beneath the Greer well are based on

interpolation between the depths of the decollements represented on C-C' and D-D' (Ryder *et al.*, 2009; 2012), as discussed in Section 3.2. Both decollement faults are assumed to be flat-lying, and to extend the full extent of the modeled region, consistent with the depiction of these decollements in cross-section D-D' (Ryder *et al.*, 2009).

7. Based on the interpretations in cross-section C-C' (Ryder *et al.*, 2012) and by Kulander and Ryder (2005), it is assumed that there is a basement fault directly beneath the Chestnut Ridge anticline. To be conservative, this fault (fault N') is included in the model at a location directly beneath the Greer well, with a top at 13,500 ft TVDSS, based on the interpreted top in cross-section C-C' (Ryder *et al.*, 2012).

8. The next closest basement fault to the west of the Chestnut Ridge anticline (fault M') is assumed to be 7 miles (37,000 ft; 11.2 km) to the west of the basement fault below the anticline. This distance was selected based on the average spacing of the Rome Trough basement faults as represented on cross-sections C-C' and D-D' (Ryder *et al.*, 2009; 2012). As with basement fault N, basement fault M is included in the model with an estimated top at 13,500 ft TVDSS, based on the interpretation in cross-section C-C' (Ryder *et al.*, 2012).

9. The next closest basement fault to the east of the Chestnut Ridge anticline (fault O') is assumed to represent the eastern boundary fault of the Rome Trough. This significant basement fault is assumed to be 11.6 mi (~61,000 ft; 18.6 km) east of the axial plane of the Chestnut Ridge anticline (the axial plane is assumed to be coincident with fault D). The lateral distance between the anticline and fault O is based on interpolation between the distances from the Chestnut Ridge anticline to the eastern boundary fault represented on cross-sections C-C' and D-D' (Ryder *et al.*, 2009; 2012), as discussed in Section 3.2. Fault O, the presumed eastern boundary fault of the Rome Trough, is assumed to have a top at the Salina decollement fault (-6920 ft TVDSS), based on the interpretation in cross-section D-D' (Ryder *et al.*, 2009) and the goal of generating conservative model results.

10. All three basement faults in the model (faults M-O) are assumed to be vertical due to a lack of reliable data on fault dip direction.

11. The strike orientation of all modeled faults (with the exception of the two decollement faults) is assumed to be N 24° E, consistent with the general average trend of the faults as shown on Figure 42.

6.2.3 Hydraulic Parameters

Because this evaluation assumes a "closed system" (no interaction with surface water or other water-bearing units is assumed to occur), the only hydraulic parameters required for the model are porosity and hydraulic conductivity; these values are summarized in Table 3. Hydraulic conductivities were derived from permeability values using a conversion value of 2.75 ft/d (K) per Darcy (Johnson, 1963) and further refined during the calibration process. The listed values only take into account the hydraulic conductivity of the matrix. Secondary permeability resulting from fractures may yield hydraulic conductivities several orders of magnitude higher than those shown in the table.

Reported values for hydraulic conductivity (K) in the literature range from 10^{-8} ft/day for unfractured shale to 10^{-4} ft/day for fractured shale (Heath, 1983; Domenico and Schwartz, 1990). Primary porosity in shale typically ranges from 0-10% (Freeze and Cherry, 1979). Secondary porosity (porosity associated with fractures in the rock) may be significantly higher.

6.2.4 General Modeling Assumptions

The following key assumptions were necessary to accomplish the modeling effort:

1. The thickness of the perforated interval in the Onondaga is equal to 80 ft (24 m).
2. The daily data reports from 2008 to 2012 for the disposal well that were used for calibration are the best available data and equipment used to collect the data was calibrated and well-maintained.
3. Formation thicknesses and hydraulic data are reasonable estimations.
4. Whereas unit thicknesses are known to be variable (Figure 27), for the purposes of this numerical model, all units are assumed to have constant thicknesses; porosity and hydraulic conductivities are also assumed to be constant within each formation, with the exception of the cells representing the modeled faults.
5. All faults are assigned the same hydraulic conductivity; this value is set to be constant over the length and width of each fault.

6.2.5 Model Calibration

The calibration process involved iteratively adjusting model parameters to obtain the best match between the daily pressure data at the injection well and the modeled (monthly average) data. The calibration match is shown on Figure 44. Calibration is typically achieved by matching water elevations in observation wells to modeled elevations for grid cells that represent the observation wells. Because this project only involves a single deep injection well, no observation well data are available for use as calibration targets. As an alternative, head values at the well were selected as initial calibration targets. The calibration process typically yields a specific combination of hydraulic parameters that provide a best fit for the field data.

6.3 MODEL DETAILS

The unit thicknesses, porosities, and hydraulic conductivities used in the model are summarized in Table 3. The relatively permeable fault zones were represented in the model as ~300-ft-wide strips of increased hydraulic conductivity. The modeled fault hydraulic conductivity is 0.0012 ft/day, approximately two to five orders of magnitude greater than that of the host rock.

Published models of fluid flow in cases of potentially induced seismicity (e.g., Raleigh *et al.*, 1976; Hsieh and Bredehoeft, 1981; Davis and Pennington, 1989), utilize the assumption that fault conductivity is up to eight times the shale conductivity though this may in fact be a significant underestimation of the true K value of the fault. In a recent article that addresses in detail the modeling of potential migration pathways through faults and fractures within the Marcellus shale, Myers (2012) reports that whereas porous flow through unfractured shale is negligible due to low bulk permeability, fractures and faults control flow and give rise to shale properties that can vary by several orders of magnitude. To reflect this large range, Myers

(2012) uses simulated K values for shale that range from 0.00001 to 1 m/d (or 3.28 x 10^{-5} to 3.28 ft/d) in model scenarios. Faults were modeled as pathways through sandstone with K values of 10 to 1000 times that of the surrounding rock (Myers, 2012). Fracture flow modeling is routinely conducted with hydraulic conductivity values several orders of magnitude above the surrounding rock.

The model was calibrated and run using monthly averages of injection rates for the period of record. Although the use of monthly averages of injection rates has the effect of dampening the pressure response by smoothing the impact of daily and weekly fluctuations in injection rate, a lack of substantial daily or weekly fluctuations (Figure 40) indicates that monthly averages provide a reasonable approximation.

6.4 DISCUSSION

The purpose of the modeling effort was to present a reasonable scenario for fluid movement associated with injection activities at the Greer well. Figure 45 shows a W-E cross section through the model (with 10X vertical exaggeration). The labeled regions in Figure 45 indicate areas in the model outside of the region of influence that were deactivated in the final run to decrease the model runtime. Hydraulic conductivities of the faults and strata in the model are also indicated on Figure 45.

The horizontal and vertical extent of fluid flow away from the well over the period of record is presented on Figures 46 and 47, respectively. The following points were noted from the modeling activities and results:

- The total observed maximum horizontal extent of the injectate was 1,590 ft (485 m) along a fault-parallel trend and 1,365 ft (416 m) along a fault-perpendicular trend (Figure 46).
- The maximum vertical extent of the injectate was observed at a distance of 660 ft (201 m) above and 846 ft (258 m) below the Greer well, for a total observed maximum vertical extent of 1,506 ft (459 m) (Figure 47) (note the vertical exaggeration on Figure 47).
- For the period of record, the fault (_fault F') that intersects the Greer well plays a significant role in channeling fluid flow, as is shown by the greater fault-parallel lateral extent of the injectate relative to the fault-perpendicular extent (Figure 46) and is also apparent in the vertical extent of the fluid (Figure 47).
- All of the other modeled faults are beyond the extent of fluid flow during the period of record and therefore do not impact the flow during this modeled time period.
- The maximum change in pressure at the bottom of the well over the period of record is equivalent to the maximum injection pressure: 2,480 psi (171 bars).

In addition to the uncertainties in the structural model and hydraulic parameters, another source of uncertainty in the modeling effort is in the calibration to the daily maximum pressure. To accurately simulate field conditions, the average daily injection pressure is needed. Because the average daily pressure is likely to be significantly lower than the daily recorded maximums, the modeled hydraulic conductivities would need to be increased accordingly to prevent buildup of

pressure in the injection well. An increase in hydraulic conductivity would cause more pressure to build at distances from the well and/or a greater extent of fluid and pressure migration.

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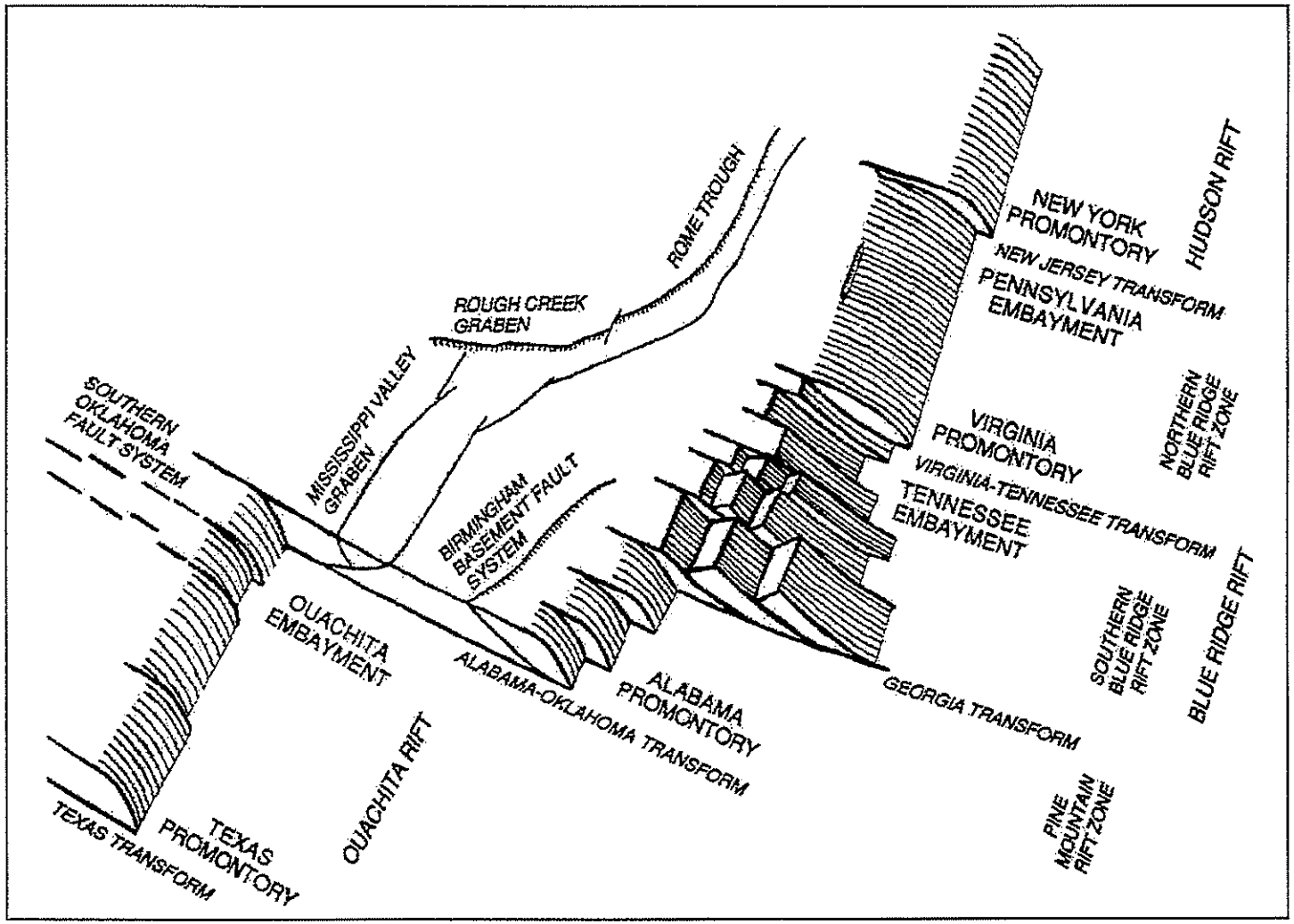
Table 1. Abridged Modified Mercalli Intensity Scale

I	Not felt except by a few under especially favorable circumstances. (RF* I)
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (RF I to II)
III	Felt quite noticeably indoors, especially on upper floor of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (RF III)
IV	Felt indoors by many, outdoors by few during the day. Some awakened at night. Dishes, windows, door disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (RF IV to V)
V	Felt by nearly everyone, many awakened. Some dishes, windows, and other fragile objects broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (RF V to VI)
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster and damaged chimneys. Damage slight. (RF VI to VII)
VII	Everybody runs outdoors. Damage negligible in buildings of good design moderate in well built ordinary structures; considerable in poorly built or bad chimneys broken. Noticed by persons driving cars. (RF VIII)
VIII	Damage slight in specially designed structures; considerable in ordinary sub collapse; great in poorly built structures. Panel wall thrown out of frame factory stacks, columns, monuments, walls. Heavy furniture overturned. Sa amounts. Changes in well water levels. Persons driving cars disturbed. (RF V
IX	Damage considerable in specially designed structures; well designed fra plumb; great in substantial buildings; with partial collapse. Buildings sh cracked conspicuously. Underground pipes broken. (RF IX +)
X	Some well built structures destroyed; most masonry and frame structur ground badly cracked. Rails bent. Landslides considerable from river bank and mud. Water splashed, slopped over banks. (RF X)
XI	Few, if any, [masonry] structures remain standing. Bridges destroy Underground pipelines completely out of service. Earth slumps and land greatly.
XII	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

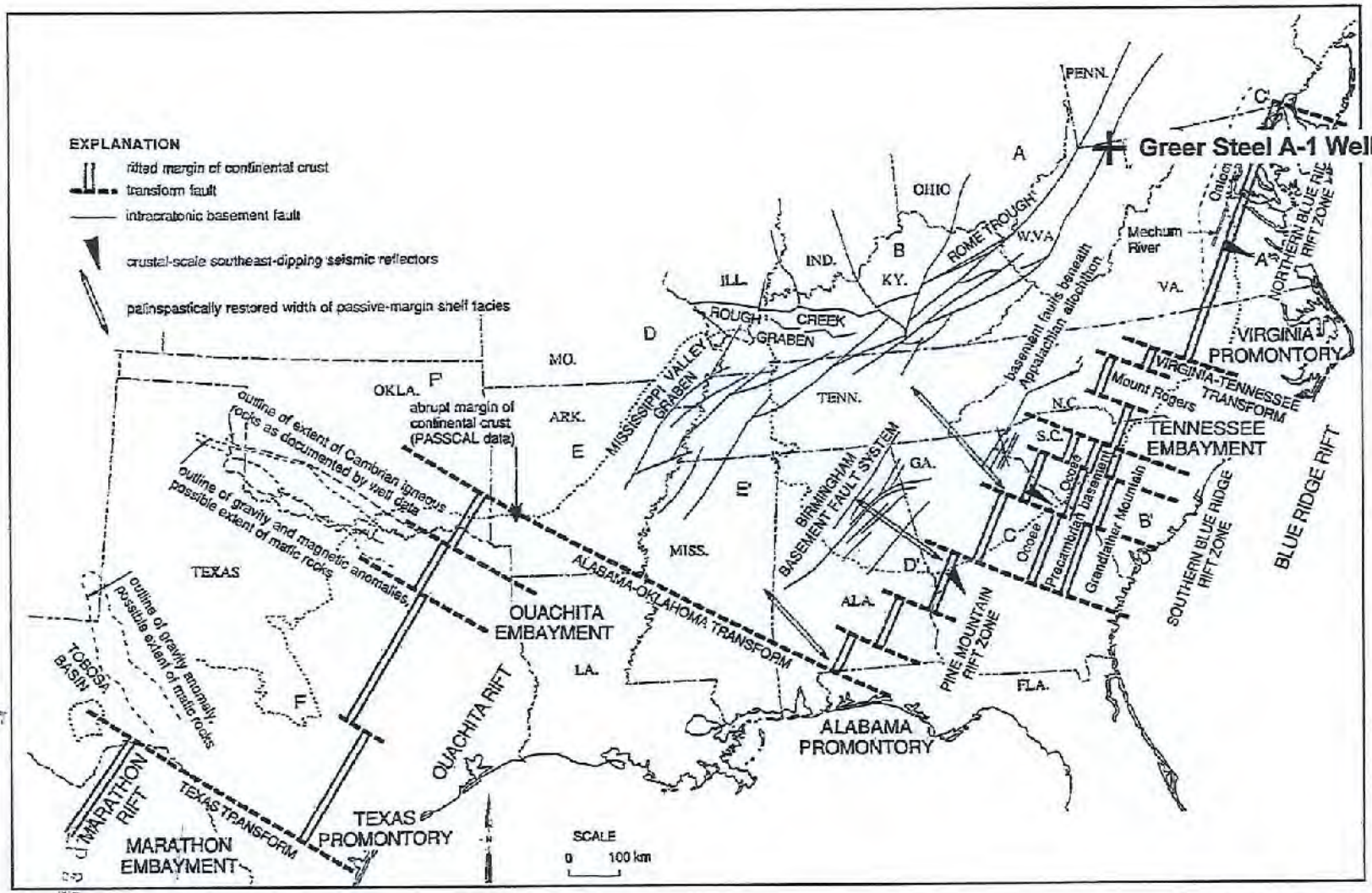
* Equivalent Rossi-Forel (RF) intensities.

Source: Bolt, 1978



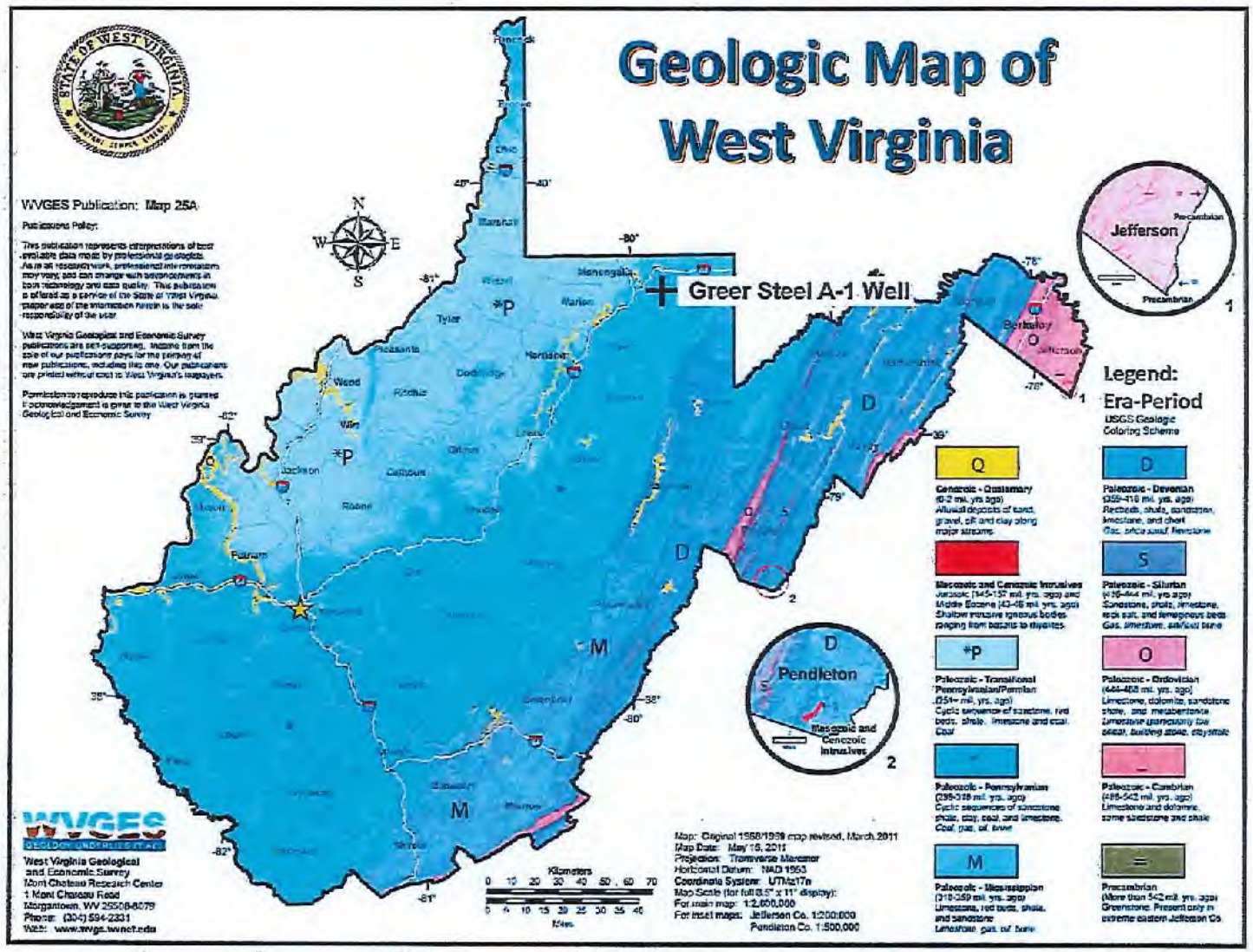
Source: Thomas (1991)

Figure 2. Iapetan rifting model



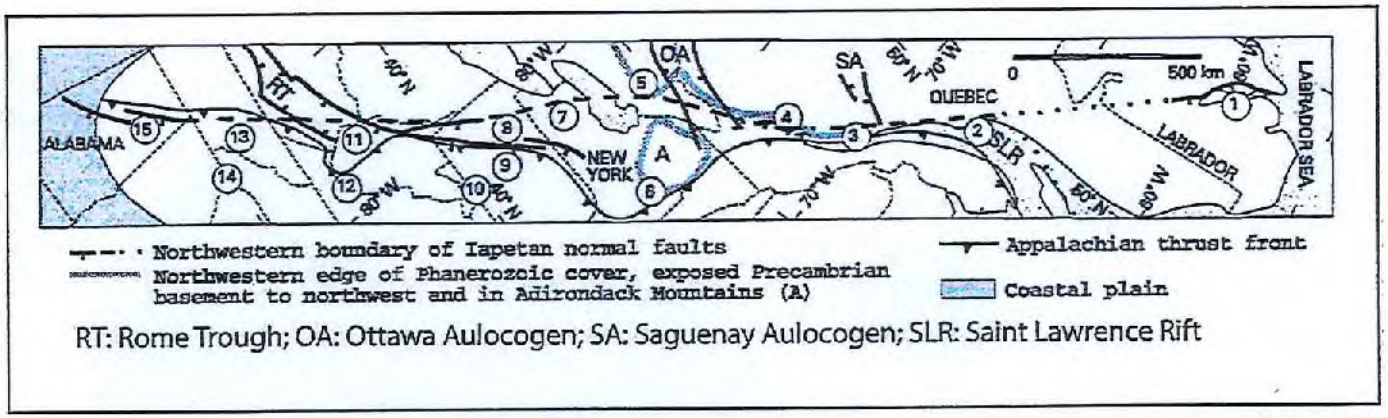
Source: Thomas (1991)

Figure 1. Map of Iapetan rifted margin



Source: WVGES (2011)

Figure 4. Geologic map of West Virginia



Source: Wheeler (1995)

Figure 3. Limit of Iapetan rifted margin (IRM)

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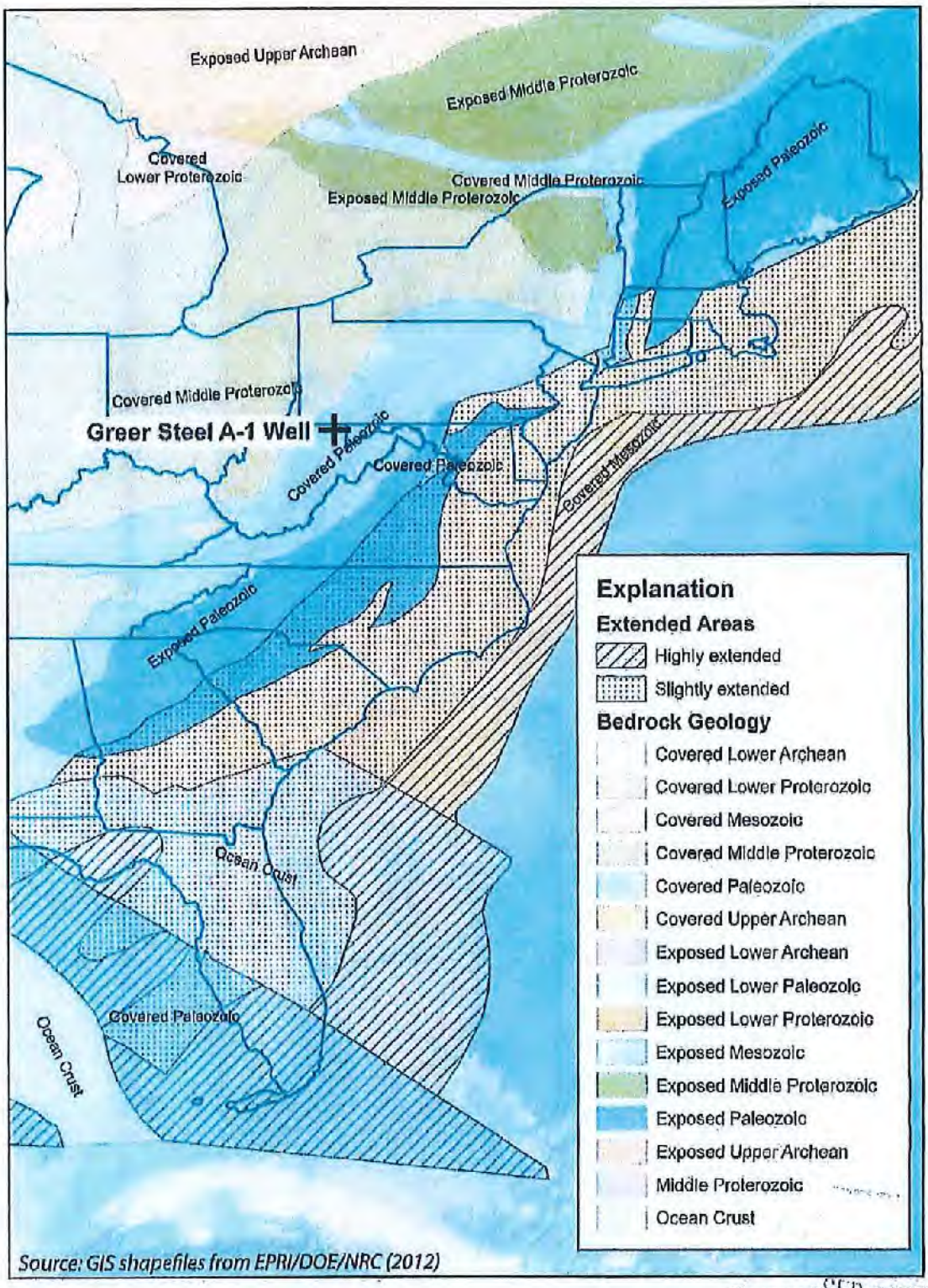
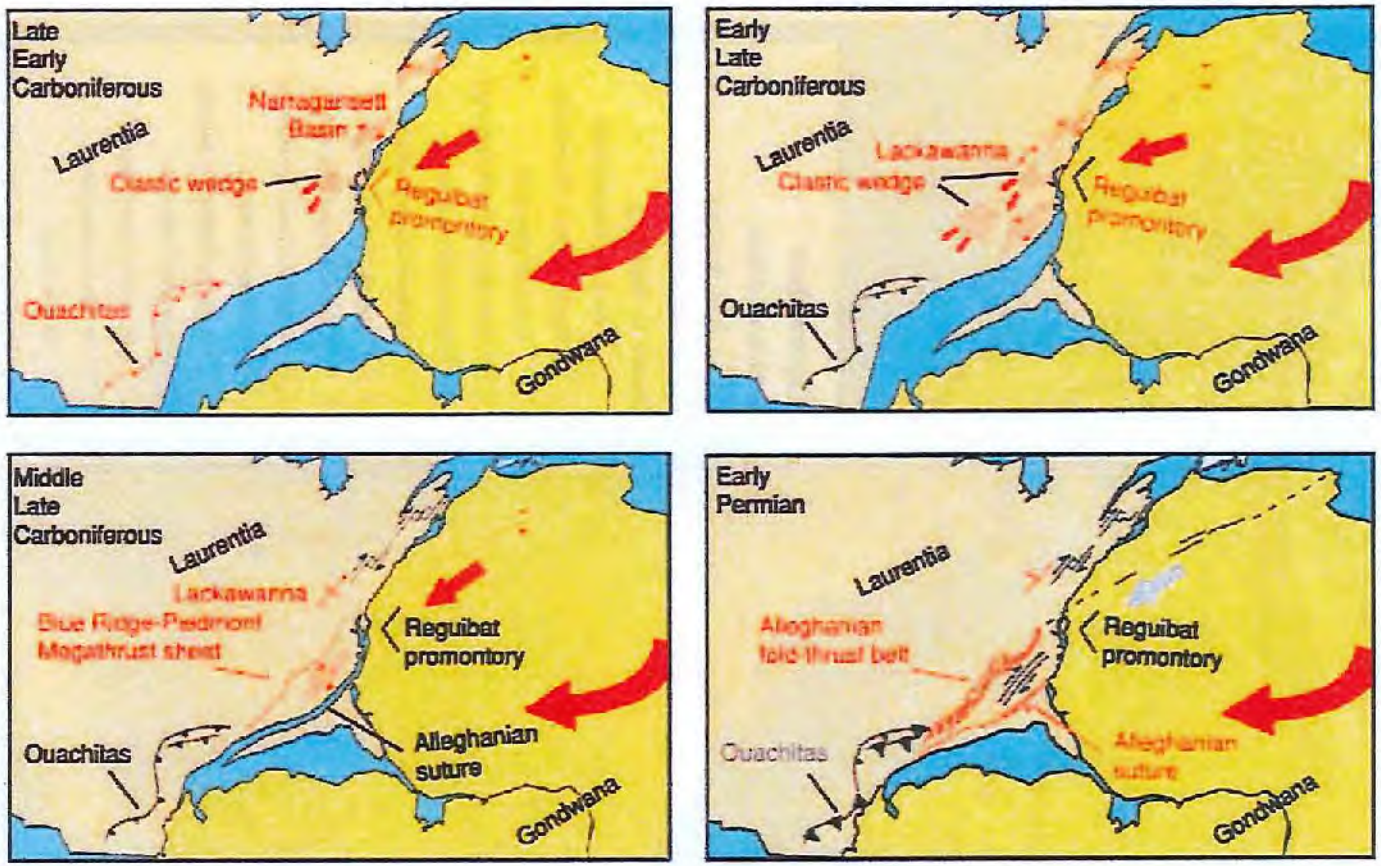


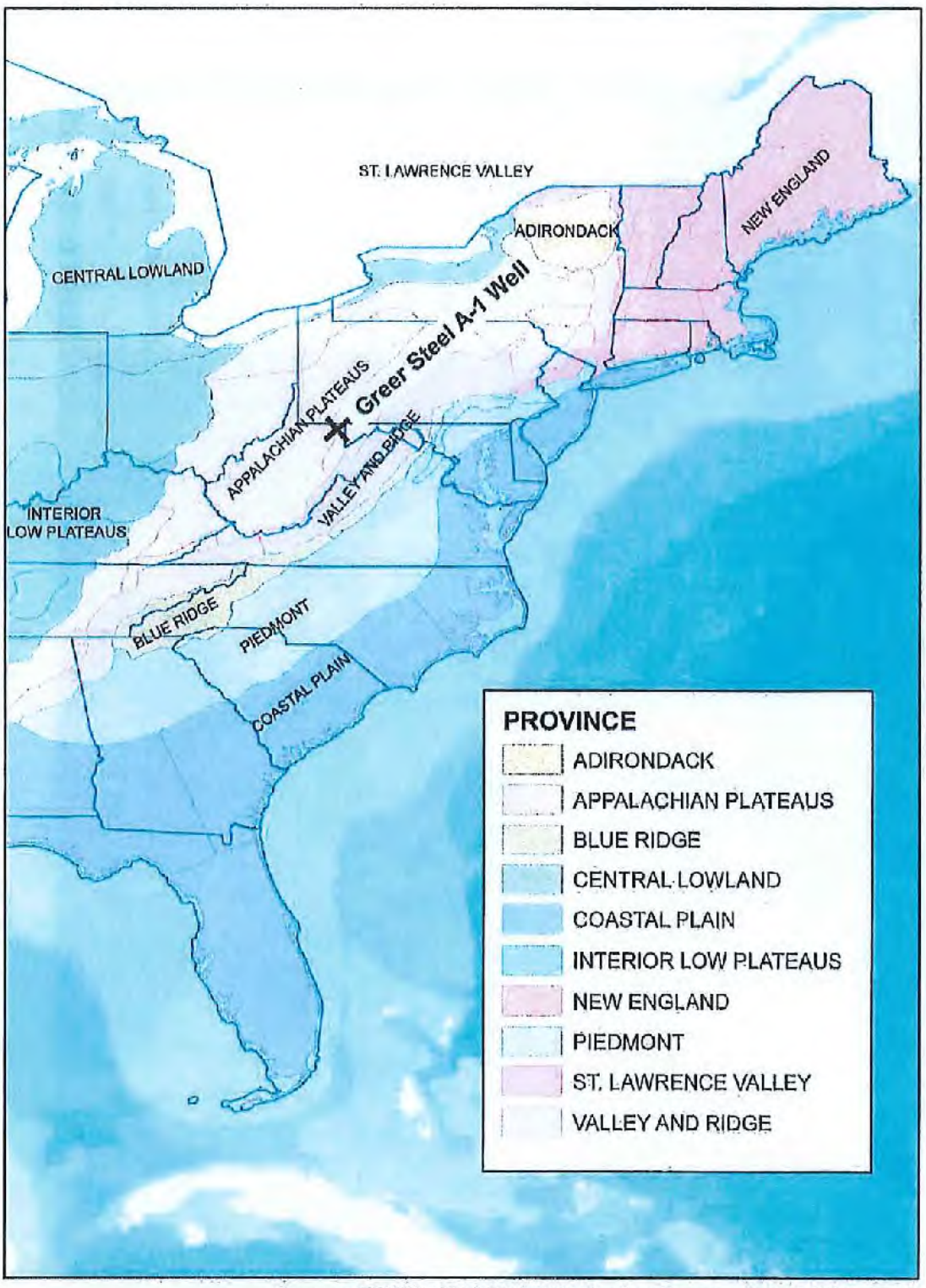
Source: Kanter (1994)

Figure 5. Bedrock geology and Mesozoic extended terrain of the eastern U.S.



Source: Hatcher (2004)

Figure 6. Progressive collision of Gondwana and Laurentia and formation of Pangaea



Source: EPRI/DOE/NRC (2012) after Fenneman and Johnson (1946)

Figure 7. Physiographic provinces of the eastern U.S.

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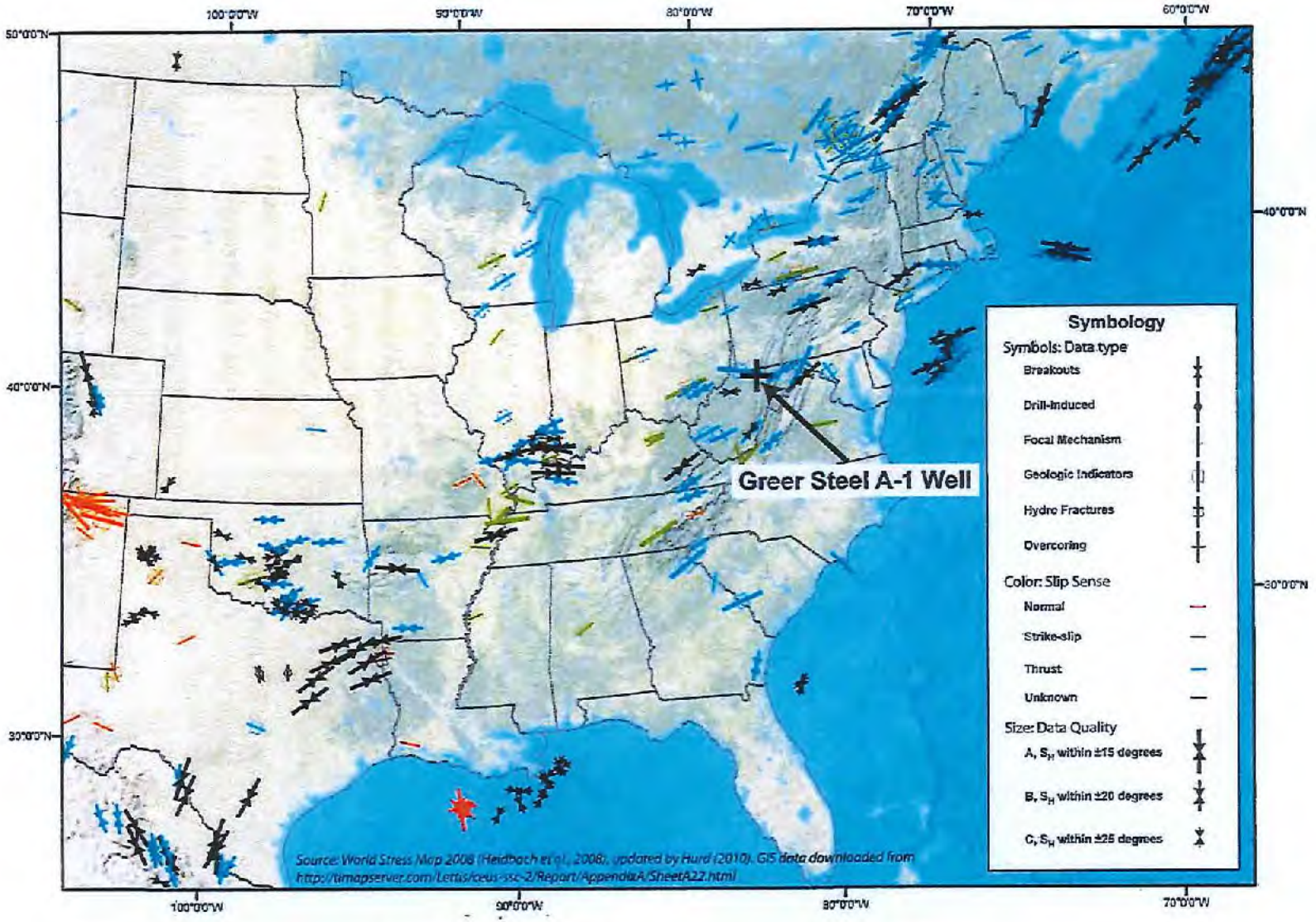
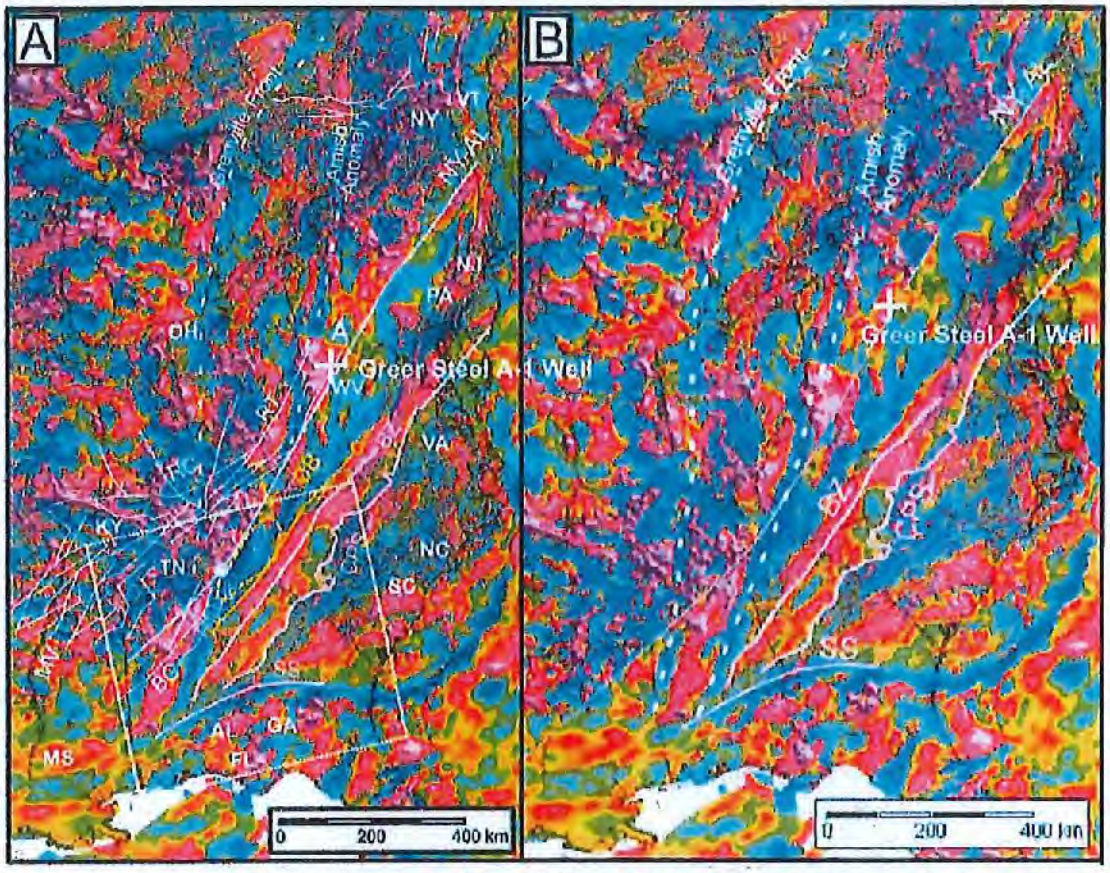


Figure 8. Stress map for the central and eastern U.S.



A: current configuration, B: Retrodeformation of 220 km right slip. RT: Rome Trough; OB: Ocoee Block; CPS: central Piedmont suture.

Source: Steltenpohl *et al.* (2010)

Figure 9. New York-Alabama (NY-AL) lineament

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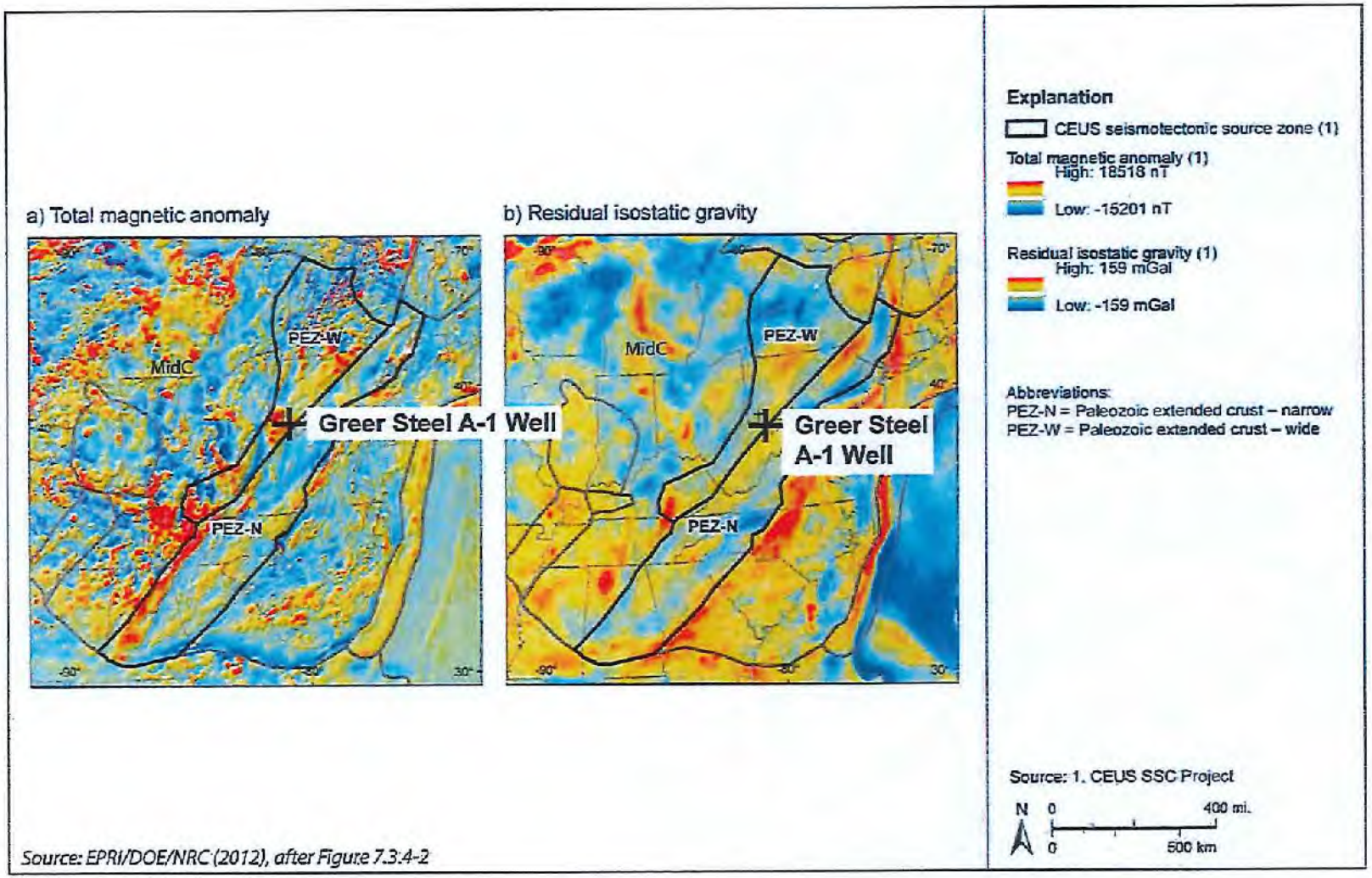
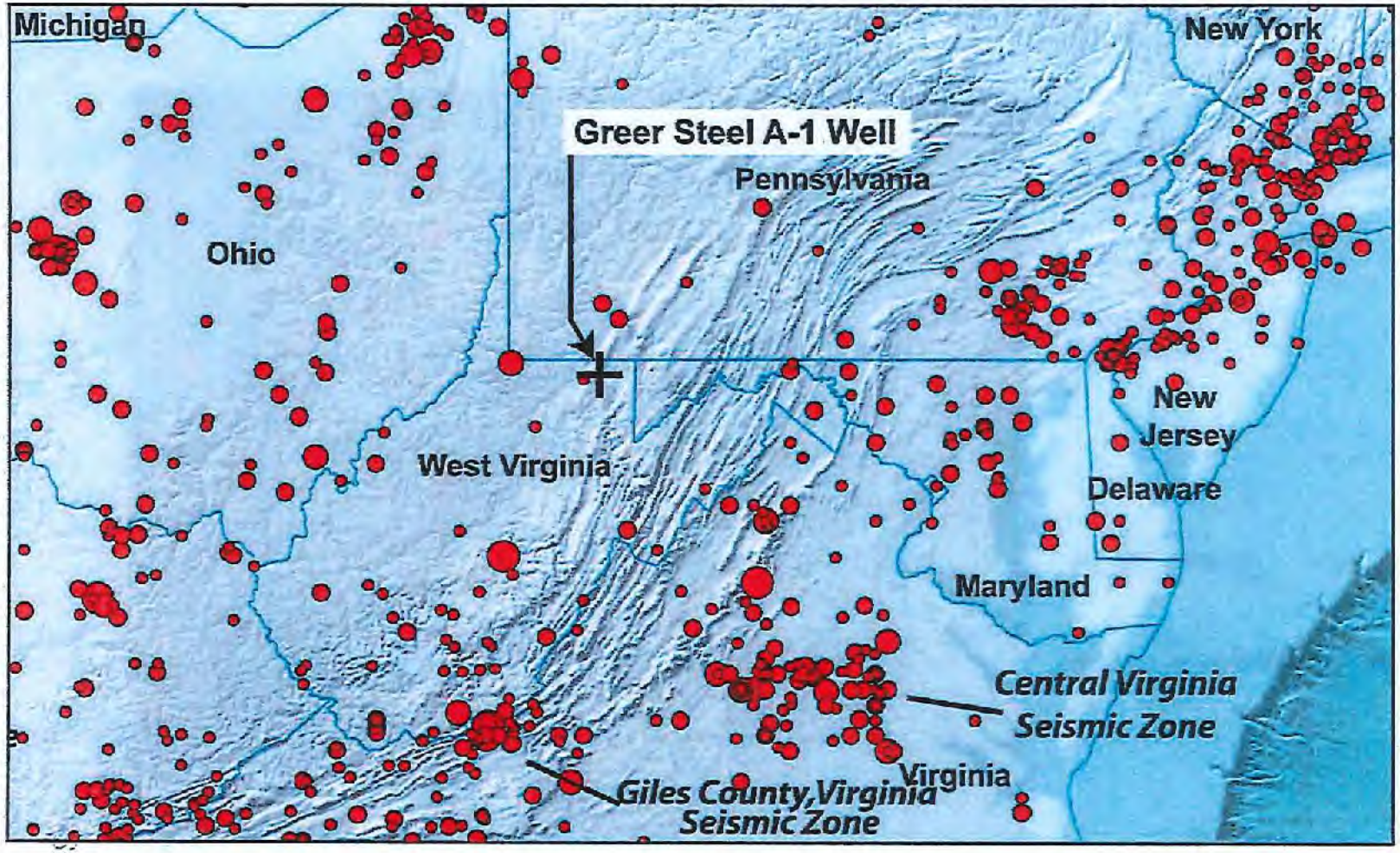


Figure 10. Magnetic and gravity anomaly maps and Paleozoic extended zone (PEZ)



Source: EPRI/DOE/NRC (2011)

Figure 11. Seismic zones near West Virginia

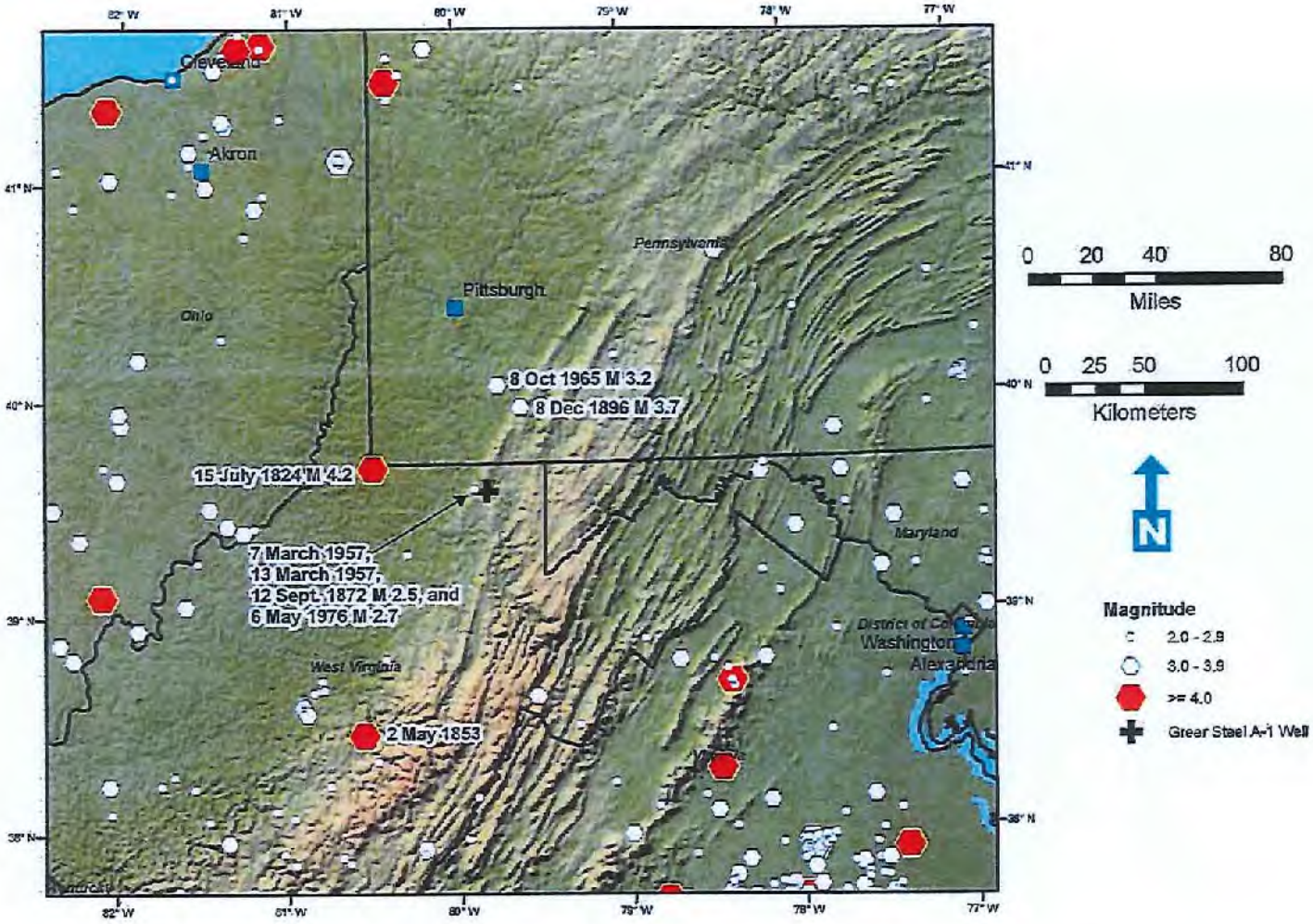


Figure 12. Historial seismicity of West Virginia, 1824 to January 2012

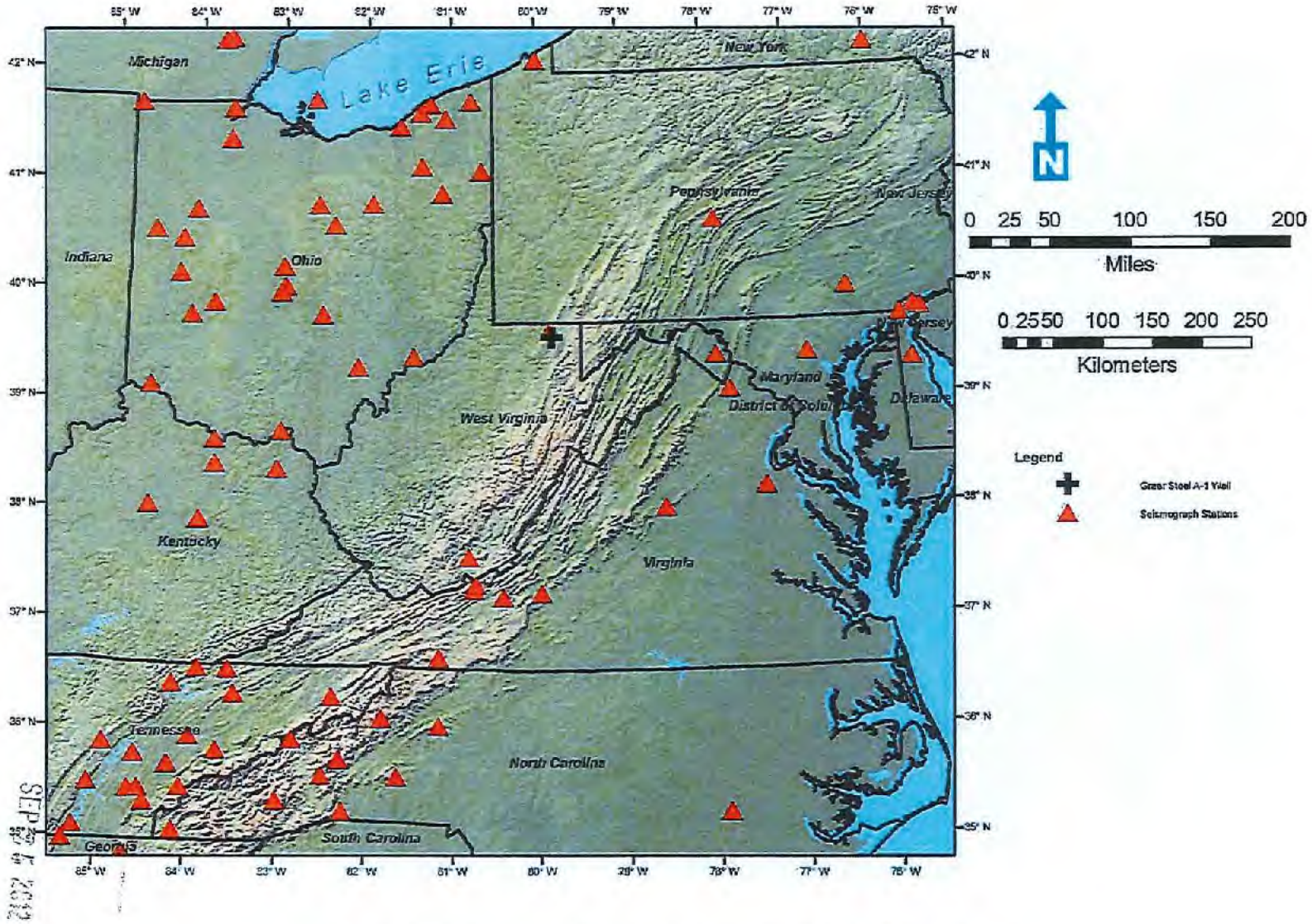


Figure 13. Current seismographic coverage of West Virginia

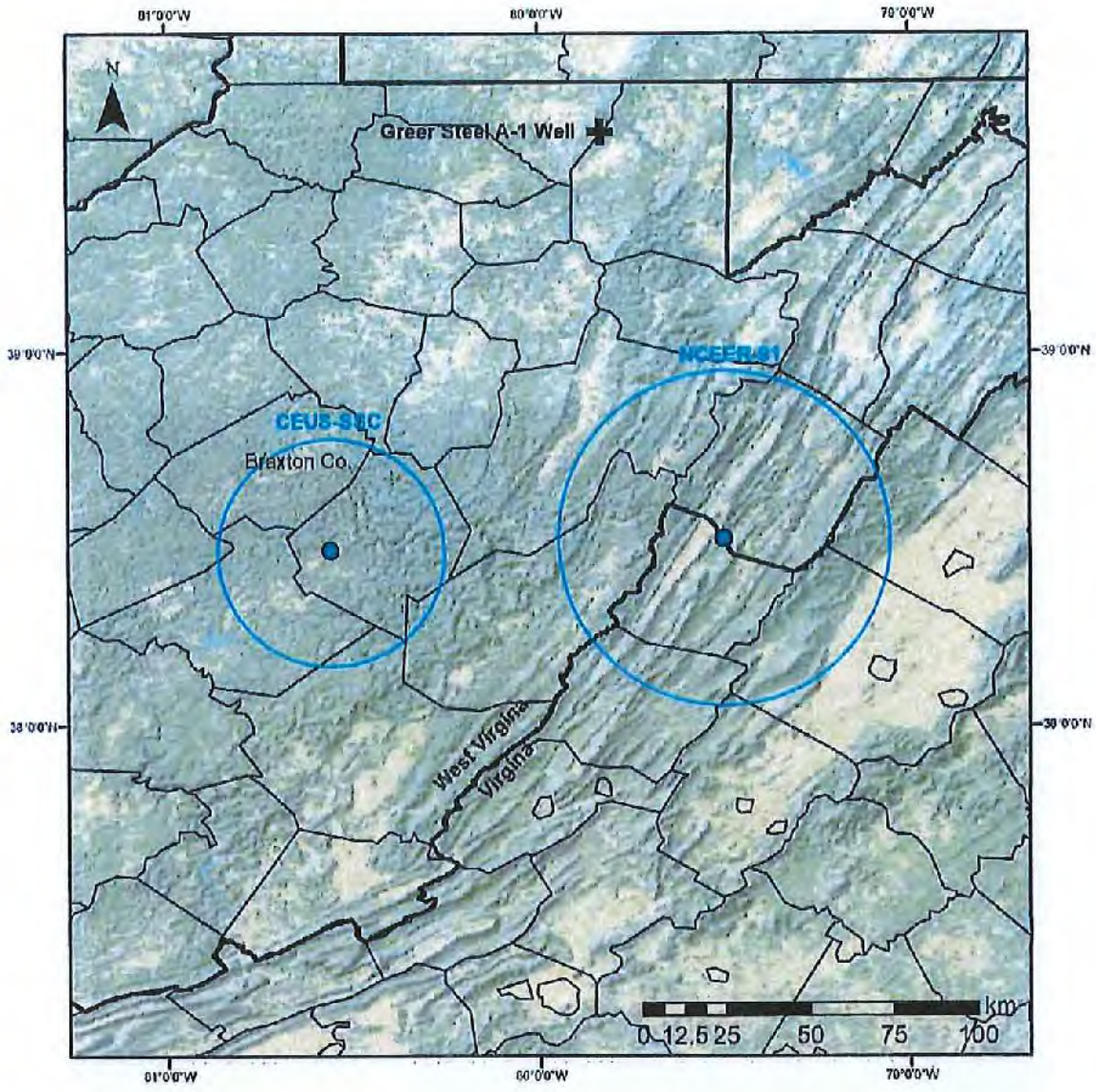


Figure 14. Locations of the 2 May 1853 earthquake with epicentral uncertainties

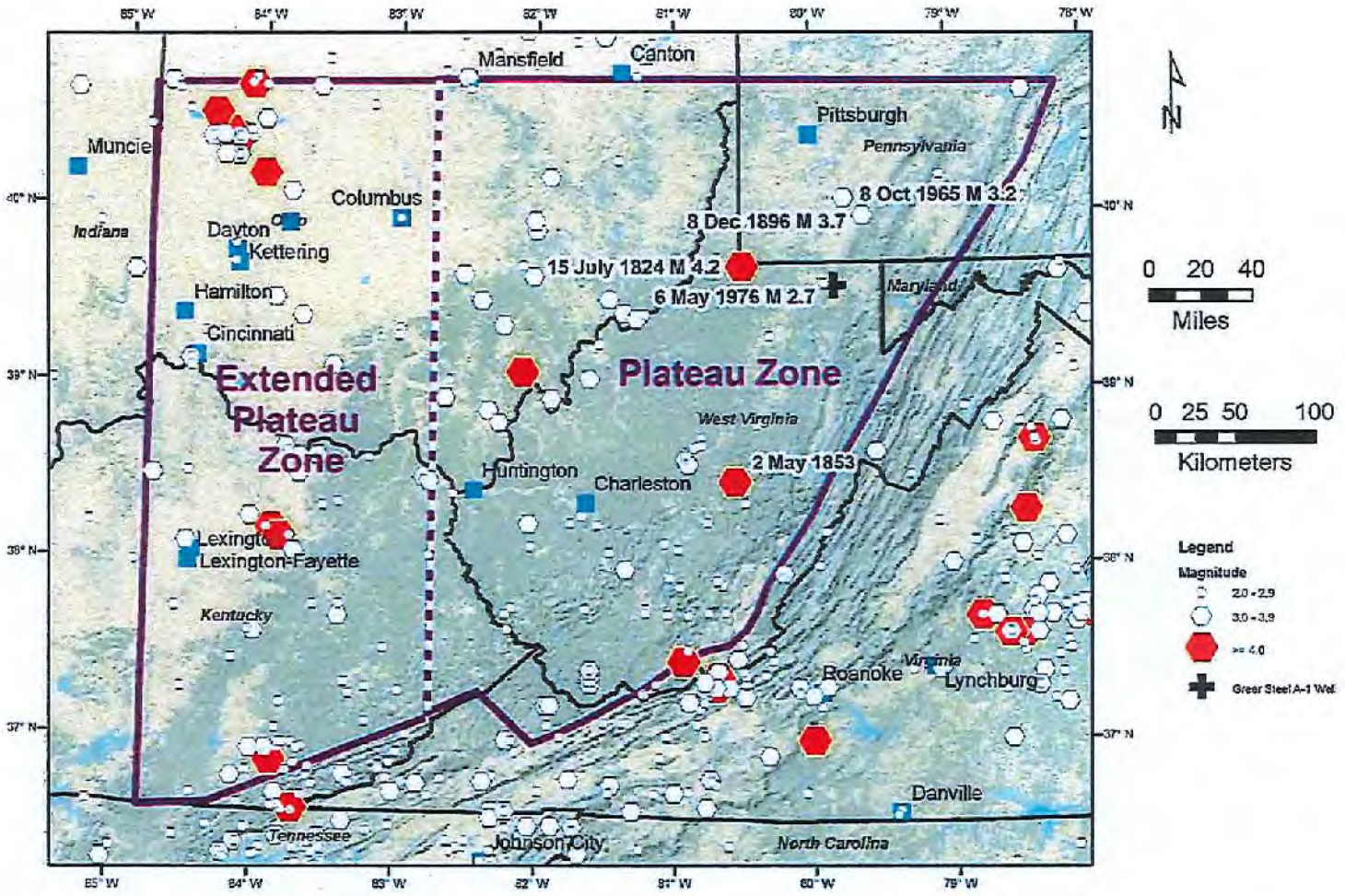


Figure 16. Historical seismicity of Plateau zone and extended Plateau zone, January 1776 to January 2012

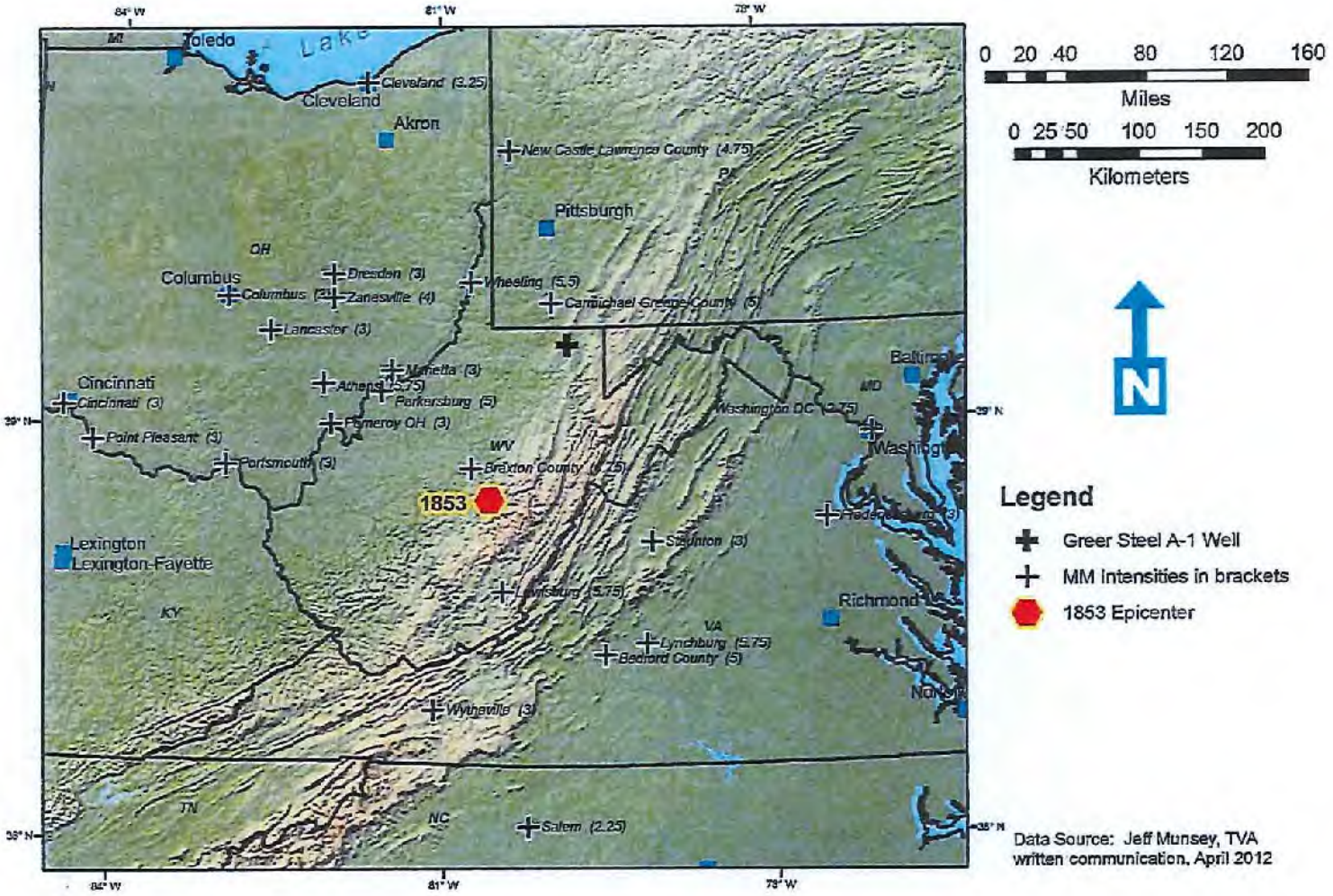


Figure 15. MM intensities for the 2 May 1853 earthquake

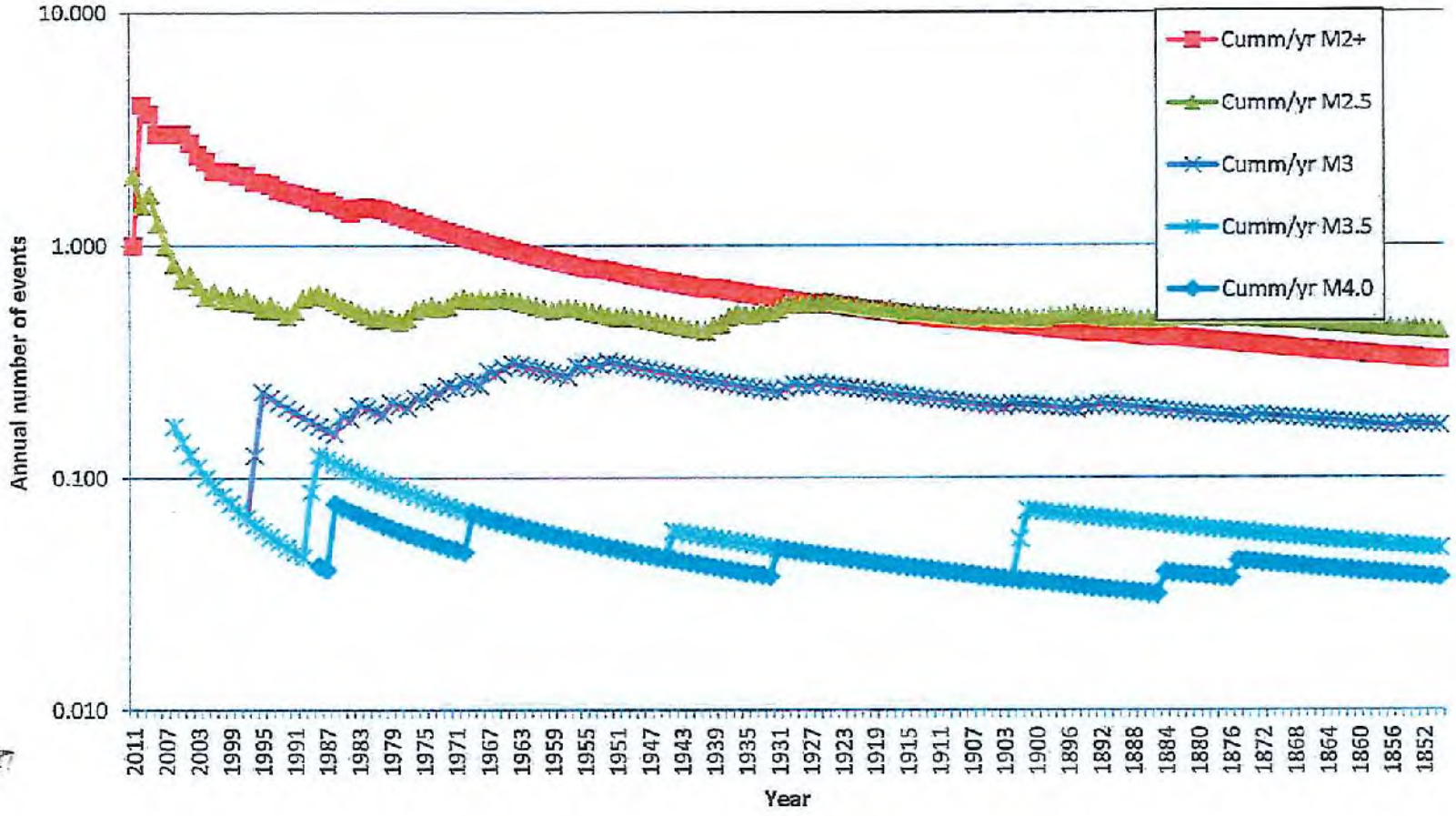


Figure 17. Stepp plot for the extended Plateau catalog

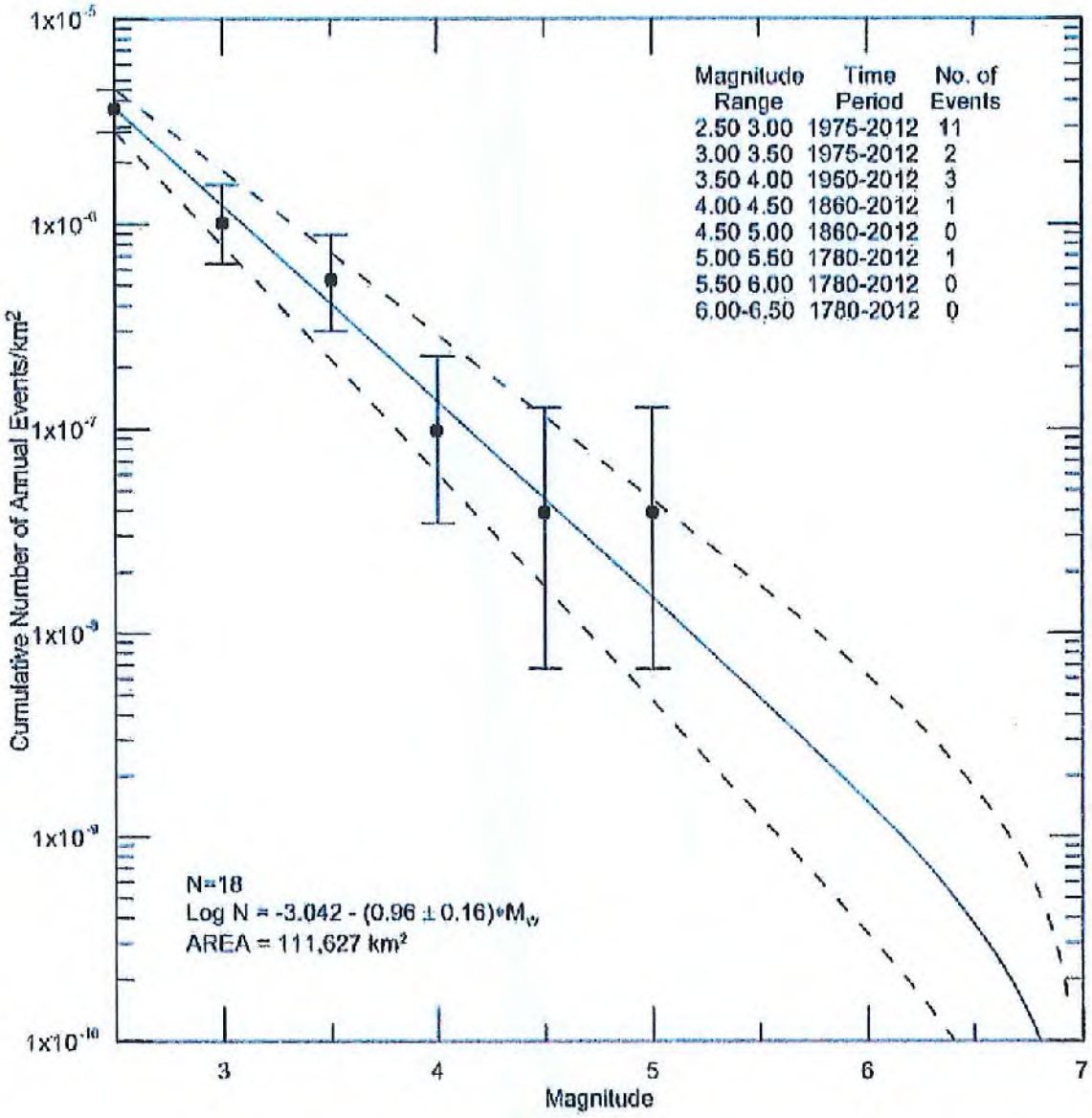


Figure 18. Earthquake recurrence for Plateau zone crustal earthquake

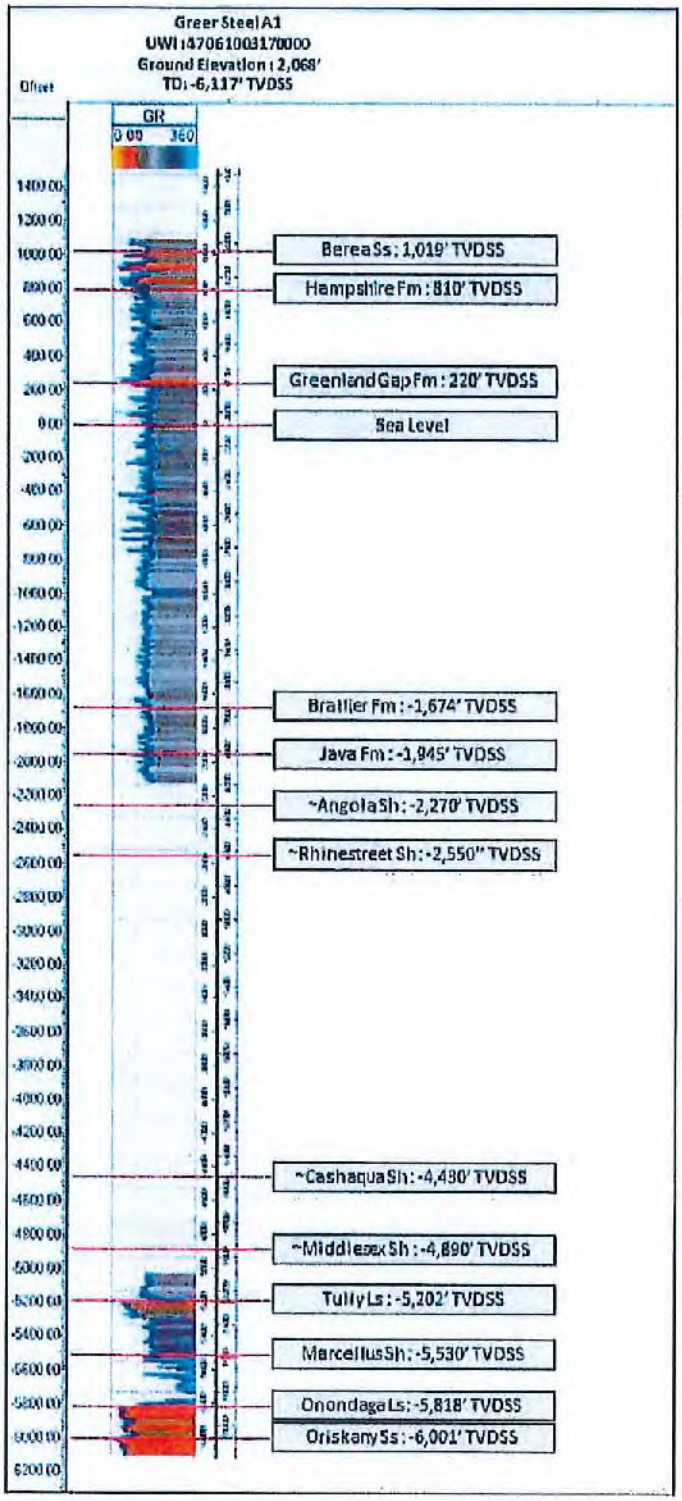


Figure 20. Log profile for the Greer well

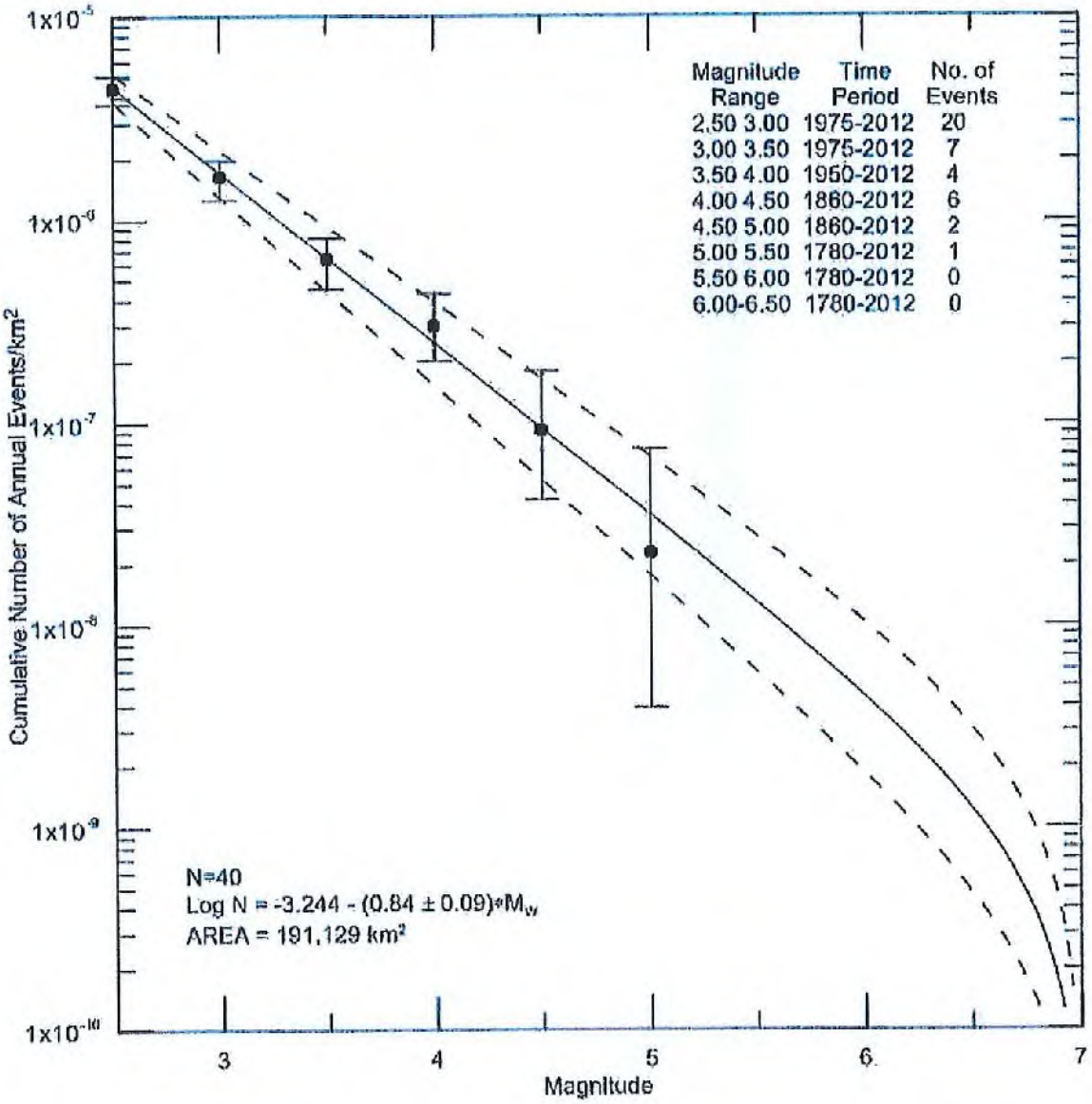


Figure 19. Earthquake recurrence for Extended Plateau zone crustal earthquake

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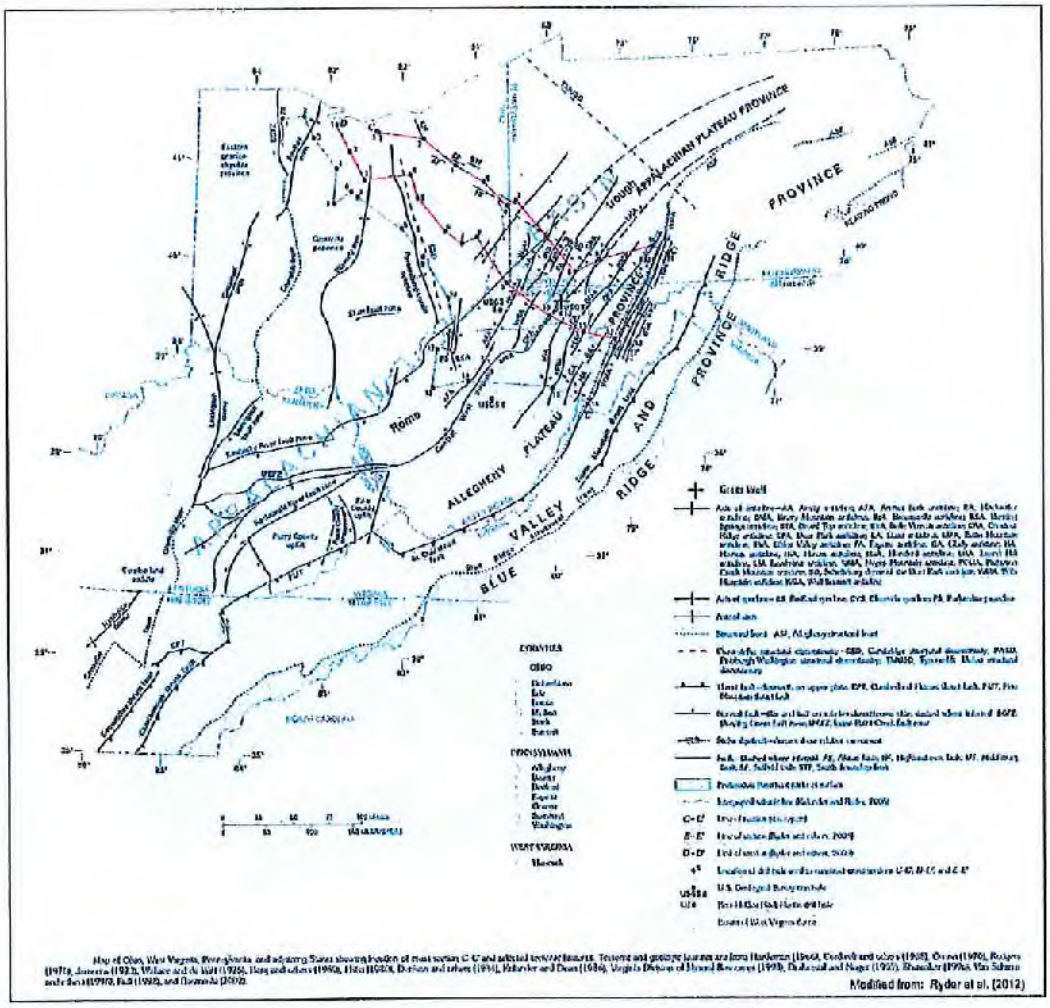

Figure 21. Map showing location of Greer well relative to U.S. Geological Survey geologic cross sections C-C' and D-D'

SEP 26 2012

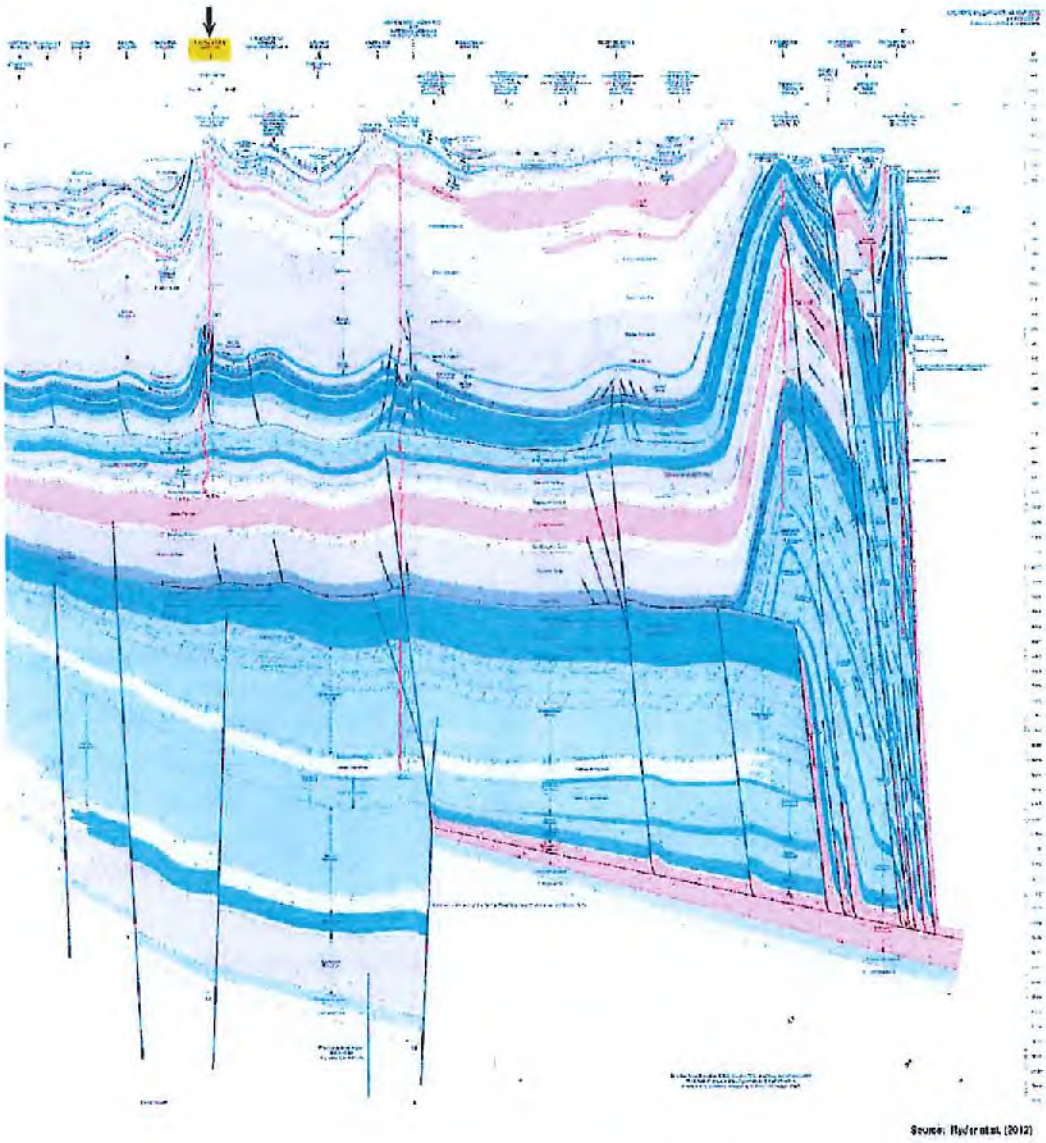

Figure 22. Southeastern portion of geologic cross section C-C' through the Appalachian Basin from Ryder *et al.* (2012)

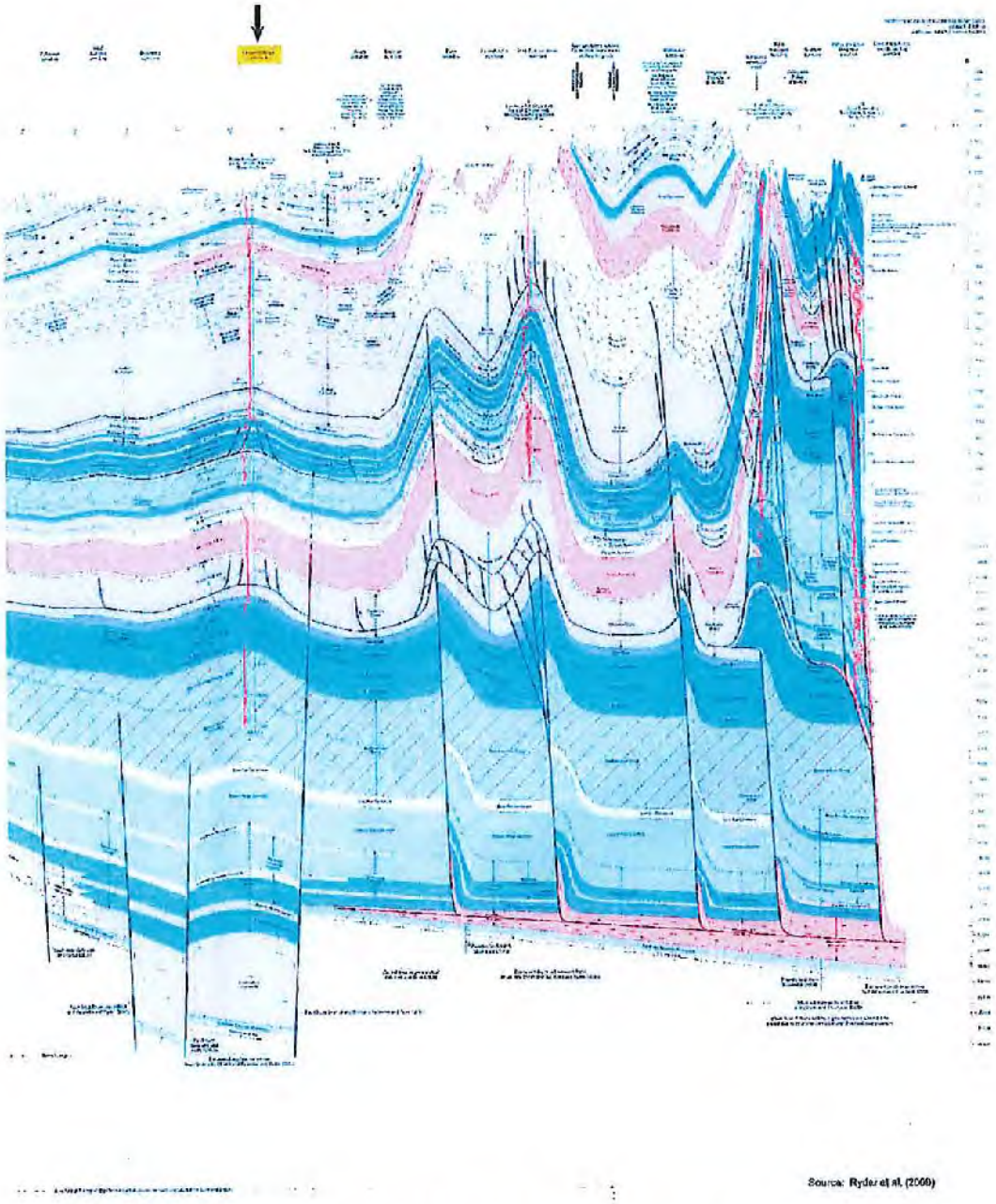

Figure 23. Southeastern portion of geologic cross section D-D' through the Appalachian Basin from Ryder *et al.* (2009)

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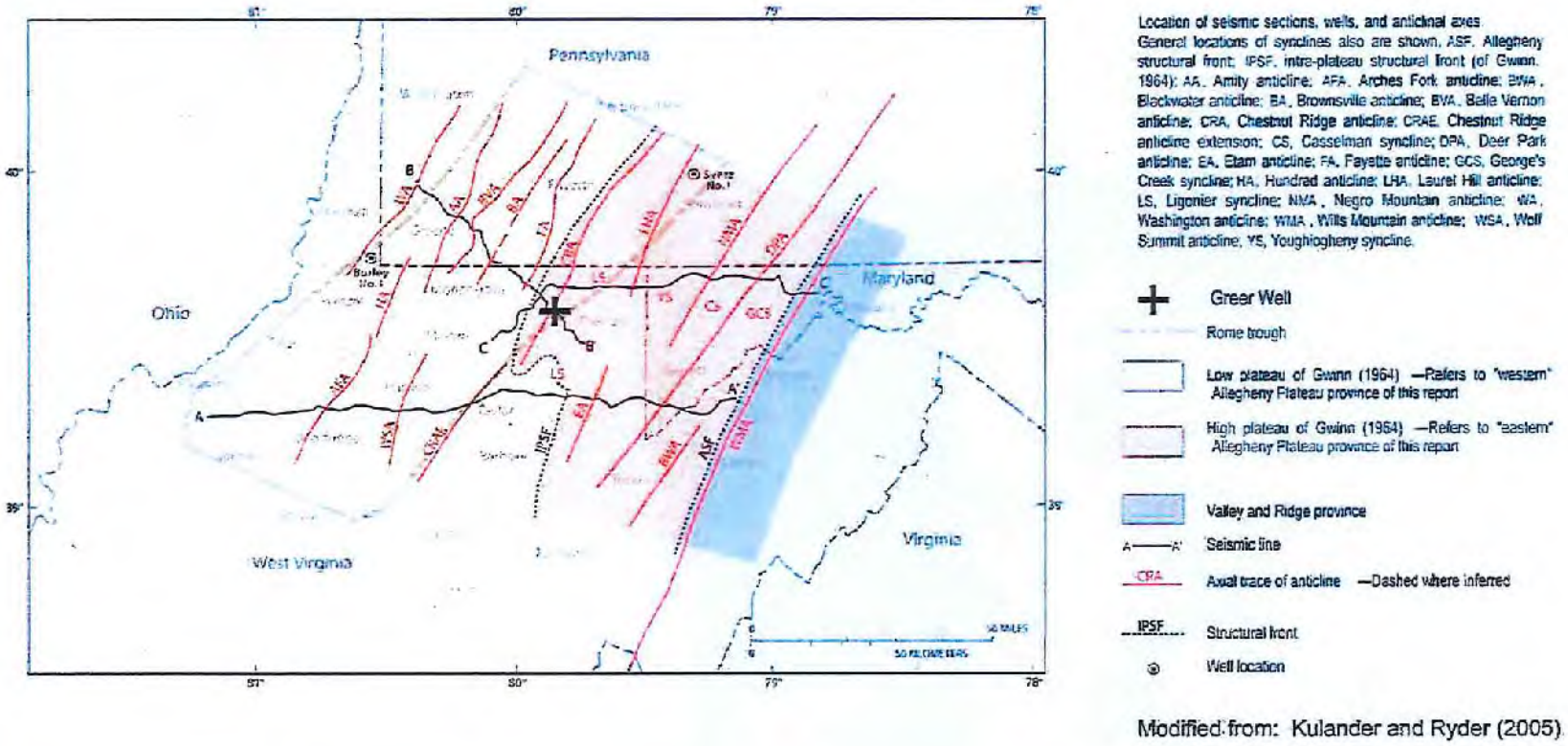

Modified from: Kulander and Ryder (2005)

Figure 24. Location of Greer well relative to structural features according to Kulander and Ryder (2005)

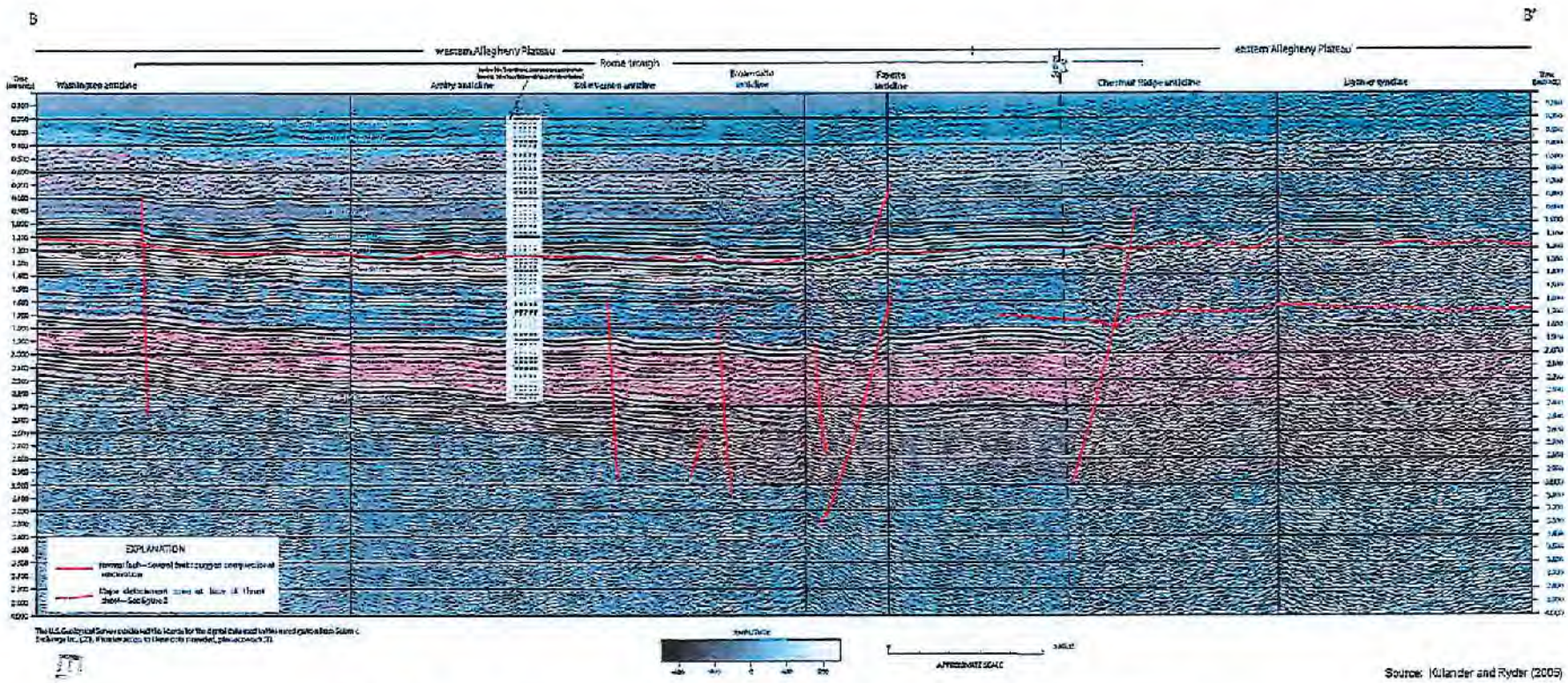

Figure 2S. Interpreted regional seismic section B-B' over the Allegheny Plateau according to Kulander and Ryder (2005)

SEP 25 2012

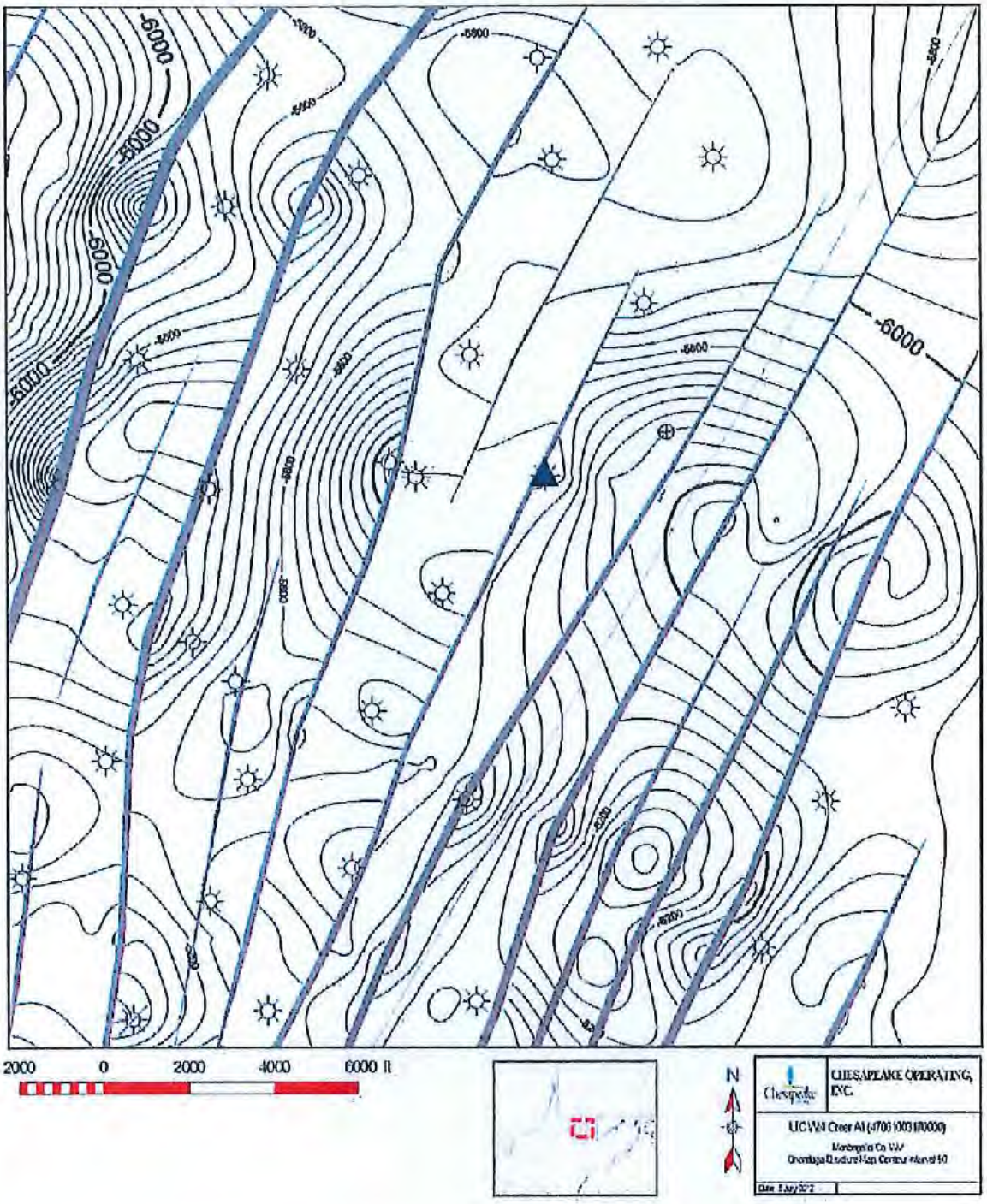

Figure 26. Greer well Onondaga structure map, TVDSS contours (50 ft contour interval)

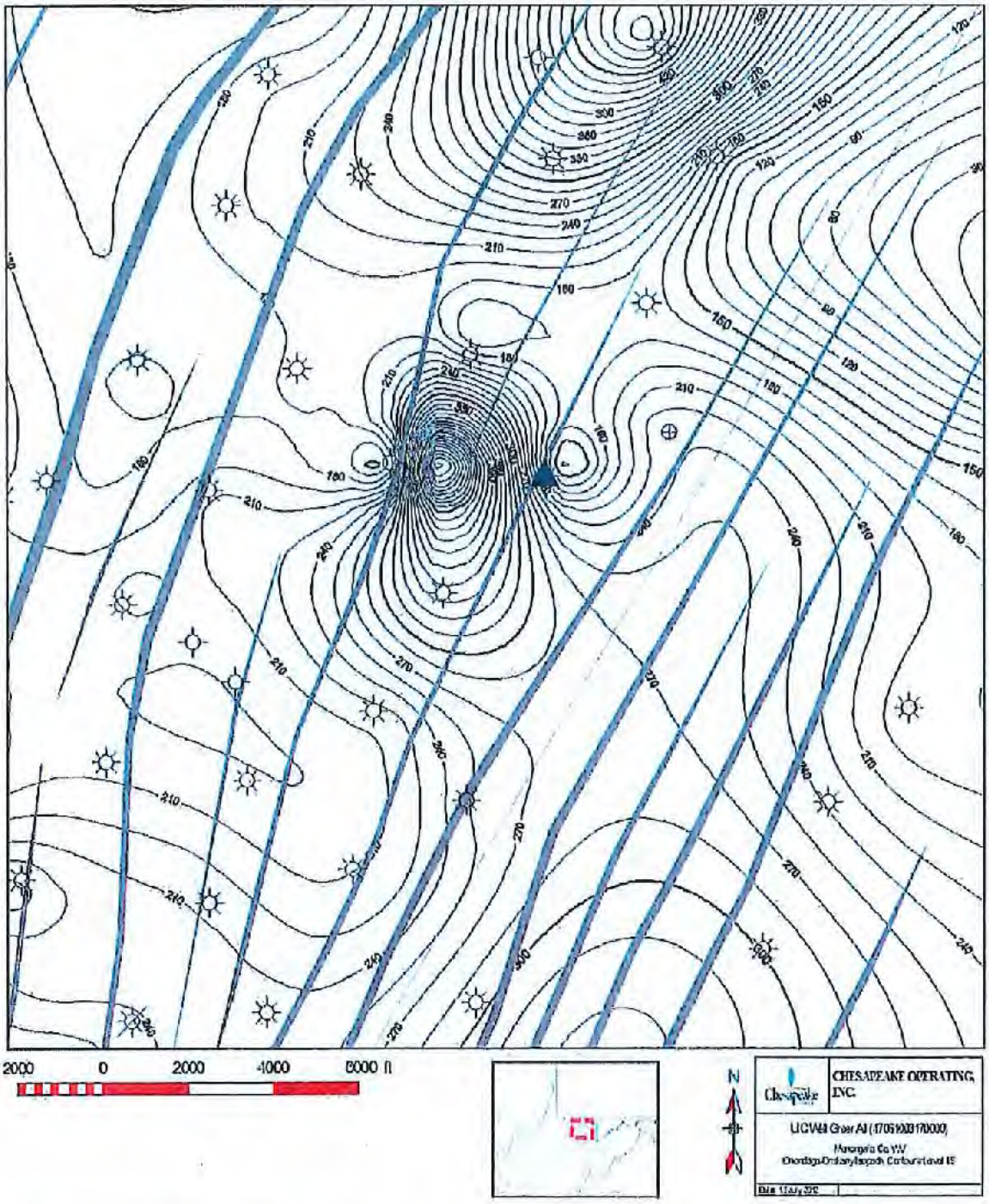

Figure 27. Greer well Onondaga – Oriskany isopach map (15 ft contour interval)

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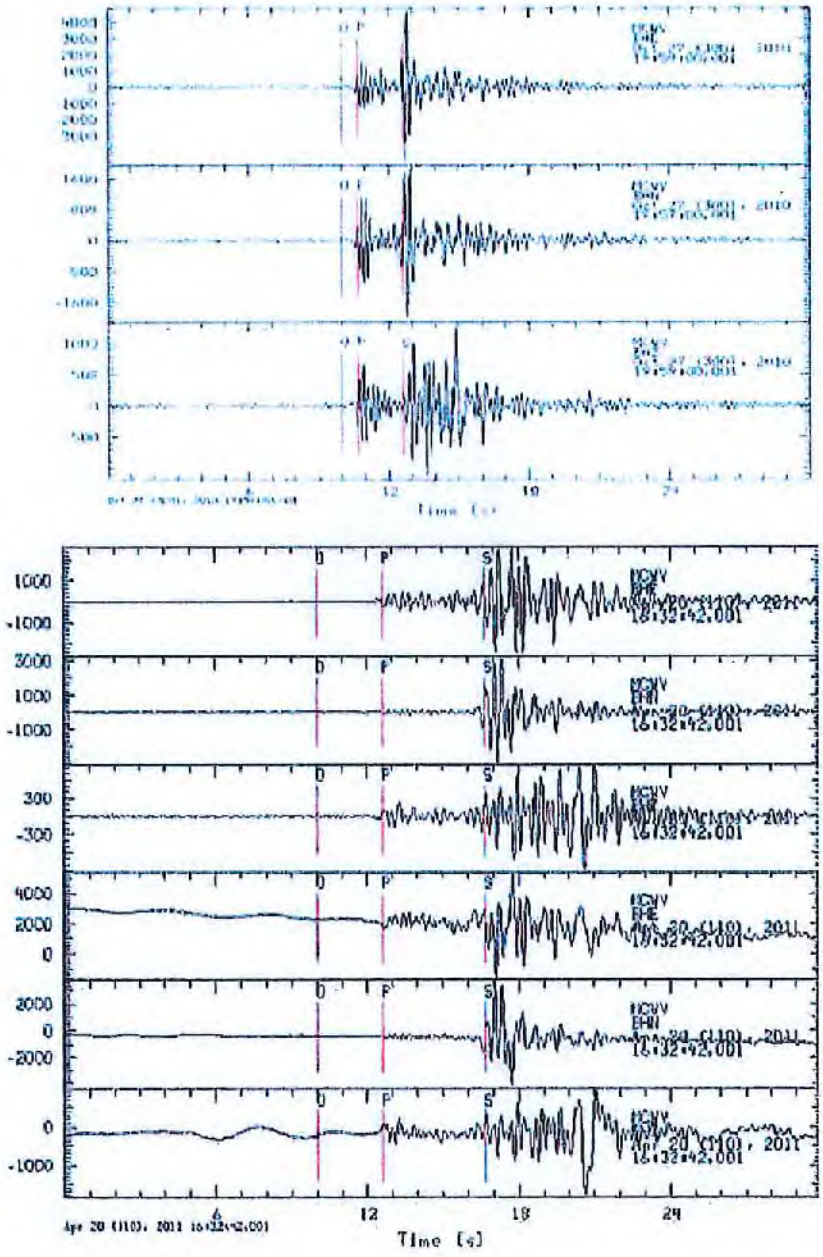
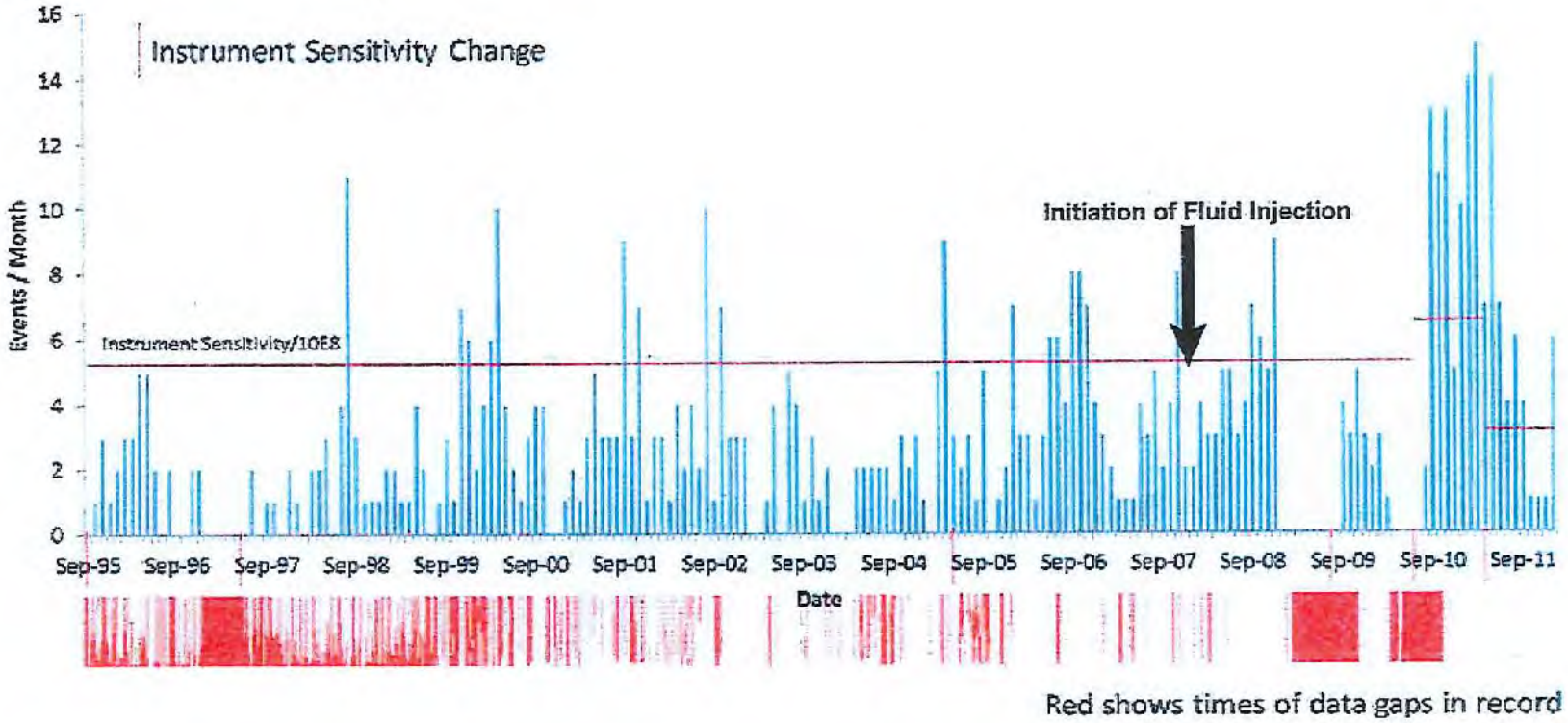


Top: An event detected on October 27, 2010, with a P- to S-wave delay time of 2 s. Bottom: An event detected on April 20, 2011, with a P- to S-wave delay time of 4 s. Red lines indicate the origin time (O) and picked P-wave (P) and S-wave (S) arrival times.

Figure 28. Example waveforms of two events detected on the US.MCWV station



The number of events detected by month using an STA/LTA detection algorithm on the continuous data record from the US.MCWV seismic station. Red line shows the reported station sensitivity divided by 10E8. Red areas below the date show time periods of gaps in the data.

Figure 29. Number of events detected from US.MCWV station by month

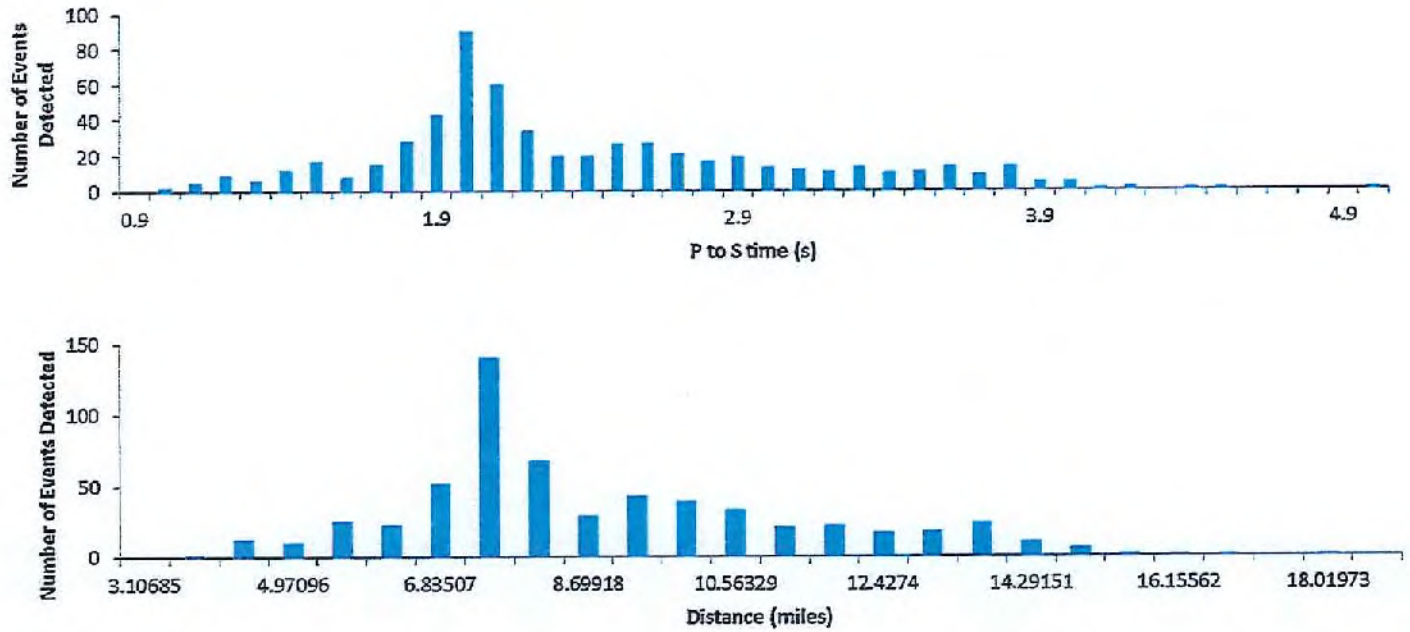


Figure 30. Distribution of measured P- to S-wave delay times from events detected at US.MCWV seismic station

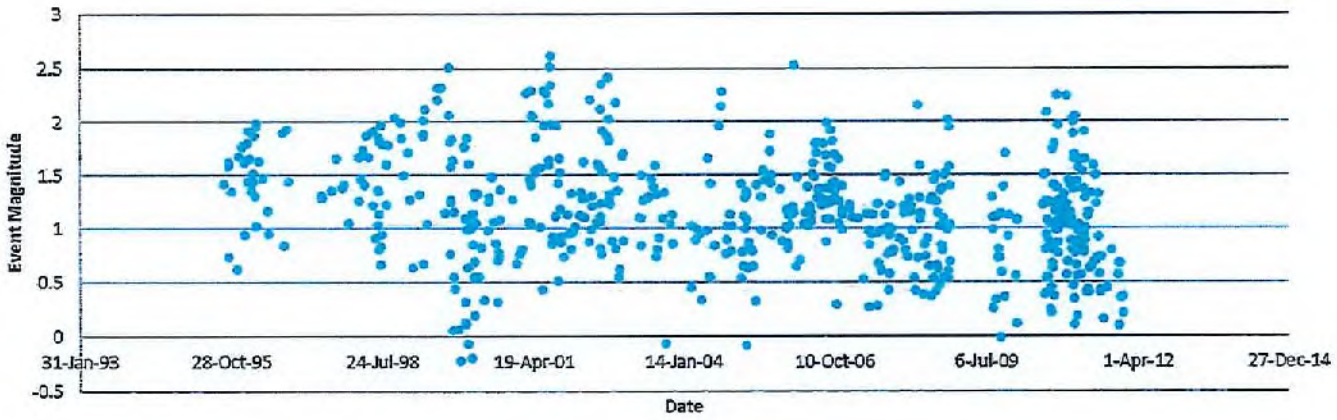


Figure 31. Calculated local magnitude (M_L) of events at the US.MCWV station as a function of time

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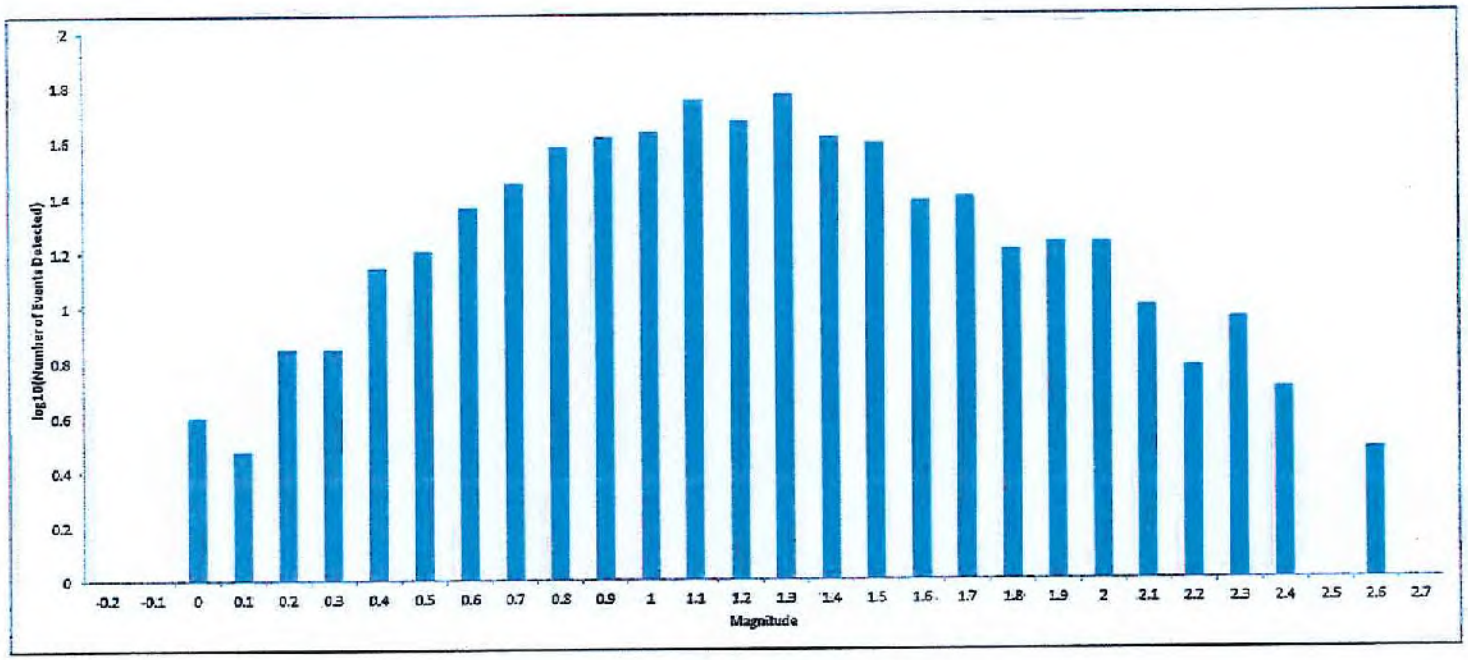
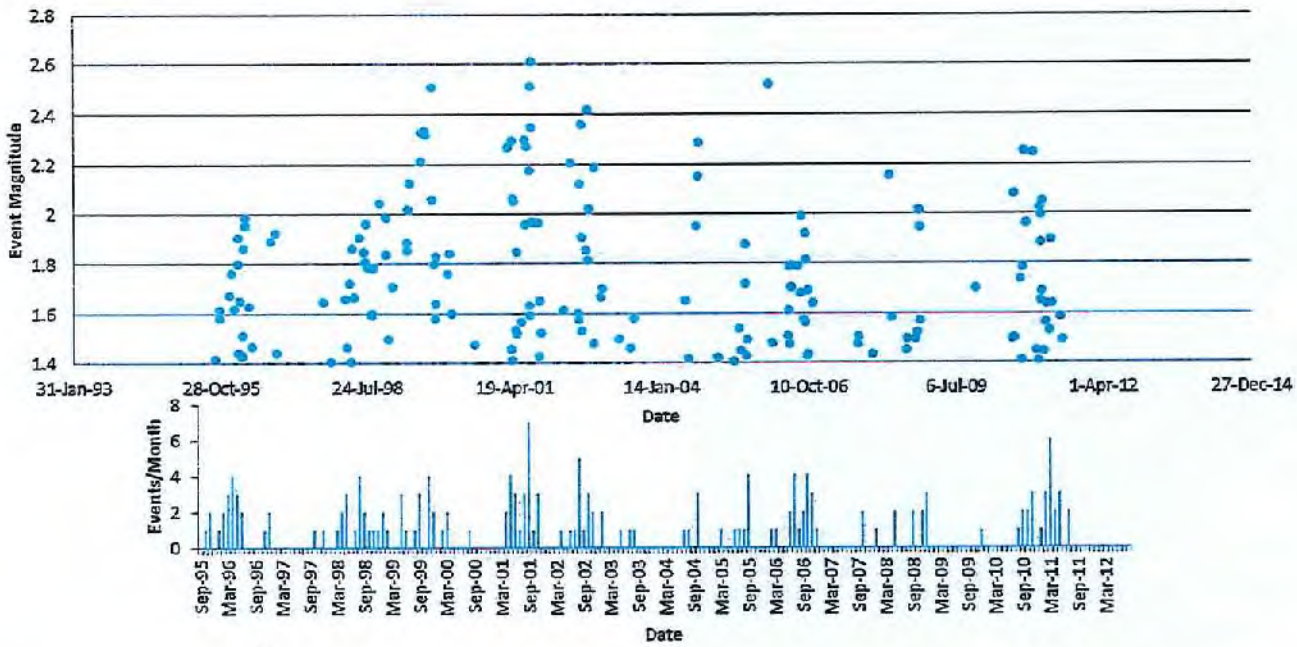


Figure 32. Distribution of calculated local magnitudes (M_L) on a log scale



TOP: The calculated local magnitude of events detected at MCWV above M 1.4 (the estimated minimum magnitude of catalog completeness) as a function of date. BOTTOM: The distribution per month of events detected on the MCWV station with calculated local magnitudes above 1.4. The magnitude and rate of seismicity shows little to no variation, and no recent increase in activity is observed.

Figure 33. Calculated local magnitude (M_L) of events detected at US.MCWV station and distribution per month of detected events with $M_L > 1.4$

SEP 23 2012

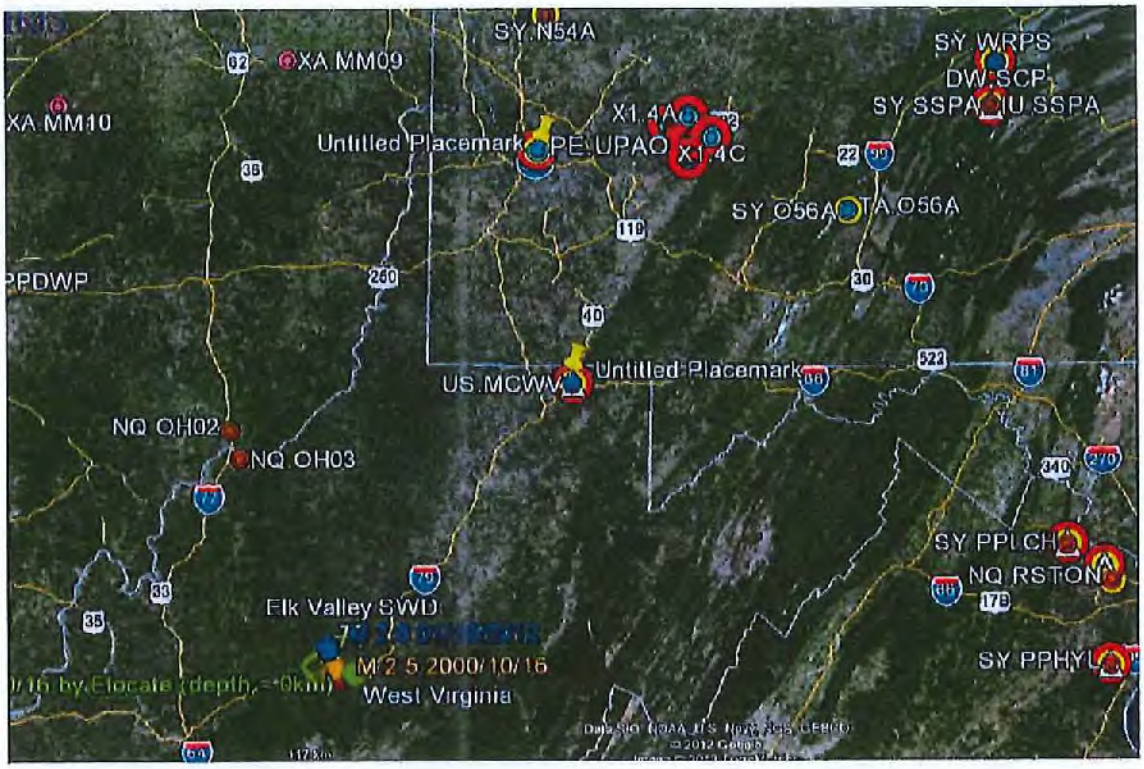
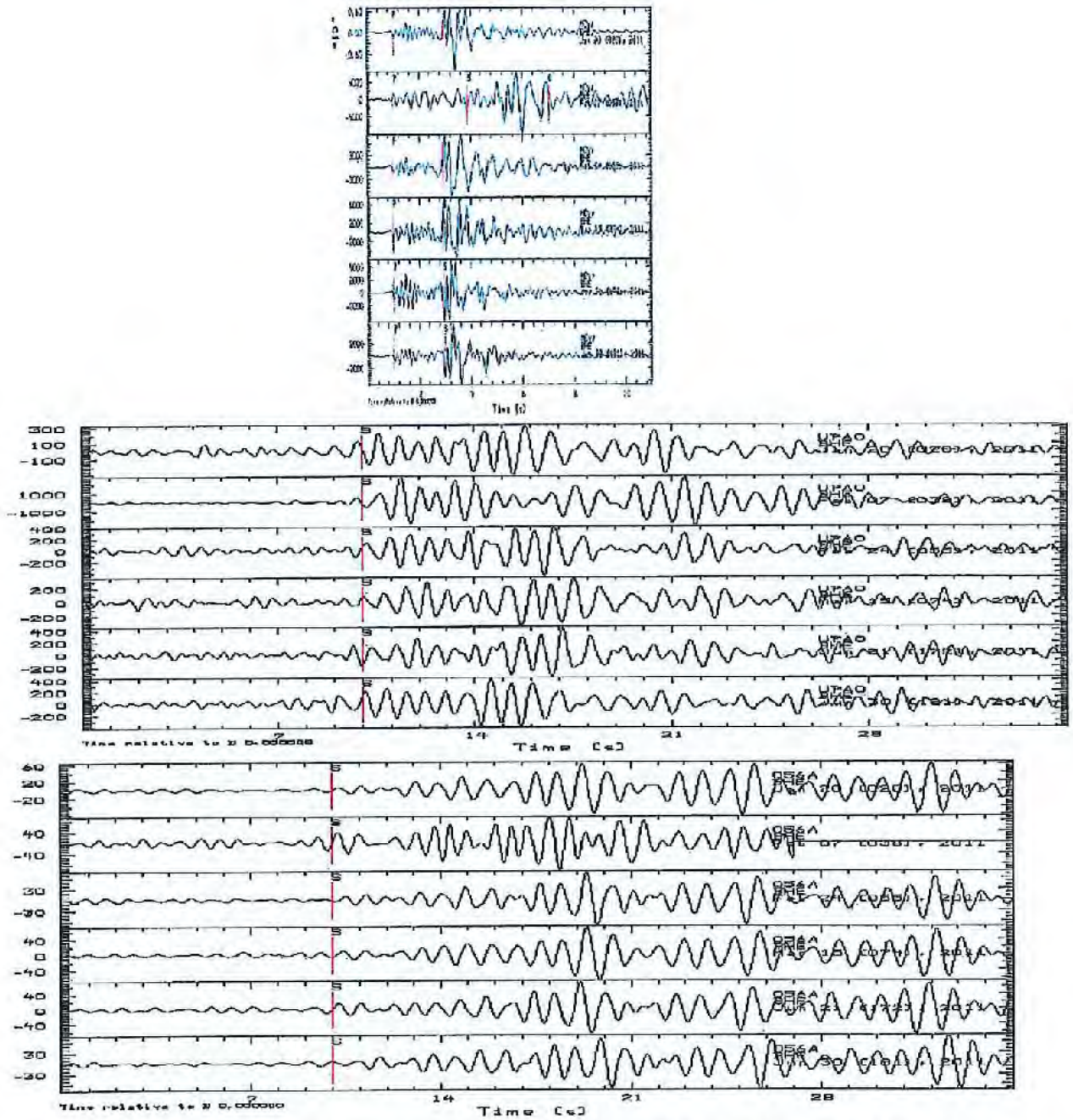


Figure 34. Regional map showing locations of stations used for event locations



The waveform of the six located events recorded on the…TOP: MCWV seismic station and bandpass filtered from 1 to 10 Hz. MIDDLE: UPAO seismic station and bandpass filtered from .8 to 2 Hz. BOTTOM: TA.O56A seismic station and bandpass filtered from .8 to 2 Hz. Red lines show P-wave (P) and S-wave (S) picks.

Figure 35. Waveforms of six located events

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Depth [km]	Vp [km/s]	Vp/Vs
2	3.893292	1.8
4	4.834496	1.8
6	5.492733	1.8
8	5.714978	1.8
10	5.512771	1.8
12	5.887431	1.8
14	6.38293	1.8
16	6.525022	1.8
18	6.625822	1.8
20	6.676829	1.8
22	6.696867	1.8
24	6.767913	1.8
26	6.767913	1.8
28	6.747267	1.8
30	6.828636	1.8
32	6.929436	1.8
34	7.030843	1.8
36	7.192974	1.8
38	7.273735	1.8
40	7.233051	1.8
42	7.284058	1.8
44	7.475942	1.8
46	7.739479	1.8
48	7.779557	1.8
50	7.567026	1.8
52	7.516626	1.8

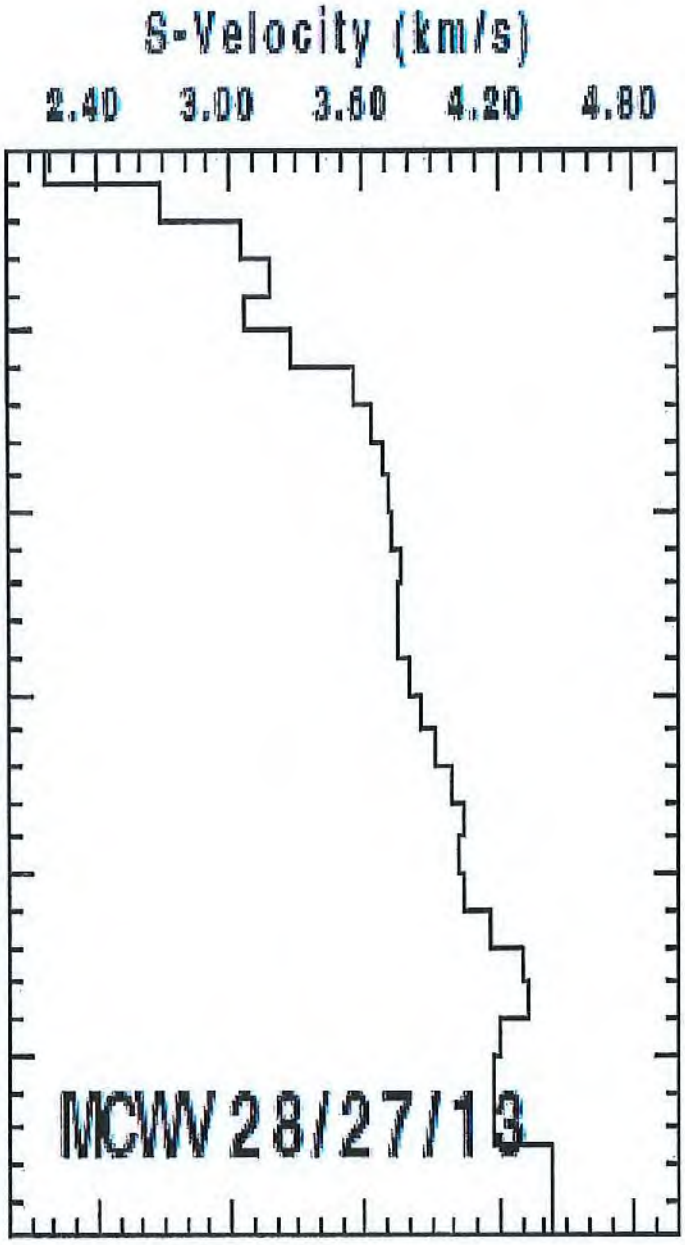

Figure 36. Velocity model from Fnais (2004) used in event locations

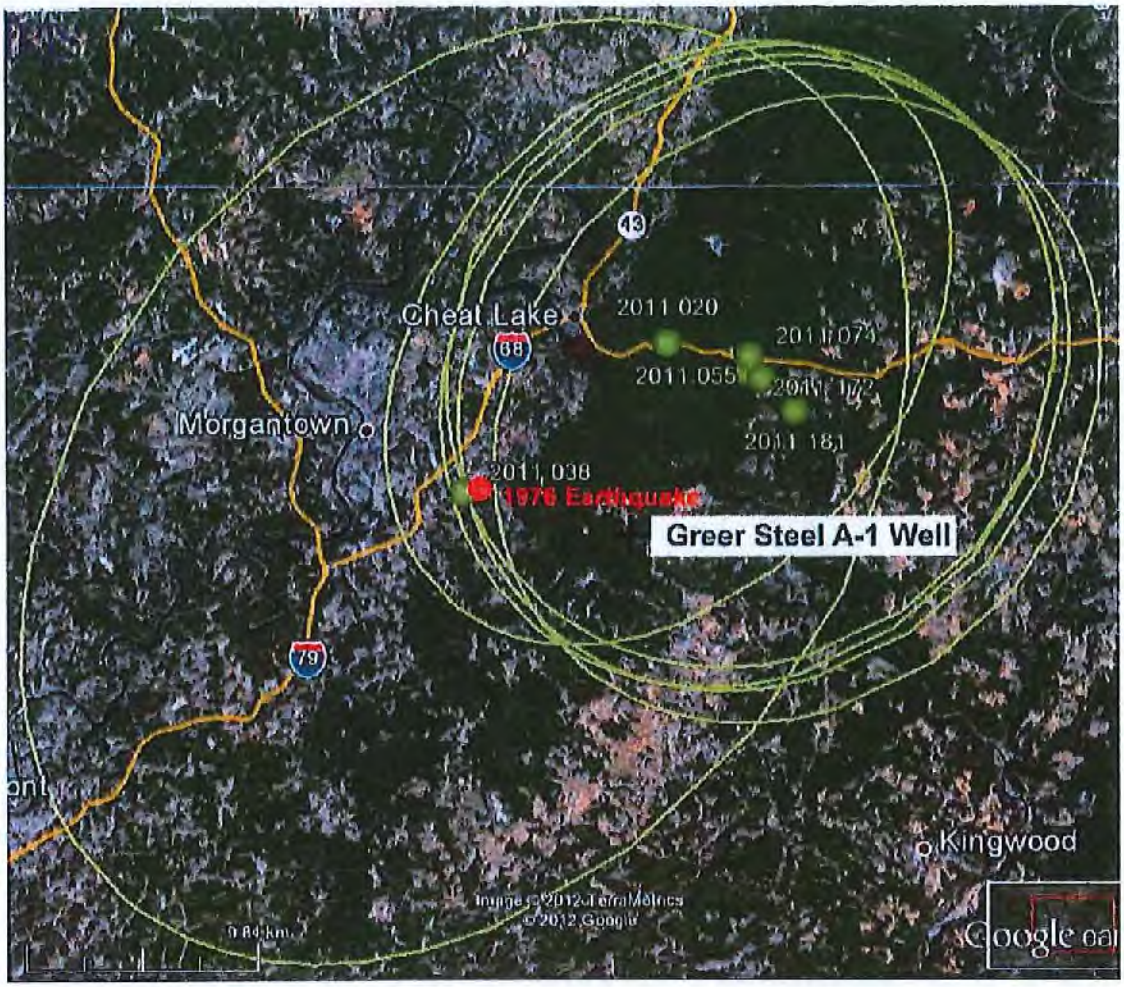

Figure 37. Epicenters and error ellipses for six located earthquakes

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Current Wellbore Schematic

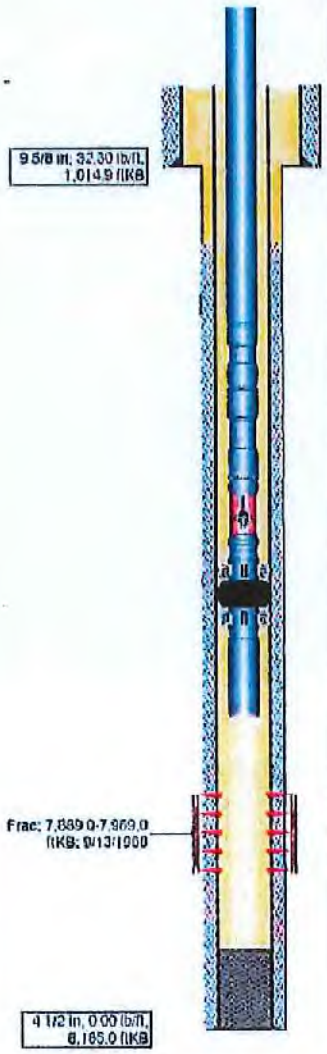
WELL (PN): GREER A-1 SWD (611885)
FIELD OFFICE:
FIELD:
STATE / COUNTY: WEST VIRGINIA / MONONGALIA
LOCATION: T/D CLINTON, Q-MASONTOWN
ROUTE: CE-DISPOSAL-NORTH
ELEVATION: GL: KB: KB Height:
DEPTHS: TD: 8,185.0

Chesapeake ENERGY

API #: 4706100317
Serial #: 317
SPUD DATE: 8/25/1968
RIG RELEASE: 9/10/1968
FIRST SALES: 2/11/1969

VERTICAL - Original Hole, 8/27/2012 3:31:07 PM

Vertical schematic (actual) | Zones



Casing String: Production

Set Depth (ftKB): 8,185.0 | Wellbore: Original Hole | Set Depth (TVD):

Item Des	OD (in)	ID (in)	Wt (lb/ft)	Grade	Top (ftKB)	Btm (ftKB)
Casing Joints	4 1/2				14.0	8,185.0

Cement

Description: Production Casing Cement
7,500.0-8,186.0
Top of Cement (ftKB): 7,500.0 Top Measurement Method:

Fluid	Amount (sacks)	Class	Dens (lb/gal)	Vol Pumped (bbl)	Yield (ft³/sack)
	250				

Perforations

Date	Zone/Formation	Top (ftKB)	Btm (ftKB)	Shot Dens (shot s/ft)	Phasing (°)
9/13/1968	CHERT	7,889.0	7,969.0		

Tubing String: Tubing - Production

Set Depth (ftKB): 7,766.4 | Wellbore: Original Hole | Run Date:

Item Des	OD (in)	ID (in)	Wt (lb/ft)	Grade	Top Thread	Top (ftKB)	Btm (ftKB)	Len (ft)
Tubing	2 3/8	1.995	4.70	J-55		0.0	7,756.5	7,756.50
Nipple	2 3/8					7,756.5	7,757.1	0.59
On-Off Tool	2 3/8					7,757.1	7,758.5	1.42
Valve	2 3/8					7,758.5	7,760.0	1.50
Packer; A-3	2 3/8					7,760.0	7,763.8	3.82
Tubing	2 3/8	1.995	4.70	J-55		7,763.8	7,766.4	2.56

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Figure 38. Schematic diagram of the Greer well

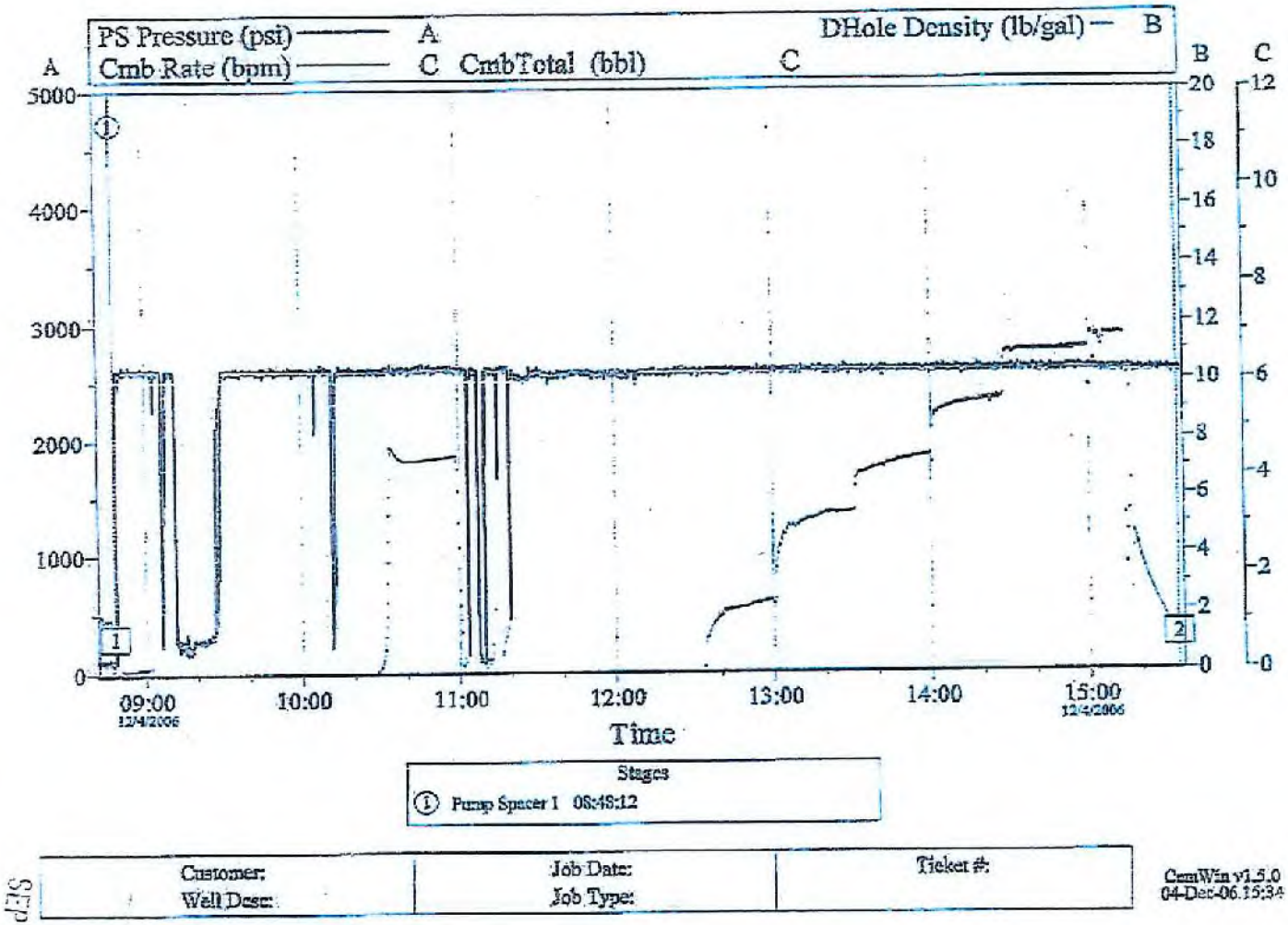

Figure 39. Step-rate injection test of the Greer well

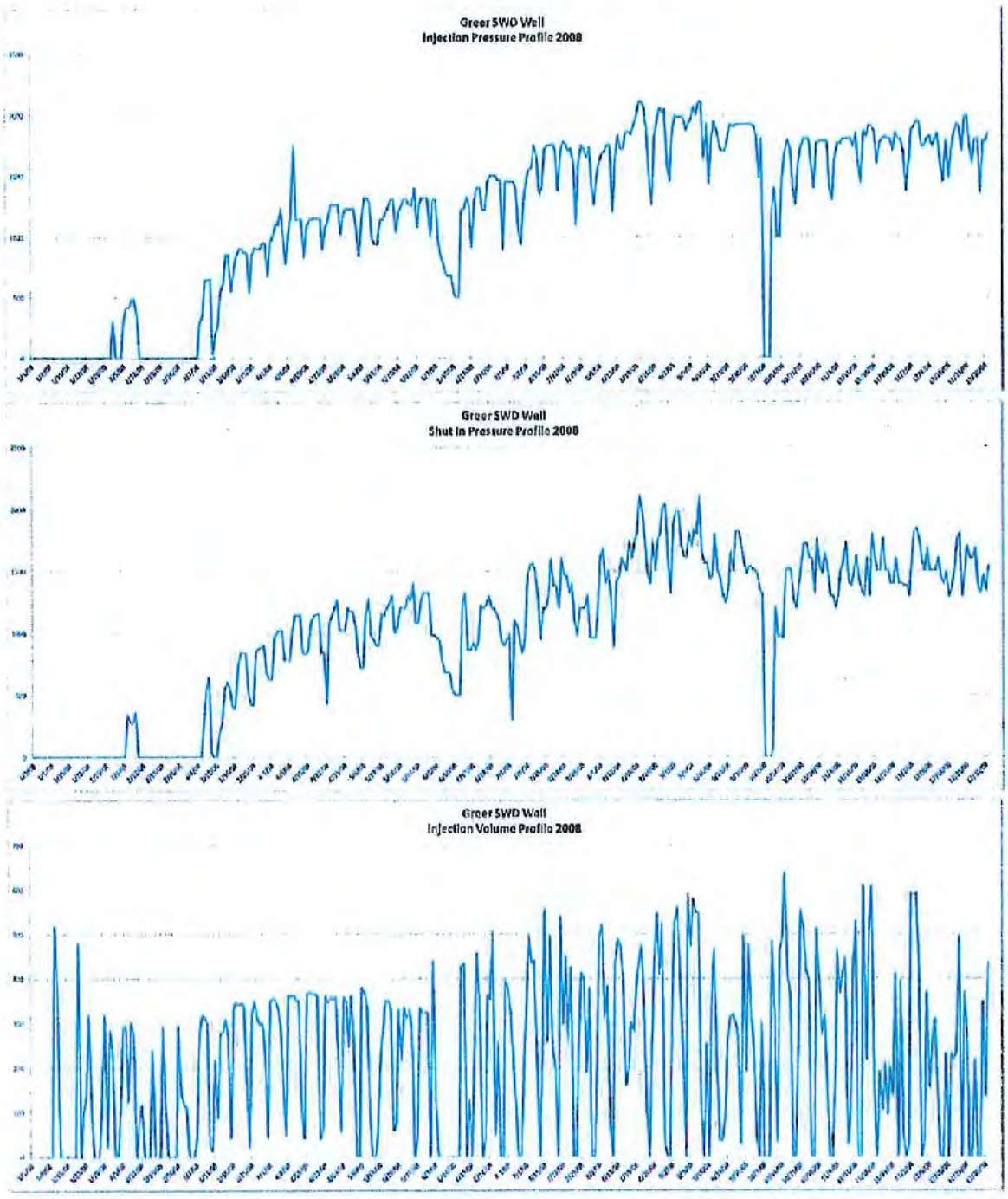

Figure 40a. Greer SWD Well – 2008 Operating Data

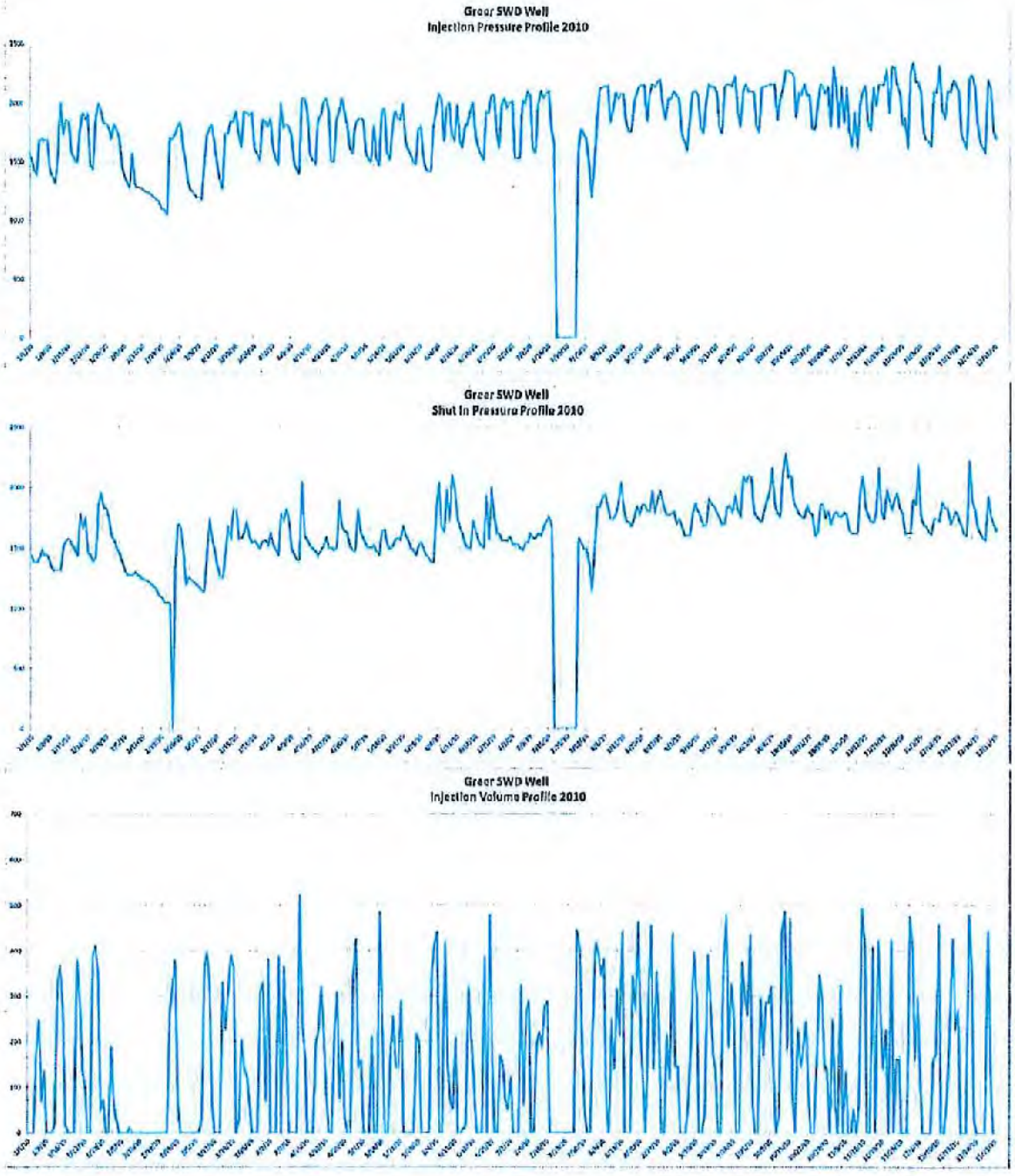

Figure 40c. Greer SWD Well – 2010 Operating Data

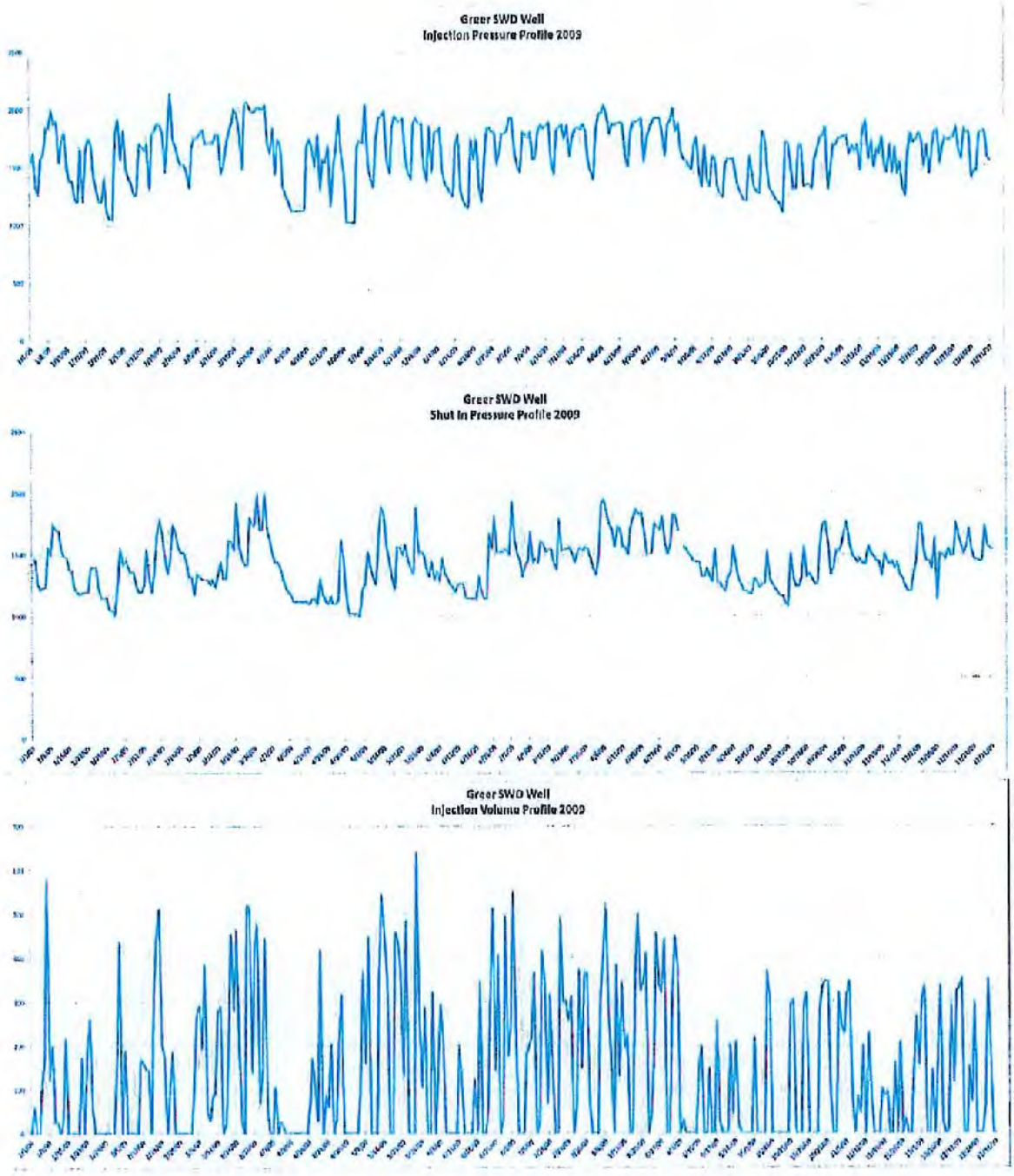

Figure 40b. Greer SWD Well – 2009 Operating Data

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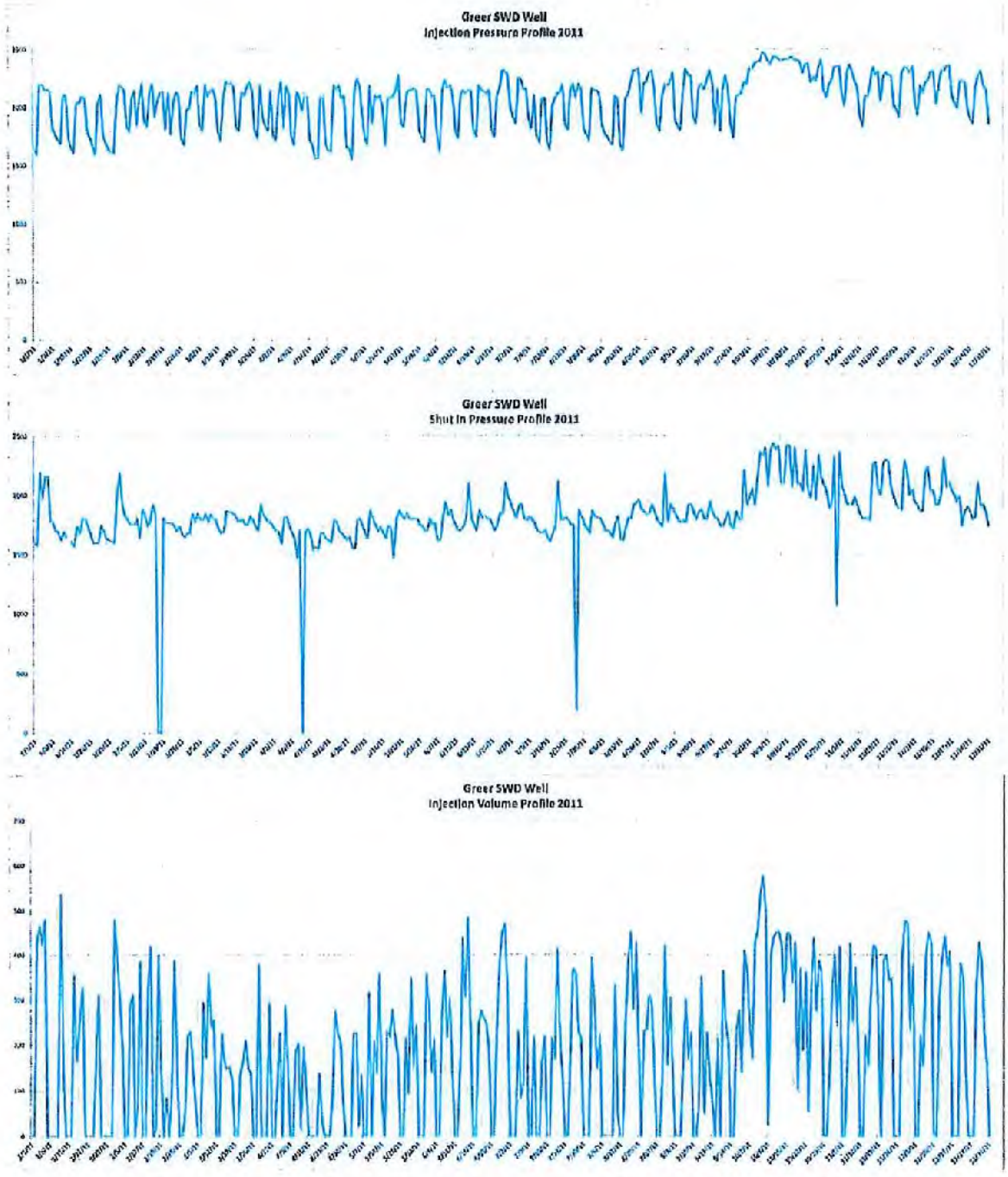

Figure 40d. Greer SWD Well – 2011 Operating Data

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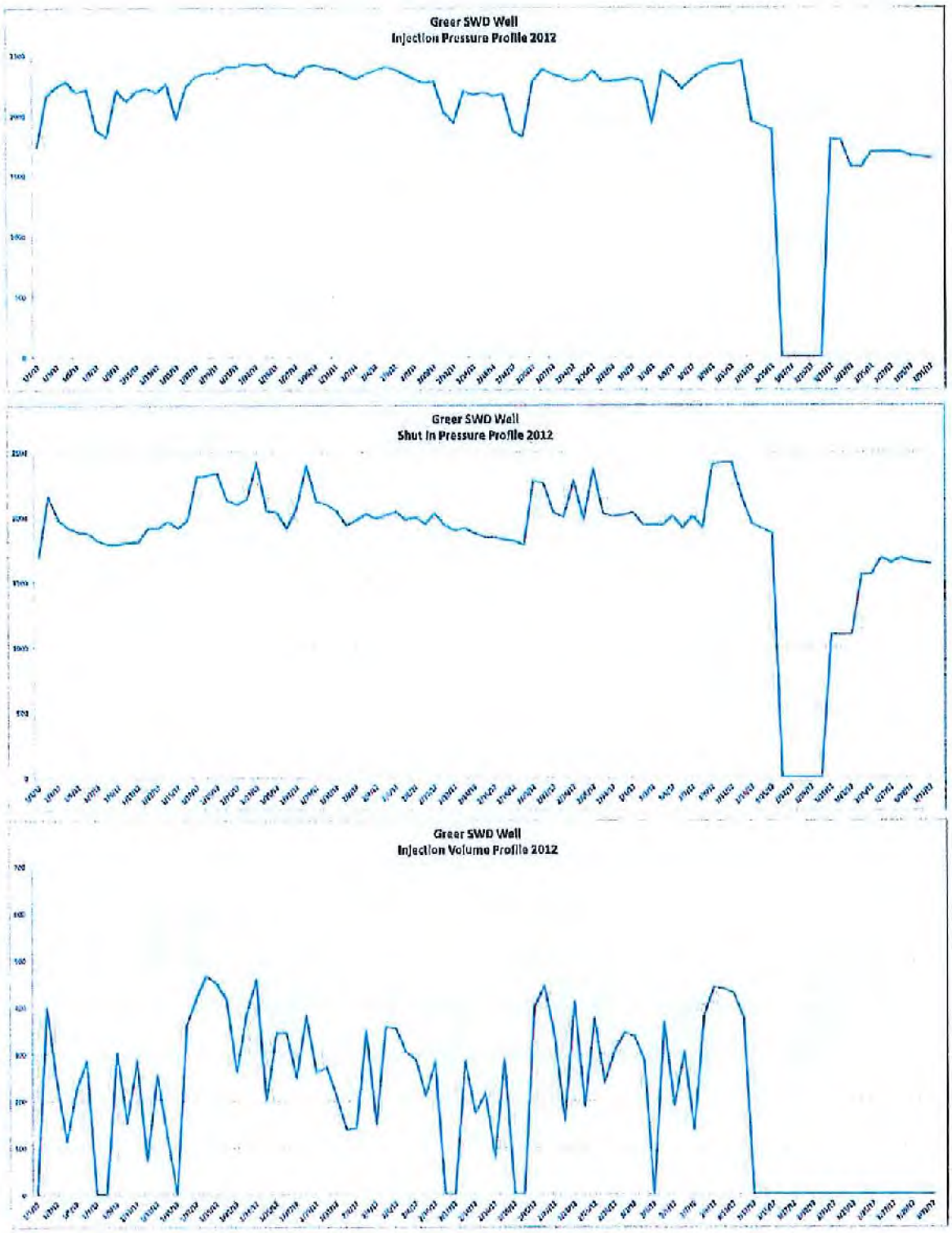


Figure 40e. Greer SWD Well – 2012 Operating Data (through 3/2012)

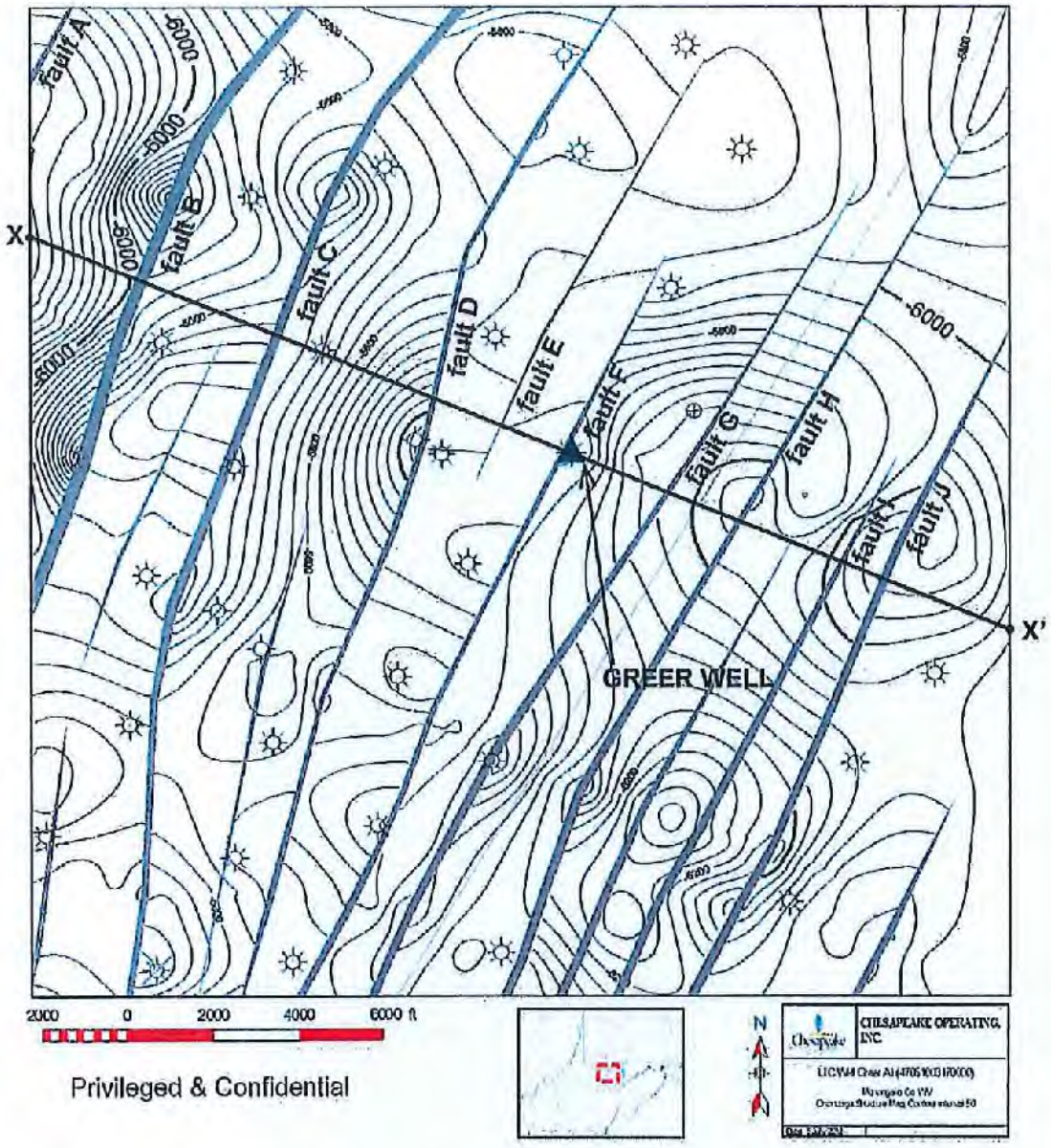


Figure 42. Fault model – map (Onondaga structure map, 50 ft TVDSS contours)

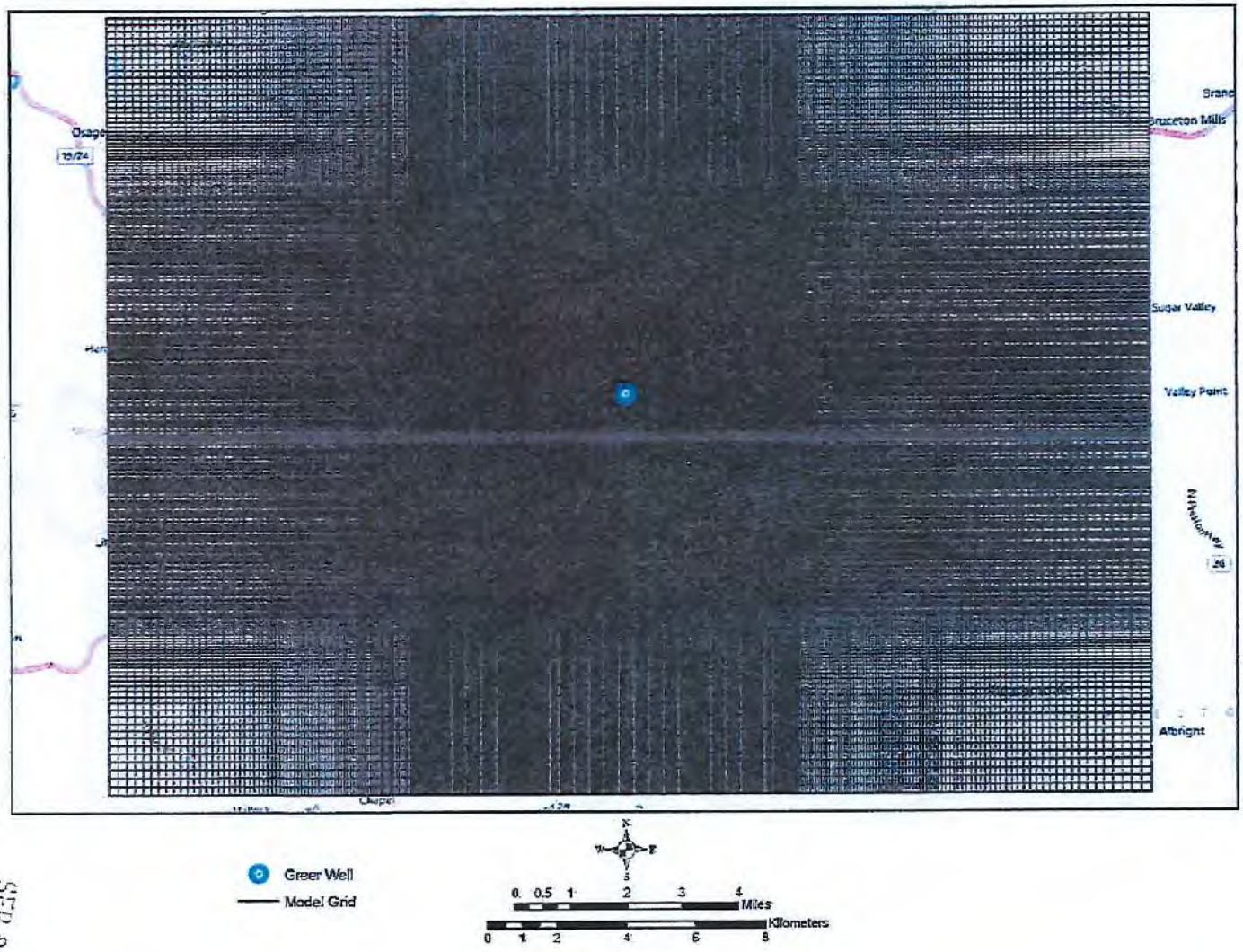
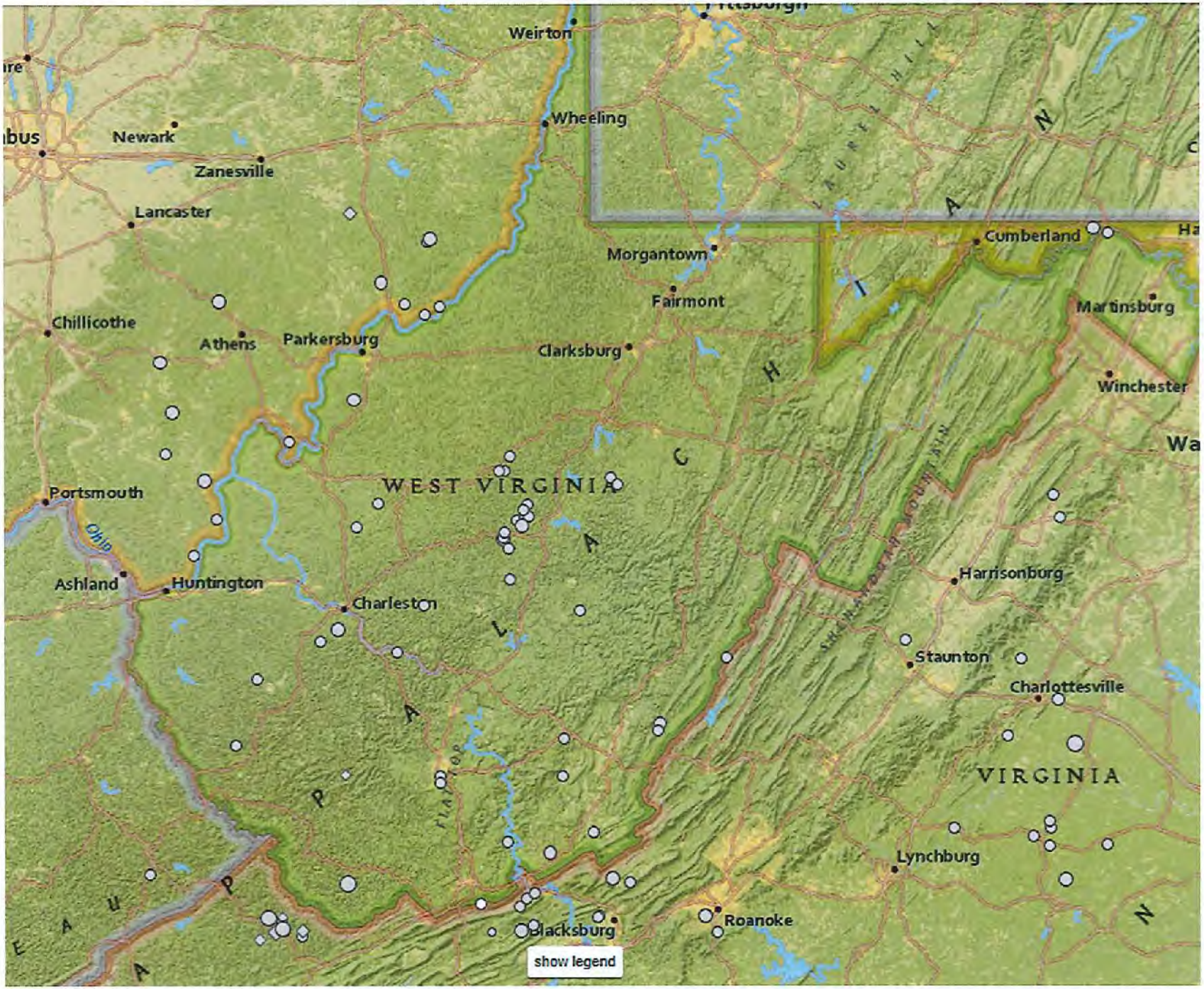


Figure 41. Model grid

USGS MAP OF ALL EARTHQUAKES FROM 1900 TO 2017



SECTION 9

OPERATING REQUIREMENTS

SECTION 9: OPERATING REQUIREMENTS / DATA

1) Proposed Operating Data:

   A. Average daily rate or volume of fluid to be injected = 300 barrels
   B. Maximum daily rate or volume of fluid to be injected = 500 barrels
   C. Average injection pressure = 2,500 psi
   D. Maximum injection pressure = 2,682 psi

2) The list of all wells by API number to be serviced by the brine disposal well is included in **Appendix G**.

3) The physical and chemical characteristics of the injection fluid are as follows and the analytical results of the sample collected is attached:

pH	9	
Chloride	126000	mg/L
TSS	320	mg/L
TDS	234680	mg/L
Spec. Gravity	1.1558	calc.
Sulfate	760	mg/L
MBAS	0.54	mg/L
TOC	427	mg/L
Aluminum	ND	mg/L
Arsenic	ND	mg/L
Barium	5050	mg/L
Calcium	20770	mg/L
Iron	137	mg/L
Manganese	5.23	mg/L
Sodium	56900	mg/L
TPH-Diesel Range	16.3	mg/L
TPH-Oil Range	2.24	mg/L
TPH Gasoline Range	ND	mg/L
Methane	0.135	mg/L
Ethane	ND	mg/L
Propane	ND	mg/L
Butane	ND	mg/L
Benzene	ND	mg/L
Toluene	ND	mg/L
Ethylbenzene	ND	mg/L
m,p-Xylene	ND	mg/L
o-Xylene	ND	mg/L

Total Coliform	Present
E Coli	Absent

4) The following injection fluid additives will be used during operations and the Safety Data Sheet for each chemical (SDS) is attached:

   a. Scale Inhibitor at 250PPM to 500PPM
   b. Wetting Agent (Iron Oxide Control Compound) at 250PPM to 500PPM

5) The fluid in the annulus between the tubing and the casing is produced water. The fluid level is estimated to be at 2,575'. A SDS of produced water is attached.

6) **Contingency Plan:**
   In the event of a well failure, operations would immediately cease and the well would be shut in. The freshwater casing installed in the well would prevent migration of fluid into any Underground Source of Drinking Water (USDW). Production fluid to be disposed of would be transferred / rerouted to a permitted underground injection commercial disposal facility.

Analytical Results

Greer A-1 Fluid

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: GREER A-1 INJECTION WATER

SAMPLED BY: M. MCGUIRE

DATE/TIME SAMPLED:* 11-06-17 0900

DATE/TIME RECEIVED: 11-06-17 1023

LABORATORY ID: HG 171106-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
pH O	5.6	units	SM 22nd 4500 H B	.1	11-07-17 1027	KH
Cl^-	126000.	mg/L	EPA 300.0 Rev 2.1-1993	.50	11-08-17 1634	DC
TSS	320	mg/L	SM22nd 2540 D	4	11-09-17 1604	MRS
TDS	234680	mg/L	SM22nd 2540 C	4	11-09-17 1604	MRS
SPEC GRAVITY	1.1558	calc	CALCULATION		11-07-17 1256	SW
SO_4	760.	mg/L	EPA 300.0 Rev 2.1-1993	1.0	11-09-17 1709	DC
MBAS	.54	mg/L	SM22nd 5540C	.01	11-07-17 2314	SW
TOC	427.	mg/L	SM22nd 5310B	1.0	11-09-17 1250	LM
Al	[1]U	mg/L	EPA 200.7 Rev 4.4-1994	.02	11-08-17 0543	DB
As	U	mg/L	SM22nd 3113 B	.0005	11-10-17 1045	RC
Ba	5050.	mg/L	EPA 200.7 Rev 4.4-1994	.002	11-08-17 1200	DB
Ca	20770.	mg/L	EPA 200.7 Rev 4.4-1994	.10	11-08-17 0543	DB
Fe	137.	mg/L	EPA 200.7 Rev 4.4-1994	.02	11-08-17 0543	DB
Mn	5.23	mg/L	EPA 200.7 Rev 4.4-1994	.002	11-08-17 0543	DB
Na	56900.	mg/l	EPA 200.7 Rev 4.4-1994	.03	11-08-17 1200	DB

*Client Provided

**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.

Data Qualifiers

B Analyte found in reagent blank. Indicates possible reagent or background contamination.
E Estimated Reported value exceeded calibration range.
J Reported value is an estimate because concentration is less than reporting limit.
PND Precision not determined.
R Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND Recovery not determined.
U Compound was analyzed for, but not detected.
O Out of holding. Time does not meet 40 CFR 136/141 compliance.
T This result is not supported by our certification ID.
A Does not meet 40 CFR 136/141 compliance.
C Does not meet 47 CSR 32 compliance.

Narrative:

[1]MATRIX INTERFERENCE PRESENT IN SAMPLE.

Approved Dwight W Beard

Sturm Environmental Services

JOHN W. STURM, PRESIDENT

COMPANY: H.G. ENERGY, LLC.

SAMPLE ID: MATT McGUIRE
GREER A-1 INJECTION WATER

SAMPLED BY: L. GARLITZ

LOG NO: W763-17

DATE/TIME SAMPLED: 11-06-17 0900

DATE/TIME RECEIVED: 11-06-17 1023

LABORATORY ID: IIG 171106-1

PARAMETER	TEST RESULTS	UNITS	METHOD	METHOD DETECTION LIMIT	DATE/TIME ANALYZED	ANALYST
Total Coliform	PRESENT	P/A (Cfu)	9223 Colilert	1	11-06-17 1115	KC
E Coli	ABSENT	P/A (Cfu)	9223 Colilert	1	11-06-17 1115	KC

*Client Provided
**See Attached. The following results meet or exceed requirements and standards set forth by the certifying authority except where noted.
Microbiological analysis results will be discarded after 5 years
Method of Analysis from "Standard Methods for the Examination of Water and Wastewater,"
Data Qualifiers

B	Analyte found in reagent blank. Indicates possible reagent or background contamination.
E	Estimated Reported value exceeded calibration range.
J	Reported value is an estimate because concentration is less than reporting limit.
PND	Precision not determined.
R	Sample results rejected because of gross deficiencies in QC or method performance. Re-sampling and/or re-analysis is necessary.
RND	Recovery not determined.
U	Compound was analyzed for, but not detected.
O	Out of holding. Time does not meet 40 CFR 136/141 compliance.
T	This result is not supported by our certification ID.
A	Does not meet 40 CFR 136/141 compliance.
C	Does not meet 47 CSR 32 compliance.

Narrative:

Approved Douglas A. Bostic

STURM ENVIRONMENTAL SERVICES

Main Office:
STURM ENVIRONMENTAL SERVICES
BRUSHY FORK ROAD
P.O. BOX 650
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
P.O. BOX 8337
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

REPORT TO: Client Name: HG Energy, LLC
Address: 5260 Dupont Road
City/State/Zip: Parkersburg, WV 26101
Contact Person: Matt McGuire
Telephone Number: 3044201126 Fax No.
Email Address: MMcguire@hgenergyllc.com
Sampler Name: (Print) Matt McGuire
Sampler Signature:
Project Name: Greer A-1 SWD
Special Reporting: [X] Email Results [ ] Fax Results

BILL TO: Client Name: Same
Address:
City/State/Zip:
Contact Person:
Telephone Number: Fax No.
Email Address:
Purchase Order #:
TURN AROUND TIME: [X] Standard By Nov. 16th 2017
[ ] RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: See attached	# of Bottles	Flow (gpm, cfs, mgd) circle one	Field pH	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
Greer A-1					11/6/17	0900	X	X			X		X	X						X		13						
Injection water																												

Comments

Records retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: >6
Bottles Preserved? Y N

colilert # 860 17

Relinquished by:	Date	Time	Received by:	Date	Time
	11/6/17	1023		11/6/17	1023
Relinquished by:	Date	Time	Received by:	Date	Time

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304) 255-2500
Website: www.reiclabs.com

Improving the environment, one client at a time...

3029-C Peters Creek Road
Roanoke, VA 24019
TEL: 540.777.1276

1557 Commerce Road, Suite 201
Verona, VA 24482
TEL: 540.248.0183

16 Commerce Drive
Westover, WV 26501
TEL: 304.241.5861

Monday, November 20, 2017

Kim Krehel
STURM ENVIRONMENTAL SERVICES
P O BOX 650
BRIDGEPORT, WV 26330

TEL: (304) 623-6549
FAX: (304) 623-6552

RE: H.G. ENERGY, LLC.
Work Order #: 17111062

Dear Kim Krehel:

REI Consultants, Inc. received 1 sample(s) on 11/8/2017 for the analyses presented in the following report.

Sincerely,

Jimmy Suttle
Project Manager
(304) 250-6234

REI Consultants, Inc. - Case Narrative

WO#: 17111062

Date Reported: 11/20/2017
Original

Client: STURM ENVIRONMENTAL SERVICES

Project: H.G. ENERGY, LLC.

The analytical results presented in this report were produced using documented laboratory SOPs that incorporate appropriate quality control procedures as described in the applicable methods. Verification of required sample preservation (as required) is recorded on associated laboratory logs. Any deviation from compliance or method modification is identified within the body of this report by a qualifier footnote which is defined at the bottom of this page.

All sample results for solid samples are reported on an "as-received" wet weight basis unless otherwise noted.

Results reported for sums of individual parameters, such as TTHM and HAA5, may vary slightly from the sum of the individual parameter results, due to rounding of individual results, as required by EPA.

The test results in this report meet all NELAP and/or VELAP requirements for parameters clearly designated as PA, VA, PA/VA, or VELAP in the column labeled NELAP.

Please note if the sample collection time is not provided on the Chain of Custody, the default recording will be 0:00:00. This may cause some tests to be apparently analyzed out of hold.

All tests performed by REIC Service Centers are designated by an annotation on the test code. All other tests were performed by REIC's Main Laboratory in Beaver, WV.

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DEFINITIONS:
MCL: Maximum Contaminant Level
MDL: Method Detection Limit; The lowest concentration of analyte that can be detected by the method in the applicable matrix.
Mg/Kg or mg/L: Units of part per million (PPM) - milligram per Kilogram (weight/weight) or milligram per Liter (weight/volume).
NA: Not Applicable
ND: Not Detected at the PQL or MDL
PQL: Practical Quantitation Limit; The lowest verified limit to which data is quantified without qualifications. Analyte concentrations below PQL are reported either as ND or as a number with a "J" qualifier.
Qual: Qualifier that applies to the analyte reported.
TIC: Tentatively Identified Compound, Estimated Concentration denoted by "J" qualifier.
Ug/Kg or ug/L: Units of part per billion (PPB) - microgram per kilogram (weight/weight) or microgram per liter (weight/volume).

QUALIFIERS:
X: Reported value exceeds required MCL
B: Analyte detected in the associated Method Blank at a concentration > 1/2 the PQL
E: Analyte concentration reported that exceeds the upper calibration standard. Greater uncertainty is associated with this result and data should be considered estimated.
H: Holding time for preparation or analysis has been exceeded.
J: Analyte concentration is reported, and is less than the PQL and greater than or equal to the MDL. The result reported is an estimate.
S: % REC (% recovery) exceeds control limits

CERTIFICATIONS:
Beaver, WV: WVDHHR 00412CM, WVDEP 060, VADCLS 00281, KYDEP 90039, NCDWQ 466, PADEP 68-00839, VADCLS(VELAP) 460148
Bioassay (Beaver, WV): WVDEP 060, VADCLS(VELAP) 460148, PADEP 68-00839
Roanoke, VA: VADCLS(VELAP) 460150
Verona, VA: VADCLS(VELAP) 460151
Morgantown, WV: WVDHHR 003112M, WVDEP 387

REI Consultants, Inc. - Analytical Report

WO#: 17111062

Date Reported: 11/20/2017
Original

Client:	STURM ENVIRONMENTAL SERVICES	**Collection Date:**	11/6/2017 9:00:00 AM
Project:	H.G. ENERGY, LLC.	**Date Received:**	11/8/2017
Lab ID:	17111062-01A	**Matrix:**	Liquid
Client Sample ID:	17250 GREER A-1 INJECTION WATER	**Site ID:**	

Analysis	Result	MDL	PQL	MCL Qual	Units	Prep Date	Date Analyzed	NELAC
SEMI-VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: YT**	
TPH (Diesel Range: C10 - C28)	16.3	0.14	0.28	NA	mg/L	11/11/17 9:20AM	11/13/17 1:29PM	
TPH (Oil Range: C22 - C36)	2.24	0.14	0.28	NA	mg/L	11/11/17 9:20AM	11/13/17 1:29PM	
Surr: o-Terphenyl	26.5	NA	17.6-135	NA	%Rec	11/11/17 9:20AM	11/13/17 1:29PM	
DISSOLVED GASES				**Method: GC-FID**			**Analyst: YT**	
Methane	135	10.0	20.0	NA	µg/L		11/17/17 4:58PM	
Ethane	ND	15.0	30.0	NA	µg/L		11/17/17 4:58PM	
Propane	ND	20.0	40.0	NA	µg/L		11/17/17 4:58PM	
Butane	ND	25.0	50.0	NA	µg/L		11/17/17 4:58PM	
VOLATILE RANGE ORGANICS				**Method: SW8015C**			**Analyst: CB**	
TPH (Gasoline Range: C6 - C10)	ND	25.0	50.0	NA	mg/L	11/09/17 1:50PM	11/17/17 3:27PM	PA/VA
Surr: 2,5-Dibromotoluene	90.4	NA	53.5-143	NA	%Rec	11/09/17 1:50PM	11/17/17 3:27PM	

Notes:

The reporting limit is elevated as a result of dilutions required due to matrix interference.

VOLATILE ORGANIC COMPOUNDS				**Method: SW8021B**			**Analyst: CB**	
Benzene	ND	50.0	100	NA	µg/L	11/09/17 1:50PM	11/17/17 3:27PM	
Toluene	ND	50.0	100	NA	µg/L	11/09/17 1:50PM	11/17/17 3:27PM	
Ethylbenzene	ND	50.0	100	NA	µg/L	11/09/17 1:50PM	11/17/17 3:27PM	
m,p-Xylene	ND	100	200	NA	µg/L	11/09/17 1:50PM	11/17/17 3:27PM	
o-Xylene	ND	50.0	100	NA	µg/L	11/09/17 1:50PM	11/17/17 3:27PM	
Surr: 1,1,1-Trifluorotoluene	77.2	NA	57.1-139	NA	%Rec	11/09/17 1:50PM	11/17/17 3:27PM	

Notes:

The reporting limit is elevated as a result of dilutions required due to matrix interference.

REI Consultants, Inc.
PO Box 286
Beaver, WV 25813
TEL: (304)255-2500
Website: www.reiclabs.com

Improving the environment, one client at a time...

Sample Receipt Checklist H.G. ENERGY, LLC.

Client Name:	**STU001**			Work Order Number:	**17111062**
RCPNo:	**1**	Date and Time Received:	**11/8/2017 1:02:07 PM**	Received by:	**William Myers**
Completed By:	**Whitney Williams**		Reviewed By:	**Stacy Heasley**	
Completed Date:	**11/8/2017 1:03:04 PM**		Reviewed Date:	**11/8/2017 2:13 PM**	

Carrier Name: REIC

1.	Chain of custody present?	Yes [x]	No [ ]	
2.	Chain of custody signed when relinquished and received?	Yes [x]	No [ ]	
3.	Are matrices correctly identified on Chain of custody?	Yes [x]	No [ ]	
4.	Is it clear what analyses were requested?	Yes [x]	No [ ]	
5.	Custody seals intact?	Yes [ ]	No [ ]	Not Present [x]
6.	Samples in proper container type and preservative?	Yes [x]	No [ ]	
7.	Were correct preservatives noted on COC?	Yes [x]	No [ ]	NA [ ]
8.	Sample containers intact?	Yes [x]	No [ ]	
9.	Sufficient sample volume for indicated test?	Yes [x]	No [ ]	
10.	Were container labels complete?	Yes [x]	No [ ]	
11.	All samples received within holding time?	Yes [x]	No [ ]	
12.	Was an attempt made to cool the samples?	Yes [x]	No [ ]	NA [ ]
13.	Sample Temp. taken and recorded upon receipt?	Yes [x]	No [ ]	To 3.6 °C
14.	Water - Were bubbles absent in VOC vials?	Yes [ ]	No [ ]	No Vials [x]
15.	Are Samples considered acceptable?	Yes [x]	No [ ]	
16.	COC filled out properly?	Yes [x]	No [ ]	

Client Notification/Response

Client Name: **STU001** Work Order Number: **17111062**

Comment:

Client Contacted: Yes [ ] No [ ] NA [x] Person Contacted:

Contact Mode: Phone [ ] Fax: [ ] Email: [ ] In Person: [ ]

Date Contacted: Contacted By:

Regarding:

Client Instructions:

Corrective Action:

DBPix Evaluation

481577

CHAIN OF CUSTODY RECORD

REIC
Research Environmental & Industrial Consultants, Inc.
MAIN LABORATORY & CORPORATE HEADQUARTERS:
[illegible] Park Rd, Beaver, WV 25813
[illegible]-2372-fax • www.reiclabs.com

17111062

Client: Stuart Environmental — PO #: 7775
Contact Person: Kim — Phone: 304 623-6549
QUOTE #: _____ Fax: _____ Email: _____
Address: on File — City: _____ State: _____ Zip: _____
Billing Address (if different): _____
City: _____ State: _____ Zip: _____
Site ID # State: _____ Project ID: _____ Sampler: M. McGuire

STURM ENVIRONMENTAL SERVICES
STU001
Jimmy Suttle

SHENANDOAH Service Center	ROANOKE Service Center	MORGANTOWN Service Center
[illegible] Rd., Ste 201	5029-C Peters Creek Rd	16 Commerce Drive
[illegible], VA 24482	Roanoke, VA 24019	Westover, WV 26501
540-248-0163	540 777 1276	304-241-5841

TURNAROUND TIME
X NORMAL
RUSH TURNAROUND*: 5 DAY | 3 DAY | 2 DAY | 1 DAY
*Rush work needs prior laboratory approval and will incur additional charges

Send Results Via: Email / Fax

All analytical reports are subject to REIC's Standard Terms and Conditions.

ANALYSIS & METHOD REQUESTED: TPH-GRO-DRO-ORO; BTEX; PAH's; Methane; Butane; Ethane; Propane

Preservative Codes:
0 None
1 Hydrochloric Acid
2 Nitric Acid
3 Sulfuric Acid
4 Sodium Thiosulfate
5 Sodium Hydroxide/Sodium Ascorbic
6 Sodium Hydroxide
7 Ascorbic Acid
8 Sodium Bisulfate/Methanol
9 Ammonium Chloride
10 CB6 Buffer
11 Sodium Sulfite/Hydrochloric Acid
12 _____
*(Fill in blank for a preservative not listed.)

ENTER PRESERVATIVE CODE

SAMPLE ID	No. & Type of Containers	Sampling Date/Time	Matrix	Sample Comp/Grab	P 1	C	C	C	C				
172-SD	1-glass liter 2-plastic 1-liter 2-vials	11-6-17 0900	L	Grab	X	X	X	X	X	X			

COMMENTS:
corrected 2 of 3
CUSTODY SEALS: Y ~~N~~

Temperature at arrival: 3.6 °C ICED? Y ~~N~~ Containers provided by: ~~REIC~~ Client Delivered by: Client ~~REIC~~ UPS FedEx USPS Other _____

[illegible]	11-7-17			
[illegible]	1155			
[illegible]	11/7/17	[illegible]	11/7/17	
	1642		1642	

www.ammara.com

STURM ENVIRONMENTAL SERVICES

Main Office:
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STURM ENVIRONMENTAL SERVICES
610 D STREET
P.O. BOX 8337
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

REPORT TO: Client Name: HG Energy, LLC
Address: 5260 Dupont Road
City/State/Zip: Parkersburg, WV 26101
Contact Person: Matt McGuire
Telephone Number: 3044201126 Fax No.
Email Address: MMcguire@hgenergyllc.com
Sampler Name: (Print) Matt McGuire
Sampler Signature:
Project Name: Greer A-1 SWD
Special Reporting: [X] Email Results [ ] Fax Results

BILL TO: Client Name: Same
Address:
City/State/Zip:
Contact Person:
Telephone Number: Fax No.
Email Address:
Purchase Order #:
TURN AROUND TIME: [X] Standard By Nov. 16th 2017
[ ] RUSH (pre-scheduled; surcharges may apply) *Please Check One*
Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: See attached	# of Bottles	Flow (gpm, cfs, mgd) circle one	Field pH	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
Greer A-1 Injection Water					11/6/17	0900	X	X			X		X	X							X	13						

Comments

Records retained for 5 years

Relinquished by:	Date	Time	Received by:	Date	Time
	11/6/17	1023		11/6/17	1023
Relinquished by:	Date	Time	Received by:	Date	Time

Laboratory Comments:
Temperature Upon Receipt: 26
Bottles Preserved? Y N
colilert # 860 17

Safety Data Sheets

multi-chem®
A HALLIBURTON SERVICE

SAFETY DATA SHEET

Product Trade Name: **MC S-2101**

Revision Date: 11-Feb-2016 **Revision Number:** 4

1. Identification

1.1. Product Identifier

Product Trade Name: MC S-2101
Synonyms: None
Chemical Family: Blend
Internal ID Code MC003050

1.2 Recommended use and restrictions on use

Application: Scale Inhibitor
Uses Advised Against Consumer use

1.3 Manufacturer's Name and Contact Details

Manufacturer/Supplier
Multi-Chem Group LLC
424 S Chadbourne St
San Angelo, TX 76903
Phone: 1 325 223 6200
Emergency Phone Number: 1-866-519-4752 (US, Canada, Mexico) or 1-760-476-3962

Halliburton Energy Services
645 - 7th Ave SW Suite 2200
Calgary, AB
T2P 4G8
Canada

Prepared By Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number

Emergency Telephone Number 1-866-519-4752 or 1-760-476-3962

2. Hazard(s) Identification

2.1 Classification in accordance with paragraph (d) of §1910.1200

Skin Corrosion / Irritation	Category 2 - H315
Serious Eye Damage / Eye Irritation	Category 2 - H319
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Single Exposure)	Category 1 - H370
Acute Aquatic Toxicity	Category 3 - H402
Flammable liquids.	Category 3 - H226

2.2. Label Elements

Hazard Pictograms

Signal Word Danger

Hazard Statements

H226 - Flammable liquid and vapor
H315 - Causes skin irritation
H319 - Causes serious eye irritation
H360 - May damage fertility or the unborn child
H370 - Causes damage to organs
H402 - Harmful to aquatic life

Precautionary Statements

Prevention

P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat/sparks/open flames/hot surfaces. - No smoking
P233 - Keep container tightly closed
P240 - Ground/Bond container and receiving equipment
P241 - Use explosion-proof electrical/ventilating/lighting/equipment
P242 - Use only non-sparking tools
P243 - Take precautionary measures against static discharge
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response

P302 + P352 - IF ON SKIN: Wash with plenty of soap and water
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
P332 + P313 - If skin irritation occurs: Get medical advice/attention
P362 - Take off contaminated clothing and wash before reuse
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P337 + P313 - If eye irritation persists: Get medical advice/attention
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P307 + P311 - IF exposed: Call a POISON CENTER or doctor/physician
P370 + P378 - In case of fire: Use water spray for extinction

Storage

P403 + P235 - Store in a well-ventilated place. Keep cool
P405 - Store locked up

Disposal

P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

2.3 Hazards not otherwise classified

None known

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Phosphonic Acid Salt	Proprietary	10 - 30%	Skin Irrit. 2 (H315) Eye Irrit. 2A (H319)
Methanol	67-56-1	10 - 30%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)
Ammonium chloride	12125-02-9	1 - 5%	Acute Tox. 4 (H302) Eye Irrit. 2 (H319) Aquatic Acute 3 (H402)
Ammonia, anhydrous	7664-41-7	1 - 5%	Acute Tox. 4 (H302) Acute Tox. 3 (H331) Skin Corr. 1B (H314) Eye Corr. 1 (H318) STOT SE 3 (H335) Aquatic Acute 1 (H400) Flam. Gas 2 (H221) Refrigerated Liquefied Gas Compressed Gas (H280)

The specific chemical identity of the composition has been withheld as proprietary. The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First-Aid Measures

4.1. Description of first aid measures

Inhalation If inhaled, move victim to fresh air and seek medical attention.

Eyes In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Skin In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes. Get medical attention.

Ingestion Do NOT induce vomiting. Rinse mouth. Never give anything by mouth to an unconscious person. Obtain immediate medical attention. Following ingestion, onset of symptoms may be delayed by 12 to 24 hours. Admission to hospital should be the first priority even if symptoms are absent

4.2 Most important symptoms/effects, acute and delayed

Causes skin irritation. Causes serious eye irritation. May damage fertility or the unborn child. Causes damage to organs.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Gastric lavage or emesis should be performed as soon as possible to minimize absorption, and is recommended within 4 hours of ingestion. Ethanol may be given intravenously to prevent build-up of toxic effects of methanol metabolites. Visual disturbances and metabolic acidosis may occur and dialysis, preferably hemodialysis may be employed to treat these complications.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

Do NOT spray pool fires directly with water. A solid stream of water directed into hot burning liquid can cause splattering.

5.2 Specific hazards arising from the substance or mixture

Special Exposure Hazards

Decomposition in fire may produce harmful gases.

5.3 Special protective equipment and precautions for fire-fighters

Special Protective Equipment for Fire-Fighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Remove sources of ignition. Ensure adequate ventilation. Avoid contact with skin, eyes and clothing. Avoid breathing vapors. Use appropriate protective equipment.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Dike far ahead of liquid spill for later disposal.
Remove ignition sources and work with non-sparking tools. Soak up with inert absorbent material. Pick up and transfer to properly labeled containers.

7. Handling and storage

7.1. Precautions for Safe Handling

Handling Precautions

Remove sources of ignition. Avoid contact with eyes, skin, or clothing. Avoid breathing vapors. Use appropriate protective equipment. Ensure adequate ventilation. Ground and bond containers when transferring from one container to another.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store in a well ventilated area. Keep from heat, sparks, and open flames.

8. Exposure Controls/Personal Protection

8.1 Occupational Exposure Limits

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Phosphonic Acid Salt	Proprietary	Not applicable	Not applicable
Methanol	67-56-1	TWA: 200 ppm	TWA: 200 ppm STEL: 250 ppm
Ammonium chloride	12125-02-9	Not applicable	TWA: 10 mg/m³ STEL: 20 mg/m³
Ammonia, anhydrous	7664-41-7	50 ppm	TWA: 25 ppm STEL: 35 ppm

8.2 Appropriate engineering controls

Engineering Controls	Ensure adequate ventilation, especially in confined areas

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment	If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.
Respiratory Protection	If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.
Hand Protection	Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.
Skin Protection	Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact. Steel-toed boots.
Eye Protection	Safety glasses with side-shields. If splashes are likely to occur, wear: Goggles, Face-shield.
Other Precautions	Not Determined

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State:	Liquid	**Color:**	Clear to Slightly Hazy , Light Amber to Dark Amber
Odor:	Pungent	**Odor Threshold:**	No information available

Property Remarks/ - Method	Values
pH:	7.0 - 8.0
Freezing Point/Range	No data available
Melting Point/Range	No data available
Boiling Point/Range	No data available
Flash Point	38.9 °C / 102 °F
Flammability (solid, gas)	No data available
upper flammability limit	No data available
lower flammability limit	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	1.0369-1.0669
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available
Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available

Liquid Density 8.64 - 8.90 lbs/gal

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical Stability
Stable

10.3. Possibility of Hazardous Reactions
Will Not Occur

10.4. Conditions to Avoid
Keep away from heat, sparks and flame.

10.5. Incompatible Materials
Strong oxidizers. Strong acids. Strong bases.

10.6. Hazardous Decomposition Products
Carbon oxides. Oxides of nitrogen. Oxides of phosphorus.

11. Toxicological Information

11.1 Information on likely routes of exposure
Principle Route of Exposure Skin contact. Ingestion. Inhalation. Eye contact.

11.2 Symptoms related to the physical, chemical and toxicological characteristics
Acute Toxicity

Inhalation May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.

Eye Contact Causes serious eye irritation.
Skin Contact Causes skin irritation.
Ingestion May cause headache, dizziness, nausea, vomiting, gastrointestinal irritation and central nervous system depression. Ingestion may result in blindness.

Chronic Effects/Carcinogenicity Suspected of damaging fertility or the unborn child.

11.3 Toxicity data

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Phosphonic Acid Salt	Proprietary	No data available	No data available	No data available
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, vapor, 4h)
Ammonium chloride	12125-02-9	1410 mg/kg (Rat) 1220 mg/kg (Rat) 1630 mg/kg (Rat) 1300 mg/kg (Mouse)	> 2000 mg/kg (Rat)	No data available
Ammonia, anhydrous	7664-41-7	350 mg/kg (Rat)	No data available	2000 ppm (Rat) 4 h 5.1 mg/L (Rat) 1 h

Substances	CAS Number	Skin corrosion/irritation
Phosphonic Acid Salt		May cause moderate skin irritation.
Methanol	67-56-1	Non-irritating to the skin (Rabbit) Not irritating to skin in rabbits.
Ammonium chloride	12125-02-9	Non-irritating to the skin (Rabbit)
Ammonia, anhydrous	7664-41-7	Causes severe skin irritation with tissue destruction. (Rabbit)

Substances	CAS Number	Eye damage/irritation
Phosphonic Acid Salt		May cause moderate eye irritation.
Methanol	67-56-1	Non-irritating to the eye (Rabbit) Non-irritating to rabbit's eye
Ammonium chloride	12125-02-9	Causes moderate eye irritation. (Rabbit)
Ammonia, anhydrous	7664-41-7	Causes severe eye irritation which may damage tissue. (Rabbit)

Substances	CAS Number	Skin Sensitization
Phosphonic Acid Salt		No information available
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)
Ammonium chloride	12125-02-9	Did not cause sensitization on laboratory animals (guinea pig)
Ammonia, anhydrous	7664-41-7	No information available

Substances	CAS Number	Respiratory Sensitization
Phosphonic Acid Salt		No information available
Methanol	67-56-1	No information available
Ammonium chloride	12125-02-9	No information available
Ammonia, anhydrous	7664-41-7	No information available

Substances	CAS Number	Mutagenic Effects
Phosphonic Acid Salt		No information available
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.
Ammonium chloride	12125-02-9	Not regarded as mutagenic.
Ammonia, anhydrous	7664-41-7	In vitro tests did not show mutagenic effects. (similar substances)

Substances	CAS Number	Carcinogenic Effects
Phosphonic Acid Salt		No information available.
Methanol	67-56-1	No data of sufficient quality are available.
Ammonium chloride	12125-02-9	Did not show carcinogenic effects in animal experiments
Ammonia, anhydrous	7664-41-7	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Phosphonic Acid Salt		No information available
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals
Ammonium chloride	12125-02-9	Did not show teratogenic effects in animal experiments. Animal testing did not show any effects on fertility. (similar substances)
Ammonia, anhydrous	7664-41-7	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments. (similar substances)

Substances	CAS Number	STOT - single exposure
Phosphonic Acid Salt		No information available
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)
Ammonium chloride	12125-02-9	No information available
Ammonia, anhydrous	7664-41-7	May cause respiratory irritation.

Substances	CAS Number	STOT - repeated exposure
Phosphonic Acid Salt		No information available
Methanol	67-56-1	No data of sufficient quality are available.
Ammonium chloride	12125-02-9	No significant toxicity observed in animal studies at concentration requiring classification.
Ammonia, anhydrous	7664-41-7	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Phosphonic Acid Salt		No information available
Methanol	67-56-1	Not applicable No information available
Ammonium chloride	12125-02-9	Not applicable
Ammonia, anhydrous	7664-41-7	Not applicable

12. Ecological Information

12.1. Toxicity

Ecotoxicity Effects

Harmful to aquatic life

Product Ecotoxicity Data

No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Phosphonic Acid Salt	Proprietary	No information available	No information available	No information available	No information available
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Dapnia magna) NOEC (21 d) =208 mg/L (Dapnia magna)
Ammonium chloride	12125-02-9	EC50 40-70 mg/L (Skeletonema costatum) EC50 (10d) 90.4 mg/L (Navicula sp.) NOEC (10d) 26.8 mg/L (growth rate) (Navicula sp.) EC50 (5d) 1300 mg/L (growth rate) (Chlorella vulgaris)	LC50 (96h) 275 mg/L (Cyprinus carpio) LC50 (96h) 163 mg/L (Pimephales promelas) LC50 (96h) 218 mg/L (Lepomis cyanellus) LC50 (96h) 34 mg/L (Oncorhynchus mykiss) NOEC (28d) 11.8 mg/L (Pimephales promelas)	EC50 (30m) 1618 mg/L (activated sludge, domestic)	TLM96 16 mg/L (Crangon crangon) EC50 (48h) 101 mg/L (Daphnia magna) NOEC (21d) 14.6 mg/L (Daphnia magna)
Ammonia, anhydrous	7664-41-7	No information available	LC50(96h): 0.5 mg/L (Lepomis cyanellus) LC50(96h): > 0.75 mg/L (Pimephales promelas) LC50(96h): > 0.16 mg/L (Oncorhynchus mykiss) NOEC(61d): 1.2 mg/L (Oncorhynchus gorbuscha)	No information available	LC50(48h): 101 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Phosphonic Acid Salt	Proprietary	No information available
Methanol	67-56-1	(95-97% @ 20d)
Ammonium chloride	12125-02-9	The methods for determining biodegradability are not applicable to inorganic substances.
Ammonia, anhydrous	7664-41-7	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Phosphonic Acid Salt	Proprietary	No information available
Methanol	67-56-1	-0.77 BCF = 1.0 – 4.5 (Cyprinus carpio) BCF < 10 (Leuciscus idus melanotus)
Ammonium chloride	12125-02-9	No information available
Ammonia, anhydrous	7664-41-7	No information available

12.4. Mobility in soil

Substances	CAS Number	Mobility
Phosphonic Acid Salt	Proprietary	No information available
Methanol	67-56-1	No information available
Ammonium chloride	12125-02-9	No information available
Ammonia, anhydrous	7664-41-7	No information available

12.5 Other adverse effects

No information available

13. Disposal Considerations

13.1. Waste treatment methods

Disposal Method Disposal should be made in accordance with federal, state, and local regulations.

Contaminated Packaging Dispose of container according to national or local regulations.

14. Transport Information

US DOT

UN Number: UN1993
UN Proper Shipping Name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable
NAERG: NAERG 128

Canadian TDG

UN Number: Not restricted
UN Proper Shipping Name: Not approved for transport in Canada
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Not approved for transport in Canada

IMDG/IMO

UN Number: UN1993
UN Proper Shipping Name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable
EMS: EmS F-E, S-E

IATA/ICAO

UN Number: UN1993
UN Proper Shipping Name: Flammable Liquid, N.O.S. (Contains Methanol)
Transport Hazard Class(es): 3
Packing Group: III
Environmental Hazards: Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

Special Precautions for User: None

15. Regulatory Information

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

TSCA Significant New Use Rules - S5A2

Substances	CAS Number	TSCA Significant New Use Rules - S5A2
Phosphonic Acid Salt	Proprietary	Not applicable
Methanol	67-56-1	Not applicable
Ammonium chloride	12125-02-9	Not applicable
Ammonia, anhydrous	7664-41-7	Not applicable

EPA SARA Title III Extremely Hazardous Substances

Substances	CAS Number	EPA SARA Title III Extremely Hazardous Substances
Phosphonic Acid Salt	Proprietary	Not applicable
Methanol	67-56-1	Not applicable
Ammonium chloride	12125-02-9	Not applicable
Ammonia, anhydrous	7664-41-7	100 lb

EPA SARA (311,312) Hazard Class

Acute Health Hazard
Chronic Health Hazard
Fire Hazard

EPA SARA (313) Chemicals

Substances	CAS Number	Toxic Release Inventory (TRI) - Group I	Toxic Release Inventory (TRI) - Group II
Phosphonic Acid Salt	Proprietary	Not applicable	Not applicable
Methanol	67-56-1	1.0%	Not applicable
Ammonium chloride	12125-02-9	1.0%	Not applicable
Ammonia, anhydrous	7664-41-7	1.0%	Not applicable

EPA CERCLA/Superfund Reportable Spill Quantity

Substances	CAS Number	CERCLA RQ
Phosphonic Acid Salt	Proprietary	Not applicable
Methanol	67-56-1	5000 lb 2270 kg
Ammonium chloride	12125-02-9	5000 lb 2270 kg
Ammonia, anhydrous	7664-41-7	100 lb 45.4 kg

EPA RCRA Hazardous Waste Classification

Ignitability D001

California Proposition 65 The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law One or more components listed.

NJ Right-to-Know Law One or more components listed.

PA Right-to-Know Law One or more components listed.

NFPA Ratings: Health 2, Flammability 2, Reactivity 0
HMIS Ratings: Health 2*, Flammability 2, Physical Hazard 0 , PPE: X

Canadian Regulations

Canadian DSL Inventory All components listed on inventory or are exempt.

16. Other information

Preparation Information

Prepared By

Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

Revision Date: 11-Feb-2016

Reason for Revision Update to Format

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
ErC50 – Effective Concentration growth rate 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
OSHA
ECHA C&L
www.ChemADVISOR.com/

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

multi-chem®
A HALLIBURTON SERVICE

SAFETY DATA SHEET

Product Trade Name: **MC SS-5395**

Revision Date: 11-Mar-2016 **Revision Number:** 3

1. Identification

1.1. Product Identifier

Product Trade Name:	MC SS-5395
Synonyms	None
Chemical Family:	Blend
Internal ID Code	MC003098

1.2 Recommended use and restrictions on use

Application:	Wetting Agent
Uses advised against	Consumer use

1.3 Manufacturer's Name and Contact Details

Manufacturer/Supplier
Multi-Chem Group LLC
424 S Chadbourne St
San Angelo, TX 76903
Phone: 1 325 223 6200
Emergency Phone Number: 1-866-519-4752 (US, Canada, Mexico) or 1-760-476-3962

Halliburton Energy Services
645 - 7th Ave SW Suite 2200
Calgary, AB
T2P 4G8
Canada

Prepared By Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number

Emergency Telephone Number 1-866-519-4752 or 1-760-476-3962

2. Hazard(s) Identification

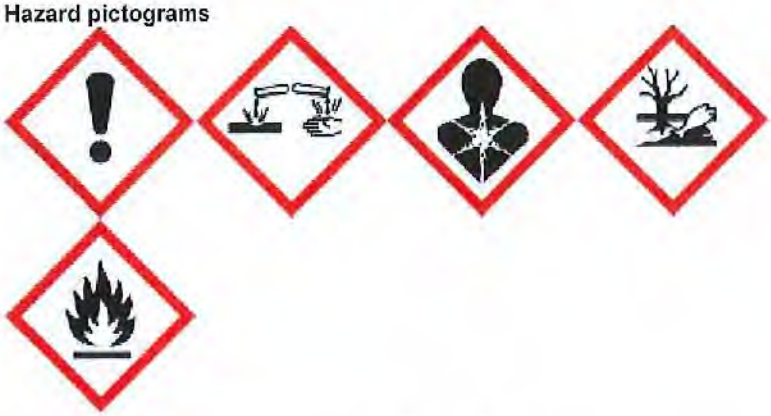
2.1 Classification in accordance with paragraph (d) of §1910.1200

Acute Oral Toxicity	Category 4 - H302
Skin Corrosion / Irritation	Category 1 A - H314
Serious Eye Damage/Irritation	Category 1 - H318
Reproductive Toxicity	Category 1B - H360
Specific Target Organ Toxicity - (Single Exposure)	Category 1 - H370
Acute Aquatic Toxicity	Category 2 - H401
Chronic Aquatic Toxicity	Category 2 - H411

Flammable liquids.	Category 3 - H226

2.2. Label Elements

Hazard pictograms



Signal Word Danger

Hazard Statements

H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H318 - Causes serious eye damage
H360 - May damage fertility or the unborn child
H370 - Causes damage to organs
H401 - Toxic to aquatic life
H411 - Toxic to aquatic life with long lasting effects
H226 - Flammable liquid and vapor

Precautionary Statements

Prevention

P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat/sparks/open flames/hot surfaces. - No smoking
P233 - Keep container tightly closed
P240 - Ground/Bond container and receiving equipment
P241 - Use explosion-proof electrical/ventilating/lighting/equipment
P242 - Use only non-sparking tools
P243 - Take precautionary measures against static discharge
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response

P301+ P312 - IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
P301 + P330 + P331 - IF SWALLOWED: rinse mouth. Do NOT induce vomiting
P303 + P361 + P353 - IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
P363 - Wash contaminated clothing before reuse
P304 + P340 - IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
P305 + P351 + P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P310 - Immediately call a POISON CENTER or doctor/physician
P307 + P311 - IF exposed: Call a POISON CENTER or doctor/physician
P391 - Collect spillage

	P370 + P378 - In case of fire: Use CO2, dry chemical, or foam
Storage	P405 - Store locked up P403 + P235 - Store in a well-ventilated place. Keep cool
Disposal	P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

2.3 Hazards not otherwise classified

None known

3. Composition/information on Ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Methanol	67-56-1	30 - 60%	Acute Tox. 3 (H301) Acute Tox. 3 (H311) Acute Tox. 3 (H331) Repr. 1B (H360) STOT SE 1 (H370) Flam. Liq. 2 (H225)
Acetic acid	64-19-7	10 - 30%	Skin Corr. 1A (H314) Eye Corr. 1 (H318) STOT SE 3 (H335) Flam. Liq. 3 (H226)
Nonylphenol ethoxylated	Proprietary	5 - 10%	Skin Irrit. 2 (H315) Eye Corr. 1 (H318) STOT SE 2 (H371) Aquatic Acute 1 (H400) Aquatic Chronic 1 (H410)
Citric acid	77-92-9	5 - 10%	Eye Irrit. 2A (H319) Combustible Dust

The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First-Aid Measures

4.1. Description of first aid measures

Inhalation	Move to fresh air. If breathing is difficult, give oxygen. If not breathing, give artificial respiration. Seek immediate medical attention/advice.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 30 minutes. Remove contact lenses after the first 5 minutes and continue washing. Seek immediate medical attention/advice. Suitable emergency eye wash facility should be immediately available
Skin	In case of contact, immediately flush skin with plenty of soap and water for at least 30 minutes and remove contaminated clothing, shoes and leather goods immediately. Get medical attention immediately.
Ingestion	Following ingestion, onset of symptoms may be delayed by 12 to 24 hours. Admission to hospital should be the first priority even if symptoms are absent. Do NOT induce vomiting. Rinse mouth. Never give anything by mouth to an unconscious person. Obtain immediate medical attention.

4.2 Most important symptoms/effects, acute and delayed

Harmful if swallowed. Causes severe skin irritation with tissue destruction. Causes severe eye irritation which may damage tissue. Potential reproductive hazard. May cause birth defects. May cause damage to internal organs.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician	Gastric lavage or emesis should be performed as soon as possible to minimize absorption, and is recommended within 4 hours of ingestion. Ethanol may be given intravenously to

prevent build-up of toxic effects of methanol metabolites. Visual disturbances and metabolic acidosis may occur and dialysis, preferably hemodialysis may be employed to treat these complications.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Extinguishing media which must not be used for safety reasons

Do NOT spray pool fires directly with water. A solid stream of water directed into hot burning liquid can cause splattering.

5.2 Specific hazards arising from the substance or mixture

Special exposure hazards in a fire

Decomposition in fire may produce harmful gases.

5.3 Special protective equipment and precautions for fire-fighters

Special protective equipment for firefighters

Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation. Use appropriate protective equipment. Do not breathe dust/fume/gas/mist/vapors/spray. Remove sources of ignition. Take precautionary measures against static discharges All equipment used when handling the product must be grounded Avoid contact with skin, eyes and clothing.
See Section 8 for additional information

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Dike far ahead of liquid spill for later disposal. Soak up with inert absorbent material. Pick up and transfer to properly labeled containers. Remove ignition sources and work with non-sparking tools.

7. Handling and storage

7.1. Precautions for safe handling

Handling Precautions

Do not breathe dust/fume/gas/mist/vapors/spray. Ensure adequate ventilation. Use appropriate protective equipment. Remove sources of ignition. Ground and bond containers when transferring from one container to another. Avoid contact with eyes, skin, or clothing.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Information

Store in a cool well ventilated area. Keep from heat, sparks, and open flames.

8. Exposure Controls/Personal Protection

8.1 Occupational Exposure Limits

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Methanol	67-56-1	TWA: 200 ppm	TWA: 200 ppm

			STEL: 250 ppm
Acetic acid	64-19-7	TWA: 10 ppm	TWA: 10 ppm STEL: 15 ppm
Nonylphenol ethoxylated	Proprietary	Not applicable	Not applicable
Citric acid	77-92-9	Not applicable	Not applicable

8.2 Appropriate engineering controls

Engineering Controls Ensure adequate ventilation, especially in confined areas Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection If engineering controls and work practices cannot keep exposure below occupational exposure limits or if exposure is unknown, wear a NIOSH certified, European Standard EN 149, AS/NZS 1715:2009, or equivalent respirator when using this product. Selection of and instruction on using all personal protective equipment, including respirators, should be performed by an Industrial Hygienist or other qualified professional.

Hand Protection Use gloves which are suitable for the chemicals present in this product as well as other environmental factors in the workplace.

Skin Protection Wear impervious protective clothing, including boots, gloves, lab coat, apron, rain jacket, pants or coverall, as appropriate, to prevent skin contact.

Eye Protection Safety glasses with side-shields. If splashes are likely to occur, wear: Goggles, Face-shield.

Other Precautions Eyewash fountains and safety showers must be easily accessible.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

Physical State: Liquid

Color Light Amber to Dark Amber Clear to Slightly Hazy

Odor: Pungent

Odor Threshold: No information available

Property Remarks/ - Method	Values
pH:	2.48-3.68 (10% in 1:1 IPA:H2O)
Freezing Point / Range	-40 °C / -40 °F
Melting Point / Range	No data available
Boiling Point / Range	No data available
Flash Point	27.2 °C / 81 °F (SFCC)
Flammability (solid, gas)	No data available
Upper flammability limit	No data available
Lower flammability limit	No data available
Evaporation rate	No data available
Vapor Pressure	No data available
Vapor Density	No data available
Specific Gravity	0.960-0.985
Water Solubility	Soluble in water
Solubility in other solvents	No data available
Partition coefficient: n-octanol/water	No data available
Autoignition Temperature	No data available

Decomposition Temperature	No data available
Viscosity	No data available
Explosive Properties	No information available
Oxidizing Properties	No information available

9.2. Other information

VOC Content (%)	No data available
Liquid Density	8.00 - 8.21 lbs/gal

10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical stability
Stable

10.3. Possibility of hazardous reactions
Will Not Occur

10.4. Conditions to avoid
Keep away from heat, sparks and flame.

10.5. Incompatible materials
Strong bases. Strong oxidizing agents Reactive metals Amines.

10.6. Hazardous decomposition products
Carbon oxides. Oxides of nitrogen. Oxides of sulfur.

11. Toxicological Information

11.1 Information on likely routes of exposure

Principle Route of Exposure Inhalation. Skin contact. Eye contact. Ingestion.

11.2 Symptoms related to the physical, chemical and toxicological characteristics

Acute Toxicity

Inhalation May cause central nervous system depression including headache, dizziness, drowsiness, incoordination, slowed reaction time, slurred speech, giddiness and unconsciousness.

Eye Contact Causes serious eye damage.

Skin Contact Causes severe burns.

Ingestion Ingestion of this product may cause blindness due to the presence of methanol. Harmful if swallowed. May cause headache, dizziness, nausea, vomiting, gastrointestinal irritation and central nervous system depression.

Chronic Effects/Carcinogenicity Contains known or suspected reproductive toxins. May cause birth defects. Causes damage to organs

11.3 Toxicity data

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Methanol	67-56-1	300 mg/kg-bw (human) < 790 to 13,000 mg/kg (rat)	1000 mg/kg-bw (human) 17,100 mg/kg (rabbit)	10 mg/L (human, vapor, 4h)
Acetic acid	64-19-7	3310 mg/kg (Rat) 600 mg/kg (Rabbit) 4960 mg/kg (Mouse)	1060 mg/kg (Rabbit)	11.4 mg/L (Rat) 4h

Nonylphenol ethoxylated	Proprietary	2000 - 5000 mg/kg (Rat) (Similar substance)	> 2000 mg/kg (Rabbit) (similar substance)	No data available
Citric acid	77-92-9	5400 mg/kg (Rat) 5790 mg/kg (Mouse) 11,700 mg/kg (Rat)	> 2000 mg/kg	No data available

Substances	CAS Number	Skin corrosion/irritation
Methanol	67-56-1	Non-irritating to the skin (Rabbit) Not irritating to skin in rabbits.
Acetic acid	64-19-7	Corrosive to skin
Nonylphenol ethoxylated	Proprietary	Causes moderate skin irritation. (Rabbit)
Citric acid	77-92-9	Not irritating to skin in rabbits.

Substances	CAS Number	Serious eye damage/irritation
Methanol	67-56-1	Non-irritating to the eye (Rabbit) Non-irritating to rabbit's eye
Acetic acid	64-19-7	Corrosive to eyes
Nonylphenol ethoxylated	Proprietary	Causes severe eye irritation which may damage tissue. (Rabbit)
Citric acid	77-92-9	Causes severe eye irritation

Substances	CAS Number	Skin Sensitization
Methanol	67-56-1	Did not cause sensitization on laboratory animals (guinea pig)
Acetic acid	64-19-7	Not regarded as a sensitizer.
Nonylphenol ethoxylated	Proprietary	Patch test on human volunteers did not demonstrate sensitization properties
Citric acid	77-92-9	Patch test on human volunteers did not demonstrate sensitization properties

Substances	CAS Number	Respiratory Sensitization
Methanol	67-56-1	No information available
Acetic acid	64-19-7	No information available
Nonylphenol ethoxylated	Proprietary	No information available
Citric acid	77-92-9	No information available

Substances	CAS Number	Mutagenic Effects
Methanol	67-56-1	The weight of evidence from available in vitro and in vivo studies indicates that this substance is not expected to be mutagenic.
Acetic acid	64-19-7	In vivo tests did not show mutagenic effects. In vitro tests did not show mutagenic effects.
Nonylphenol ethoxylated	Proprietary	In vitro tests did not show mutagenic effects. (similar substances)
Citric acid	77-92-9	Did not show mutagenic effects in animal experiments

Substances	CAS Number	Carcinogenic Effects
Methanol	67-56-1	No data of sufficient quality are available.
Acetic acid	64-19-7	Did not show carcinogenic effects in animal experiments
Nonylphenol ethoxylated	Proprietary	Did not show carcinogenic or teratogenic effects in animal experiments (similar substances)
Citric acid	77-92-9	Did not show carcinogenic effects in animal experiments

Substances	CAS Number	Reproductive toxicity
Methanol	67-56-1	Experiments have shown reproductive toxicity effects on laboratory animals
Acetic acid	64-19-7	Did not show teratogenic effects in animal experiments. Animal testing did not show any effects on fertility.
Nonylphenol ethoxylated	Proprietary	Not a confirmed teratogen or embryotoxin. (similar substances)
Citric acid	77-92-9	Animal testing did not show any effects on fertility. Did not show teratogenic effects in animal experiments.

Substances	CAS Number	STOT - single exposure
Methanol	67-56-1	May cause disorder and damage to the Central Nervous System (CNS)
Acetic acid	64-19-7	May cause respiratory irritation.
Nonylphenol ethoxylated	Proprietary	May cause disorder and damage to the Central Nervous System (CNS)
Citric acid	77-92-9	No data of sufficient quality are available.

Substances	CAS Number	STOT - repeated exposure
Methanol	67-56-1	No data of sufficient quality are available.
Acetic acid	64-19-7	Not applicable due to corrosivity of the substance.
Nonylphenol ethoxylated	Proprietary	No significant toxicity observed in animal studies at concentration requiring classification.
Citric acid	77-92-9	No significant toxicity observed in animal studies at concentration requiring classification.

Substances	CAS Number	Aspiration hazard
Methanol	67-56-1	Not applicable

Acetic acid	64-19-7	Not applicable
Nonylphenol ethoxylated	Proprietary	Not applicable
Citric acid	77-92-9	No adverse health effects are expected from swallowing.

12. Ecological Information

12.1. Toxicity

Ecotoxicity effects

Toxic to aquatic life. Toxic to aquatic life with long lasting effects.

Product Ecotoxicity Data

No data available

Substance Ecotoxicity Data

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Methanol	67-56-1	EC50 (96 h) =22000 mg/L (Pseudokirchnerella subcapitata) NOEC (8 d) =8000 mg/L (Scenedesmus quadricauda)	LC50 (96 h) =15400 mg/L (Lepomis macrochirus) EC50 (200 h) =14536 mg/L (Oryzias latipes)	IC50 (3h) > 1000 mg/L (activated sludge)	EC50 (96 h) =18260 mg/L (Dapnia magna) NOEC (21 d) =208 mg/L (Dapnia magna)
Acetic acid	64-19-7	EC50 90 mg/L (Microcystis aeruginosa) EC50 (72h) > 1000 mg/L (>300.82 mg/L – acetate ion) (Skeletonema costatum) (Effective concentrations in the aquatic environment are attributable to a change in pH value)	LC50 79 mg/L (Pimephales promelas) LC50 75 mg/L (Pimephales promelaspar) LC50 (96h) > 1000 mg/L (>300.82 mg/L – acetate ion) (Oncorhynchus mykiss) (Effective concentrations in the aquatic environment are attributable to a change in pH value)	NOEC (16h) 1150 mg/L (Pseudomonas putida)	EC50 47 mg/L (Daphnia magna) LC50 32 mg/L (Artemia salina) NOEC (21d) 31.4 - 37.9 mg/L (Daphnia magna) (reproduction) EC50 (48h) > 1000 mg/L (>300.82 mg/L – acetate ion) (Daphnia magna) (Effective concentrations in the aquatic environment are attributable to a change in pH value)
Nonylphenol ethoxylated	Proprietary	EC50 (72h) > 3 mg/L (Pseudokirchnerella subcapitata) (similar substance)	LC50 (96h) 0.323 mg/L (Pimephales promelas) (similar substance)	EC50 (3h) 104 mg/L (Activated sludge) (similar substance)	EC50 (48h) 0.148 mg/L (Daphnia magna) (similar substance) NOEC (21d) 0.006 mg/L (Daphnia magna) (similar substance) NOEC (21d) 0.1 mg/L (Daphnia magna) (similar substance)
Citric acid	77-92-9	NOEC (8d) 425 mg/L (cell density) (Scenedesmus quadricauda) LOEC (8d) >80 mg/L (Microcystis aeruginosa)	LC50 (96h) 1516 mg/L (Lepomis macrochirus) LC50 (48h) 440 mg/L (Leuciscus idus melanotus) LC50 (96h) >100 mg/L (Pimephales promelas)	TT (72h) 485 mg/L (Entosiphon sulcatum)	TLM96 100-330 ppm (Crangon crangon) EC50 (24h) 1535 mg/L (Daphnia magna) LC50 (48h) 160 mg/L (Daphnia magna) EC50 (48h) >50 mg/L (Daphnia magna)

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Methanol	67-56-1	(95-97% @ 20d)
Acetic acid	64-19-7	Readily biodegradable (99% @ 7d)
Nonylphenol ethoxylated	Proprietary	(58.7% @ 28d) (similar substances)
Citric acid	77-92-9	Readily biodegradable (97% @ 28d)

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow

Methanol	67-56-1	-0.77 BCF = 1.0 – 4.5 (Cyprinus carpio) BCF < 10 (Leuciscus idus melanotus)
Acetic acid	64-19-7	-0.17 BCF = 3.16 (Calculated)
Nonylphenol ethoxylated	Proprietary	2.1-3.4
Citric acid	77-92-9	-1.61 to -1.80

12.4. Mobility in soil

Substances	CAS Number	Mobility
Methanol	67-56-1	No information available
Acetic acid	64-19-7	No information available
Nonylphenol ethoxylated	Proprietary	No information available
Citric acid	77-92-9	No information available

12.5 Other adverse effects

No information available

13. Disposal Considerations

13.1. Waste treatment methods

Disposal methods Disposal should be made in accordance with federal, state, and local regulations.
Contaminated Packaging Dispose of container according to national or local regulations.

14. Transport Information

US DOT

UN Number UN2924
UN proper shipping name Flammable Liquid, Corrosive, N.O.S. (Contains Methanol, Acetic acid)
Transport Hazard Class(es) 3 (8)
Packing Group: III
Environmental Hazards Marine Pollutant
NAERG: NAERG 132

Canadian TDG

UN Number Not restricted
UN proper shipping name Not approved for transport in Canada
Transport Hazard Class(es) Not applicable
Packing Group: Not applicable
Environmental Hazards Not applicable

Not approved for transport in Canada

IMDG/IMO

UN Number UN2924
UN proper shipping name Flammable Liquid, Corrosive, N.O.S. (Contains Methanol, Acetic acid)
Transport Hazard Class(es) 3 (8)
Packing Group: III
Environmental Hazards Marine Pollutant

IATA/ICAO

UN Number UN2924
UN proper shipping name Flammable Liquid, Corrosive, N.O.S. (Contains Methanol, Acetic acid)
Transport Hazard Class(es) 3 (8)
Packing Group: III
Environmental Hazards Marine Pollutant

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable
Special Precautions for User None

15. Regulatory Information

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

TSCA Significant New Use Rules - S5A2

Substances	CAS Number	TSCA Significant New Use Rules - S5A2
Methanol	67-56-1	Not applicable
Acetic acid	64-19-7	Not applicable
Nonylphenol ethoxylated	Proprietary	Not applicable
Citric acid	77-92-9	Not applicable

EPA SARA Title III Extremely Hazardous Substances

Substances	CAS Number	EPA SARA Title III Extremely Hazardous Substances
Methanol	67-56-1	Not applicable
Acetic acid	64-19-7	Not applicable
Nonylphenol ethoxylated	Proprietary	Not applicable
Citric acid	77-92-9	Not applicable

EPA SARA (311,312) Hazard Class
Acute Health Hazard
Chronic Health Hazard
Fire Hazard

EPA SARA (313) Chemicals

Substances	CAS Number	Toxic Release Inventory (TRI) - Group I	Toxic Release Inventory (TRI) - Group II
Methanol	67-56-1	1.0%	Not applicable
Acetic acid	64-19-7	Not applicable	Not applicable
Nonylphenol ethoxylated	Proprietary	Not applicable	Not applicable
Citric acid	77-92-9	Not applicable	Not applicable

EPA CERCLA/Superfund Reportable Spill Quantity

Substances	CAS Number	CERCLA RQ
Methanol	67-56-1	5000 lb 2270 kg
Acetic acid	64-19-7	5000 lb 2270 kg
Nonylphenol ethoxylated	Proprietary	Not applicable
Citric acid	77-92-9	Not applicable

EPA RCRA Hazardous Waste Classification
Ignitability D001
Corrosivity D002

California Proposition 65 The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law One or more components listed.

NJ Right-to-Know Law One or more components listed.

PA Right-to-Know Law One or more components listed.

NFPA Ratings:	Health 3, Flammability 3, Reactivity 0
HMIS Ratings:	Health 3*, Flammability 3, Physical Hazard 0

Canadian Regulations

Canadian Domestic Substances List (DSL) Product contains one or more components not listed on the inventory.

16. Other information

Preparation Information

Prepared By
Chemical Stewardship
Telephone: 1-281-871-6107
e-mail: fdunexchem@halliburton.com

Revision Date: 11-Mar-2016

Reason for Revision Update to Format

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms used in the safety data sheet
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
ErC50 – Effective Concentration growth rate 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
h - hour
mg/m^3 - milligram/cubic meter
mm - millimeter
mmHg - millimeter mercury
w/w - weight/weight
d - day

Key literature references and sources for data
www.ChemADVISOR.com/

Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in

any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet

PRODUCED WATER SDS

SAFETY DATA SHEET

Date of Preparation: September 2, 2016

SECTION 1: IDENTIFICATION

Product Name:	Produced Water
Synonyms:	Salt water; Produced salt water; Formation water.
Product Use:	Waste water stream from oil and gas operations.
Manufacturer/Supplier:	HG Energy, LLC. 5260 Dupont Road Parkersburg, WV 26101
Phone Number:	304-420-1100
Emergency Phone:	1-800-344-6601
Date of Preparation:	September 2, 2016

SECTION 2: HAZARD(S) IDENTIFICATION

GHS Classification:

- Flammable Gas
- Environmental Toxicity
- Target Organ Toxicity
- Irritant

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

- Danger
- Warning

Hazard Statements

- Extremely flammable gas
- Harmful if Swallowed

Emergency Overview: Vapors may cause flash fire or explosion.

Production upsets can result in mixing of flammable liquids with produced water, resulting in a potential flammability hazard. Wash hands thoroughly after handling. Irritating to eyes and skin.

Likely Routes of Exposure:	Eye contact. Skin contact. Inhalation. Ingestion. Skin absorption.
Eye:	Irritating to eyes. Signs/symptoms may include redness, swelling, pain, tearing, and blurred or hazy

	vision.
Skin:	May be irritating to skin. Signs/symptoms may include localized redness, swelling, and itching.
Ingestion:	May cause gastrointestinal irritation. Signs/symptoms may include abdominal pain, stomach upset, nausea, vomiting and diarrhea.
Inhalation:	No inhalation hazard under normal conditions. If misting occurs: may cause mild mucous membrane irritation of the nose, throat, and upper respiratory tract.
Chronic Effects:	None known.
Medical Conditions Aggravated By Exposure:	Not available.
Target Organs:	Skin. Eyes. Gastrointestinal tract. Respiratory system.
Potential Environmental Effects:	The product components are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

Component	CAS No.	Wt. %
Water	7732-18-5	90
Sodium chloride (NaCl)	7647-14-5	1 - <10
Calcium chloride	10035-04-8	1 - <10
Potassium chloride	7791-18-6	1 - <10

Composition Comments:
This product may contain small amounts of condensate or crude oil as a contaminant.

SECTION 4: FIRST AID MEASURES

Eye Contact:	In case of contact, immediately flush eyes with fresh water for at least 15 minutes while holding the eyelids open. Remove contact lenses if worn. Get medical attention if irritation persists.
Skin Contact:	Wash skin with soap and water for at least 15 minutes while removing contaminated clothing and shoes. If signs/symptoms develop, get medical attention.
Ingestion:	Rinse mouth thoroughly. Get medical attention if any discomfort occurs.
Inhalation:	If breathing is difficult, remove to fresh air and keep at rest in a position comfortable for breathing. Call a physician if symptoms develop or persist.
General Advice:	In case of accident or if you feel unwell, seek medical advice immediately (show the label or MSDS where possible).
Note to Physicians:	Symptoms may not appear immediately.

SECTION 5: FIRE-FIGHTING MEASURES	
Flammability:	Not flammable or combustible by OSHA/WHMIS criteria. At elevated temperatures or in headspaces of vessels this product may release combustible levels of flammable gases or vapors. These gases can accumulate in confined or poorly ventilated areas. Ensure no sources of ignition are present when working in any confined space containing this product.
Means of Extinction	
Suitable Extinguishing Media:	Water. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable Extinguishing Media:	Not available.
Products of Combustion:	Oxides of carbon. Oxides of nitrogen. Oxides of iron. Sodium oxide.
Protection of Firefighters:	A fire would be associated with vapors related to oil or natural gas condensate/crude floating on the surface of the produced water. Water maybe ineffective on flames and may even spread the fire but should be used to cool pressurized containers in the fire. Keep upwind of fire. Wear full firefighting turn-out gear (full Bunker gear) and respiratory protection (SCBA).

SECTION 6: ACCIDENTAL RELEASE MEASURES	
Personal Precautions:	Keep away from sources of ignition - No smoking. The vapors should dissipate fairly rapidly depend on the amount of oil and natural gas condensate/crude floating on the surface of the produced water. Stay upwind. Keep unnecessary personnel away. See Section 8 of the MSDS for Personal Protective Equipment.
Environmental Precautions:	Prevent further leakage or spillage if safe to do so. Do not allow to enter drains, sewers or watercourses.
Methods for Containment:	Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Prevent entry into waterways, sewer, basements or confined areas.
Methods for Clean-Up:	Recover by pumping (use an explosion-proof motor or hand pump properly grounded and bonded) or by sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal. Where feasible and appropriate, remove contaminated soil or flush with fresh water. On water spills utilize absorbent material to remove oil and natural gas liquid from the surface of the water.
Other Information:	Avoid excess skin contact with spilled material.

SECTION 7: HANDLING AND STORAGE

Handling

Handle as a flammable liquid. Tank headspaces should always be regarded as potentially flammable and care should be taken to avoid static electrical discharge and all ignition sources during filling, discharging and sampling from storage tanks. Bond and ground containers and hoses during product transfer to reduce the possibility of static-initiated fire or explosion. Keep away from heat, sparks, and open flame. Electrical equipment should be approved for classified area. Wear appropriate personal protective equipment. Avoid direct skin contact with any surface. Avoid generation of dust, smoke, fumes, etc. in the work area, or if they cannot be avoided, a tested and certified dust respirator should be worn. Smoking, eating or drinking should be prohibited when working with the equipment. Workers should wash hands and face before eating, drinking and smoking. Keep face clear of tank and/or tank car openings.

Storage

Keep containers in well-ventilated area away from flame, sparks, excessive temperatures and open flames. Keep the containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition. Do not enter storage areas and confined spaces without adequate ventilation and air monitoring. Use appropriate respiratory protection if there is the potential to exceed the exposure limit(s). Vapors containing benzene may accumulate during storage and transport.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Limits

No exposure limits noted for ingredient(s).

Engineering Controls

Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye / face protection:
If eye contact is likely, safety glasses with side shields or chemical type goggles should be worn.

Skin protection
Wear suitable protective clothing. Flame resistant clothing such as Nomex ® is recommended in areas where material is stored or handled. Wash contaminated clothing prior to reuse. Avoid unnecessary skin contamination with material. Use of chemical resistant gloves is advised to prevent skin contact.

Respiratory protection
If engineering controls and ventilation are not sufficient to control exposure to below the allowable limits then an appropriate NIOSH/MSHA approved air-purifying respirator or self-contained breathing apparatus (SCBA) should be used. Supplied air breathing apparatus must be used when oxygen concentrations are low or if airborne concentrations exceed the limits of the air-purifying respirators.

General hygiene considerations
Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Handle in accordance with good industrial hygiene and safety practice.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES	
Appearance:	Clear/Dirty/Hazy Liquid.
Color:	Colorless.
Odor:	Salty / Mild Hydrocarbon.
Odor Threshold:	Not available.
Physical State:	Liquid.
pH (1% solution in water):	Not available
Viscosity:	Not available.
Melting Point:	Not available.
Boiling Point:	212 °F (100 °C)
Flash Point:	Not available.
Evaporation Rate:	Not available.
Lower Flammability Limit:	Not available.
Upper Flammability Limit:	Not available.
Vapor Pressure:	< 0.36 psi @70°F (21°C)
Vapor Density:	10 lbs/gal (Air=1) (Estimated)
Specific Gravity:	1 (Water = 1)
Density:	Not available.
Solubility in Water:	Complete
Coefficient of Water/Oil Distribution:	Not available.
Auto-ignition Temperature:	Not available.
Percent Volatile, wt. %:	Not available.
VOC content, wt. %:	Not available.

SECTION 10: STABILITY AND REACTIVITY	
Stability:	Stable under normal storage conditions.
Conditions of Reactivity:	Contact with incompatible materials.
Incompatible Materials:	Strong acids. Strong oxidizers.
Hazardous Decomposition Products:	Carbon Oxides
Possibility of Hazardous Reactions:	None known.

SECTION 11: TOXICOLOGICAL INFORMATION

Carcinogenic: IARC: No NTP: No OSHA: No ACGIH: No

SECTION 12: ECOLOGICAL INFORMATION

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

SECTION 13: DISPOSAL CONSIDERATION

Disposal instructions: Dispose in accordance with all applicable local, state, and federal regulations.

SECTION 14: TRANSPORTATION INFORMATION

DOT: Not regulated as dangerous goods.

IMDG: Not regulated as dangerous goods.

Special Shipping Information: If this material has been carried in a vehicle that last transported crude oil or condensate, mark shipping document "Residue – Last Contained, Petroleum Crude Oil".

SECTION 15: REGULATORY INFORMATION

U.S. Federal, State, and Local Regulatory Information

Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state, and/or local reporting requirements. This product and/or its constituents may also be subject to other regulations at the state and/or local level.

SECTION 16: OTHER INFORMATION

Disclaimer:

The information provided herein is believed to be accurate as of the date of issue, but is offered without guarantee. The information provided may not be complete, as it is not practicable to provide all scientific information in the format of this document. Further, additional information may be necessary under exceptional conditions of use, or because of applicable laws or regulations. HG Energy, LLC. does not assume any liability arising out of product use even if safety procedures are followed as outlined herein. The user has the responsibility for evaluating the adequacy of the information under the conditions of use and obtaining additional information where uncertainty exists. No express or implied guarantees are made as to the effects of use, the results to be obtained, or the safety and toxicity of the product in any specific application. The user assumes all risks of use of the product. HG Energy, LLC. expressly disclaims all warranties of every kind including warranties of merchantability and fitness for any particular purpose.

Communication with Employees and Purchasers:

This Safety Data Sheet (SDS) alerts the reader to potential safety and health hazards. It also contains valuable reference material relating to the safe use and handling of the product. Make sure that this information is shared with all employees and purchasers who use or handle the product. It is an important part of the OSHA hazard communication program.

This SDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

ABBREVIATIONS:

TLV - Threshold Limit Value SDS - Safety Data Sheet STEL - Short-term Exposure Limit PEL - Permissible Exposure Limit DOT - Department of Transportation (USA) CAS - Chemical Abstract Service Number ACGIH - American Conference of Government Industrial Hygienists NFPA - National Fire Protection Association (USA) IARC – International Agency for Research on Cancer OSHA - Occupational Safety and Health Administration TSCA – Toxic Substance Control Act

The information in the sheet was written based on the best knowledge and experience currently available.

Date:	**9/2/16**
Version:	**2.0**
SDS Prepared by:	**HG Energy, LLC.**
Phone:	**(800) 579-7684**

APPENDIX G

API	WELL NAME	OPERATOR	STATE	COUNTY	DISTRICT / TOWNSHIP	PRODUCING FORMATION
4707700509	BRAY LISTON 3H	HG Energy, LLC.	WV	PRESTON	PLEASANT	MARCELLUS
4707700508	BRAY LISTON 8H	HG Energy, LLC.	WV	PRESTON	PLEASANT	MARCELLUS
4707700565	DELLSLOW HUNTING & FISHING CLUB 3H	HG Energy, LLC.	WV	PRESTON	GRANT	MARCELLUS
4707700571	DELLSLOW HUNTING & FISHING CLUB 8H	HG Energy, LLC.	WV	PRESTON	GRANT	MARCELLUS
4707700566	DENNIS HART 3H	HG Energy, LLC.	WV	PRESTON	VALLEY	MARCELLUS
4707700340	MILLER 1H	HG Energy, LLC.	WV	PRESTON	PLEASANT	MARCELLUS
4704105593	LLOYD MCCAULEY 3H	HG Energy, LLC.	WV	LEWIS	COLLINS SETTLEMENT	MARCELLUS
4704105594	LLOYD MCCAULEY 5H	HG Energy, LLC.	WV	LEWIS	COLLINS SETTLEMENT	MARCELLUS
4709703514	ARTHUR CHIDESTER 1H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703653	ARTHUR CHIDESTER 2H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703672	CRAIG BESSINGER 10H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703673	CRAIG BESSINGER 6H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703671	CRAIG BESSINGER 8H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703689	DALE WINFREE 3H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703690	DALE WINFREE 5H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703665	DELMAR LIGHT 1H	HG Energy, LLC.	WV	UPSHUR	BUCKHANNON	MARCELLUS
4709703662	DELMAR LIGHT 3H	HG Energy, LLC.	WV	UPSHUR	BUCKHANNON	MARCELLUS
4709703684	EDWARD GOWER 10H	HG Energy, LLC.	WV	UPSHUR	WARREN	MARCELLUS
4709703728	EDWARD GOWER 6H	HG Energy, LLC.	WV	UPSHUR	WARREN	MARCELLUS
4709703683	EDWARD GOWER 8H	HG Energy, LLC.	WV	UPSHUR	WARREN	MARCELLUS
4709703516	FAY & RUTH SKINNER 1H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703527	FAY-RUTH SKINNER 2H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703761	JAMES OGDEN 1H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703686	JAMES OGDEN 3H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703710	JAMES OGDEN 5H	HG Energy, LLC.	WV	UPSHUR	MEADE	MARCELLUS
4709703719	LYNETTE HOWES 3H	HG Energy, LLC.	WV	UPSHUR	WASHINGTON	MARCELLUS
4709703718	LYNETTE HOWES 5H	HG Energy, LLC.	WV	UPSHUR	WASHINGTON	MARCELLUS
4709703691	MARK HARPER 3H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703674	MIKE ROSS 10H	HG Energy, LLC.	WV	UPSHUR	BUCKHANNON	MARCELLUS
4709703670	MIKE ROSS 6H	HG Energy, LLC.	WV	UPSHUR	BUCKHANNON	MARCELLUS
4709703669	MIKE ROSS 8H	HG Energy, LLC.	WV	UPSHUR	BUCKHANNON	MARCELLUS
4709703570	RALPH G LIPPS 1H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703559	RALPH G LIPPS 3H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703502	RALPH H HARPER LUMBER CO 1H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703500	RALPH H HARPER LUMBER CO 2H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703707	TALL TREES 6H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS
4709703708	TALL TREES 8H	HG Energy, LLC.	WV	UPSHUR	BANKS	MARCELLUS

API	WELL NAME	OPERATOR	STATE	COUNTY	DISTRICT / TOWNSHIP	PRODUCING FORMATION
4707700070	JOSEPH E REGER 1	HG Energy, LLC.	WV	PRESTON	UNION	CHERT, HUNTERSVILLE CHERT
4706100226	PIXLER A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100274	BORN A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100289	SMITH Q-2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100293	SMITH Q-3	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100294	BORN A-2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100300	SCOUT B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706100301	GILES B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100302	GILES C-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100305	DALTON B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100311	HARWORTH A-1 (SI)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100312	MANNING B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100314	SELLARO A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100316	CASCADE C-1 (SI)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100318	ALLEGHENY A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	COMINGLED
4706100319	GREER B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706100638	SHUTTLESWORTH 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706100934	GILES B-2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706100951	MANNING B-2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,CHERT, HUNTERSVILLE CHERT
4706101082	SHAFFER 2	HG Energy, LLC.	WV	MONONGALIA	MORGAN	BALLTOWN,SPEECHLEY
4706101092	BEALL/VIERS 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101098	GERALDINE FORLINI TOTH 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101111	PAWLAK 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	BIG LIME,INJUN,WEIR,BEREA,GRIT BEREA,GANTZ, GORDON,SAND,BAYARD,SPEECHLEY,BALLTOWN,MARCELLUS
4706101113	GERALDINE FORLINI TOTH 2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101117	GERALDINE FORLINI TOTH 3	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101118	PAWLAK 2	HG Energy, LLC.	WV	MONONGALIA	UNION	FOURTH
4706101124	SMYTH 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101127	GILES/CAYTON 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH,BAYARD
4706101173	MCBEE 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101174	GILES 1 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101177	MARTIN 2 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101210	WHITE 10 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101311	RICHARD M TREAT 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	ORISKANY
4706101320	GREER STEEL 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101373	GREER INDUSTRIES INC 3	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT,ORISKANY
4706101386	ODIS J ROGERS 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101395	NEW AUGUSTA INC 1	HG Energy, LLC.	WV	MONONGALIA	UNION	CHERT
4706101506	MACCURRACH 1	HG Energy, LLC.	WV	MONONGALIA	UNION	CHERT
4706101511	BETHANY ANN VIERS DUGAN 1 (SI)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SAND,BALLTOWN
4706101512	BETHANY ANN VIERS DUGAN 2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	GORDON,SAND,BALLTOWN
4706101514	ROY P CAYTON ETUX 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	GORDON STRAY,SAND,BALLTOWN
4706101520	SUPPORTERS MOUNTAINEER SCOUT 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	GORDON STRAY,GORDON,SAND,BALLTOWN,SPEECHLEY
4706101522	SUPPORTERS MOUNTAINEER SCOUT 2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SAND,ELIZABETH,BALLTOWN
4706101523	SUPPORTERS MOUNTAINEER SCOUT 3	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SAND,ELIZABETH
4706101525	DARWIN CORP 2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	GORDON,ELIZABETH,BALLTOWN
4706101526	DARWIN CORP 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	GORDON,SAND,ELIZABETH,BALLTOWN
4707700118	SMITH P-1	HG Energy, LLC.	WV	PRESTON	VALLEY	COMINGLED,ORISKANY,COMINGLED
4707700126	HOLMES D-1	HG Energy, LLC.	WV	PRESTON	VALLEY	ONONDAGA LIMESTONE,COMINGLED,ORISKANY
4707700127	JASPER B-1	HG Energy, LLC.	WV	PRESTON	VALLEY	ONONDAGA LIMESTONE
4707700128	HALBRITTER A-1	HG Energy, LLC.	WV	PRESTON	VALLEY	ONONDAGA LIMESTONE,COMINGLED,ORISKANY
4707700139	B BORN 1	HG Energy, LLC.	WV	PRESTON	VALLEY	ONONDAGA LIMESTONE,ORISKANY,COMINGLED
4707700207	MURRAY 1 (WV)	HG Energy, LLC.	WV	PRESTON	VALLEY	ORISKANY

4707700251	HOLMES C-2	HG Energy, LLC.	WV	PRESTON	VALLEY	COMINGLED,COMINGLED
4707700279	WARD 3	HG Energy, LLC.	WV	PRESTON	VALLEY	SPEECHLEY,BALLTOWN
4707700317	REX W BORN ETAL 1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4706100322	ROBY D-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100935	ROBY D-2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101178	BROWN 8	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101180	WILLIAMS 2 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101182	SHALE 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101192	TEETS 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SPEECHLEY
4706101193	BRITTON 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101214	KING-BRITTON 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	MARCELLUS / CHERT
4706101217	HOLT 6	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101244	FUMICH 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101255	NUEVE INC 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101314	TIMOTHY A SCHIFFBAUER 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706101368	SHAFFER UNIT 3	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101374	CHARLES E BUCHANAN 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT
4706101397	JOHN WILLIAM BROWN III 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4707700102	HOLMES B-1	HG Energy, LLC.	WV	PRESTON	VALLEY	COMINGLED,ORISKANY,COMINGLED
4707700110	HOLMES C-1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4707700288	BOLYARD 2	HG Energy, LLC.	WV	PRESTON	LYON	FOURTH
4707700289	FREY 1	HG Energy, LLC.	WV	PRESTON	LYON	FOURTH
4707700294	HELMS 1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4707700318	HOLMES B UNIT 4	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4707700319	CHARLES T NEYMAN 1	HG Energy, LLC.	WV	PRESTON	LYON	CHERT
4707700320	HOWDERSHELT UNIT 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON
4707700321	REHE UNIT AKA TRICKETT 1	HG Energy, LLC.	WV	PRESTON	LYON	CHERT
4707700335	MICHAEL R MILLER ETAL 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	CHERT
4707700337	CALE 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	SECOND ELK,THIRD ELK
4707700338	JANET J HERTIG 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON
4707700339	JEFFREY D EANES 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	ELIZABETH,SPEECHLEY,BENSON
4707700342	DARWIN E TITCHENELL ETAL 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	MARCELLUS
4707700345	JAMES & VIRGINIA KELLY 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	CHERT
4707700346	CALE 2	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON
4707700348	DONALD D & SHARON L GRAHAM 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	RILEY,BENSON
4707700349	JANET J HERTIG 2	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON
4707700350	WILLIAM C BISHOFF ETUX 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON
4707700351	WILLIAM C BISHOFF ETUX 2	HG Energy, LLC.	WV	PRESTON	PLEASANT	SPEECHLEY,BENSON
4707700352	JAMES R & ROSE ANN LENHART 1	HG Energy, LLC.	WV	PRESTON	PLEASANT	BENSON,RILEY,BALLTOWN
4706100281	SMITH Q-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100287	MORRIS E-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100297	POWLEY A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100303	PERRY A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100307	MAY A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100313	CASCADE A-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SPEECHLEY,BALLTOWN,CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100315	CASCADE B-1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,ORISKANY
4706100952	SMITH Q-4	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101078	BRAGG UNIT 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,CHERT, HUNTERSVILLE CHERT
4706101088	BRAGG 2	HG Energy, LLC.	WV	MONONGALIA	CLINTON	SPEECHLEY,BALLTOWN
4706101108	HESS 2 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101110	HESS 3 (WV)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101112	STUBNA 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH,FIFTH,BAYARD,SPEECHLEY
4706101114	HOKE 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101119	LAURITA 31	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT,CHERT, HUNTERSVILLE CHERT
4706101122	LAURITA 33	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH

4706101123	LAURITA 32	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FOURTH
4706101179	BOY SCOUTS 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101218	JOHNSON 6	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101233	WHITE 11 (WV)	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101237	JOHNSON 7	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101242	HESS 4	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101246	JOHNSON 8 (SI)	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101247	JOHNSON 9	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101254	SPENCER-MUFFLY 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	SPEECHLEY,CHERT, HUNTERSVILLE CHERT
4706101258	NICHOLSON 1 (WV)	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101279	GARY MCMILLEN-HOPE 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101313	ROLFE M MCDONALD ETUX 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	CHERT, HUNTERSVILLE CHERT
4706101316	GREER INDUSTRIES INC 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706101328	DALE SHAW 1	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT
4706101372	GREER INDUSTRIES INC 4	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT
4706101521	EARL F SMYTH 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	BALLTOWN
4706101524	MOUNTAIN AREA BOY SCOUTS 1	HG Energy, LLC.	WV	MONONGALIA	CLINTON	FIFTH,SAND,BAYARD,BENSON
4706100321	FARMER A-1 HOPE	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706100336	FARMER A-2 HOPE	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT
4706100347	MCMILLIAN/HOPE 1 (SI)	HG Energy, LLC.	WV	MONONGALIA	MORGAN	CHERT, HUNTERSVILLE CHERT,ORISKANY
4707700183	KASPER-BORN 1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4707700184	LAUREL-HOPE 1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT
4707700186	HOLMES-HOPE 1	HG Energy, LLC.	WV	PRESTON	VALLEY	CHERT, HUNTERSVILLE CHERT

SECTION 10

MONITORING

SECTION 10: MONITORING

1) HG will monitor the injection pressure, annulus pressure, flow rate, and the cumulative volume of the injected fluid. Monitoring will be completed on a daily basis during active operations at the facility by field personnel. Each monitoring event will consist of documenting the readings on Form WR-40 in the field.

   A well head pressure gauge is installed and maintained on the injection tubing to facilitate inspection and ensure compliance of maximum injection pressures as approved. A daily reading of the injection pressure will be taken and reported on Form WR-40.

   The 2 3/8" x 4 ½" and 4 ½" x 9 5/8" casing annuli will be monitored with pressure gauges. A daily reading of the annuli will be taken and reported on Form WR-40.

2) A manifesting system documenting fluid sources, quantity, transportation type, and dates is currently established for the operations and will continue moving forward. This system consists of truck manifests completed for each load of water delivered to the facility. Each manifest documents the fluid source, quantity, transportation type and company, and the dates of the transfer. The truck manifests are collected routinely, reviewed and then filed at a local field office in Salem, WV. Truck manifests are available to be reviewed at the field office upon request by the WVDEP. A blank truck manifest is attached.

DATE

_____ / _____ / _____

(MM / DD / YY)

DRIVER NAME (PRINT)

HG Energy, LLC
5260 Dupont Road
Parkersburg, WV 26101
304-420-1100

005676

WO #

ORDERED BY

HAULED WATER FROM LOCATION & ROAD NAME - _____

DELIVERED TO - WELL/DISPOSAL FACILITY - _____

BILL TO: _____ VENDOR: _____ TRUCK NO.: _____

LDS./GALLONS	WORK DESCRIPTION	TOTAL GALLONS - WATER TYPE START TIME - END TIME AM/PM	HRS

DRIVER SIGNATURE: _____ OSR SIGNATURE: _____

SECTION 11

GPP

APPENDIX H

APPENDIX H

GROUNDWATER PROTECTION PLAN

Facility Name: Greer A-1 SWD

County: Monongalia

Facility Location:

Postal Service Address:	1910 Snakehill Road Masontown, WV	
Latitude and Longitude:	39.590402, -79.828543	

Contact Information:

Person:	Matt McGuire
Phone Number:	304-420-1126
E-mail Address:	mmcguire@hgenergyllc.com

Date: 11/7/17

1. A list of all operations that may contaminate the groundwater.

Truck transfers,
Water storage facilities
Pipelines

2. A description of procedures and facilities used to protect groundwater quality from the list of potential contaminant sources above.

Truck transfers utilize secondary containment spill buckets to prevent spillage onto the ground and oversight during fluid transfers will be continuous. Storage tanks have high level alarms and are within a concrete secondary containment. Containment sumps have high level alarms and water is removed routinely. Pipelines are inspected regularly and integrity tested every five years.

3. List procedures to be used when designing and adding new equipment or operations.

No new equipment or operations are planned. However, in the event new equipment or operations are planned, they will be designed and constructed to protect groundwater. Training will be completed with employees and contractors prior to implementing any new equipment or operations.

4. Summarize all activities at your facility that are already regulated for groundwater protection.

The facility is currently in operation under existing permit number 2D0610317.

5. Discuss any existing groundwater quality data for your facility or an adjacent property.

Groundwater analytical results for water supplies in the vicinity of the facility are included in Attachment E of this application.

6. Provide a statement that no waste material will be used for deicing or fill material on the property unless allowed by another rule.

No waste material will be used for deicing or fill material on the property.

7. Describe the groundwater protection instruction and training to be provided to the employees. Job procedures shall provide direction on how to prevent groundwater contamination.

Annual training with employees is completed. The training consists of Spill Prevention, Control, and Countermeasures (SPCC). The SPCC training includes recognizing spills, notifications, documentation, and remedial measures / emergency response coordination. In addition, employees are trained in the visual inspection of equipment / pipelines / tanks as part of the ongoing maintenance of the facility.

8. Include provisions for inspections of all GPP elements and equipment. Inspections must be made quarterly at a minimum.

Visual inspections are completed weekly during operations. Inspections include a visual survey of the facilities equipment, pipelines, and overall operations.

Signature: _____

Date: November 7, 2017

APPENDIX I

(4/25)

APPENDIX I

Requirement for Financial Responsibility to Plug/Abandon an Injection Well

To: WV Department of Environmental Protection
Office of Oil and Gas
601 57th Street, SE
Charleston, West Virginia 25304-2345
ATTN: Underground Injection Control Program

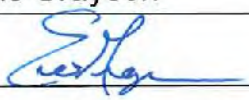
From: HG Energy, LLC.
5260 Dupont Road
Parkersburg, WV 26101

Date: November 7, 2017

Subject: Underground Injection Control (UIC) Permit Application
2D0610317
Requirement for Financial Responsibility

I, HG Energy, LLC., verify in accordance with 47CSR13-13.7.g., that I will maintain financial responsibility and resources to close, plug, and abandon underground injection wells(s) in a manner prescribed by the Chief of the Office of Oil and Gas.

Name: Eric Grayson

Signature: 

Date: November 7, 2017

SECTION 12

PLUGGING

Plugging Procedures

Well: Greer A1 47-061-00317

Cast Iron Bridge Plug to be set Below Cement Plug #1

Plug #1: 7880' to 7480'

Located above CIB plug, through Onondaga and Marcellus formations.

Plug #2: 7250' to 7150'

Located at 4 ½"" casing stub.

Plug #3: 5150' to 5050'

Plug #4: 2150' to 2000'

Located at Elevation

Plug #5: 1050' to 950'

Located at 9 5/8" Casing Shoe

Plug #6: 250' to 0'

Located at Surface

Recover all possible casing. If casing cannot be recovered, perforate for plug placement.

Monument –

- 6" minimum diameter metal pipe.
- 30" above surface.
- 10' in well below surface.
- Sealed with cement
- API Identification (1/2") height numbering.

6% gel between all plugs.

Well: 47-061-00317

Elevation: 2068'

Monument to extend 30" above surface. 10' into well. 6" min metal pipe, sealed with cement. API i.D.

Plug #6 (250') 250' to 0'

Casing Information		
Size	Depth	Weight
9 5/8"	1000	32.3#/ft
4 1/2"	8172	11.6#/ft

Plug #5 (100') 1050' to 950'

Plug #4 - Elevation (150') 2150' to 2000'

Hole Size 7.875"

Bottom Hole Cement Level Calculations

# Sacks Used	Cement Depth
250	7254.938

Hole Size	Casing Size	Depth
7.875	4.5	8185

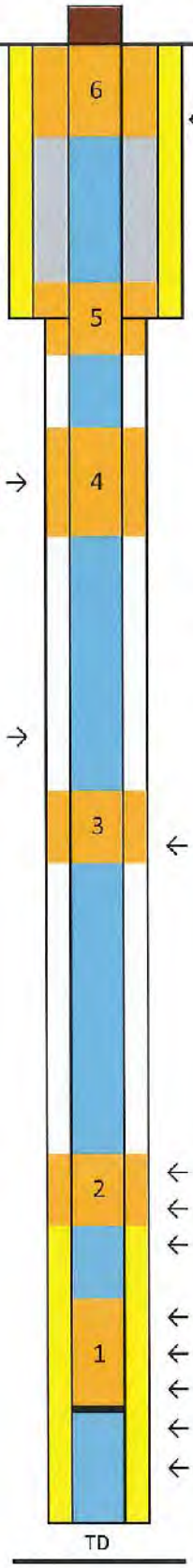
diameter delta	Conv. Factor	bbls / ft.
41.765625	1029.4	0.040573

cubic ft. per vertical ft. depth
0.227795902

Sacks per vertical ft. depth
0.268799164

Yield options

50/50 posmix 6% gel = 1.64
Neat w/ salt flakes = 1.19
50/50 w/ 2% gel = 1.27



50 sacks cement to surface

Freepoint Cut and Pull Casing	
Size	Approx. Depth
4 1/2	7200'

Cement Plugs		
NO.	Bottom	Top
1	7880	7480
2	7250	7150
3	5150	5050
4	2150	2000
5	1050	950
6	250	0

Plug #3 (100') 5150' to 5050'

Plug #2 (100') across 4.5" casing stub
Free point part and pull 4.5" casing
250 Sacks Cement T.O.C. 7254'

Plug #1 (400') 7880' to 7480'
Top of Marcellus 7595'
Onondaga Confining Zone 7886'
CIB Plug to be set below cement plug
Injection zone 8034' to 7886'
Perforations 7969' to 7889'

SECTION 13

ADDITIONAL BONDING

OP-8
Rev. 1/12

BOND NUMBER B1233303

STATE OF WEST VIRGINIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS
BLANKET BOND FOR OIL OR GAS WELLS,
LIQUID INJECTION WELLS OR WASTE DISPOSAL WELLS

KNOWN ALL MEN BY THESE PRESENTS:

(1) That we, HG Energy, LLC

(2) 850 Cranberry Woods Dr., Cranberry Twp, PA 16066

As Principal, and (3) Cincinnati Insurance Company

(4) 9200 S. Gilmore Rd., Fairfield, OH 45014

a firm and/or a corporation authorized to do business in the State of West Virginia, as Surety, are held and firmly bound unto the State of West Virginia in the just and full sum of (5) Five Thousand dollars ($ 5,000) to the payment whereof well and truly to make, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above bound Principal in pursuance of the provisions of Chapter 22, Article 6 and/or 6A, of the Code of West Virginia, 1931, as amended, and the regulations promulgated thereunder, has made or intends to make application to the Chief of the Office of Oil and Gas, Department of Environmental Protection, the State of West Virginia for a permit to perform well work (as defined in Chapter 22, Article 6 and/or 6A), on oil or gas wells and/or liquid injection wells and/or waster disposal wells, or has acquired or purchased, or shall hereafter acquire or purchase such wells, or has been or shall be assigned operating responsibility for such wells located in West Virginia; and

WHEREAS, THE Obligee as a condition precedent to the issuance of such Permit or release of other obligation has required the Principal to furnish a SURETY BOND acceptable to the Obligee guaranteeing the performance of said provisions of Chapter 22, Article 6 or 6A, of the Code of West Virginia, 1931, as amended, and the regulations promulgated thereunder;

NOW THEREFORE, the condition of this obligation is such that if the Principal, its personal representatives, successors, heirs and assigns shall in performing well work (as defined in Chapter 22, Article 6 and/or 6A) or operating such wells shall furnish all reports, information and affidavits as may be required by the Department of Environmental Protection, Office of Oil and Gas, documenting that said wells have been plugged and abandoned in accordance with Chapter 22, Article 6, of the Code of West Virginia, 1931, as amended, and the regulations promulgated thereunder, then this obligation to be void; otherwise to remain in full force and effect.

This bond shall be effective from the (11) 6th day of June, 2016, until released by the Department of Environmental Protection.

IN WITNESS WHEREOF the said Principal has hereunder set his or its hand and affixed his or its seal, and the said surety has caused its corporate name to be signed hereto and its corporate seal to be hereunto affixed by its duly authorized officer or agent this instrument this (12) 10th day of June, 2016.

(15) Principal Corporate Seal

(13) HG Energy, LLC [signature] (Seal)
(Principal)

(14) By: President
(Title)
(Must be President or V. President)

(10) Surety Corporate Seal

(16) The Cincinnati Insurance Company (Seal)
(Surety)

(17) By: Jamie Jackson

19) Countersigned: [signature]
(Resident West Virginia Agent)

(20) Address: PO Box 910, Bluefield, WV 24701

(21) Telephone: 304-324-8024

(REVERSE)

ACKNOWLEDGMENTS

Acknowledgment by Principal if Individual or Partnership

1. STATE OF _____
2. County of _____ to-wit:
3. I, _____, a Notary Public in and for the
4. county and state aforesaid, do hereby certify that _____ whose name is signed to the foregoing writing, has this day acknowledged the same before me in my said county.
5. Given under my hand this _____ day of _____ 20_____.
6. Notary Seal 7. _____

(Notary Public)

8. My commission expires on the _____ day of _____ 20 ___.

Acknowledgment by Principal if Corporation or Limited Liability Company

9. STATE OF WEST VIRGINIA
10. County of WOOD to-wit:
11. I, MARK J. SCHALL, a Notary Public in and for the
12. county and state aforesaid, do hereby certify that JARED HALL
13. who as, PRESIDENT signed the foregoing writing for
14. HG ENERGY LLC a corporation/LLC, has this day, in my said county, before me, acknowledged the said writing to be the act and deed of the said corp/LLC.
15. Given under my hand this 29TH day of JUNE 20 16.
16. Notary Seal 17. _____

OFFICIAL SEAL
NOTARY PUBLIC, STATE OF WEST VIRGINIA
MARK J SCHALL
HG Energy LLC
PO Box 5519, Vienna, WV 26105
My Commission Expires November 2, 2021

(Notary Public)

18. My commission expires on the 2ND day of NOVEMBER 20 21

Acknowledgment by Surety

19. STATE OF Virginia
20. County of City of Salem to-wit:
21. I, Sara Mundy, a Notary Public in and for the
22. county and state aforesaid, do hereby certify that Jamie Latham
23. who as, Attorney-in-Fact signed the foregoing writing for
24. The Cincinnati Insurance Company a corporation has this day, in my said county, before me, acknowledged the said writing to be the act and deed of the said corporation.
25. Given under my hand this Sara C. Mundy day of June 20 16.
26. Notary Seal Notary Public Commonwealth of Virginia Registration Number 295472 (Notary Public)
27. Sara C. Mundy
28. My commission expires on the 30th day of November 20 16.

Sufficiency in Form and Manner Of Execution Approved

This _____ day of _____ 20 ___

Attorney General

By _____
(Assistant Attorney General)

THE CINCINNATI INSURANCE COMPANY

Fairfield, Ohio

POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS: That THE CINCINNATI INSURANCE COMPANY, a corporation organized under the laws of the State of Ohio, and having its principal office in the City of Fairfield, Ohio, does hereby constitute and appoint
E. Gerald Stump; William E. Haynie; Mark B. Stump; Paula B. Gibson; Samuel A. Lowman, Jr.; Mike Repass; Timothy Merry; Jamie Latham; Jacob M. Stump; Amy Glover; Angela Shively; Stacie Gray; Marc Turner and/or Stacy Hall **each in their separate capacity.**
of Salem and Midlothian, Virginia its true and lawful Attorney(s)-in-Fact to sign, execute, seal and deliver on its behalf as Surety, and as its act and deed, any and all bonds, policies, undertakings, or other like instruments, as follows:

Any such obligations in the United States, up to
Twenty Million and No/100 Dollars ($20,000,000.00).

This appointment is made under and by authority of the following resolution passed by the Board of Directors of said Company at a meeting held in the principal office of the Company, a quorum being present and voting, on the 6th day of December, 1958, which resolution is still in effect:

"RESOLVED, that the President or any Vice President be hereby authorized, and empowered to appoint Attorneys-in-Fact of the Company to execute any and all bonds, policies, undertakings, or other like instruments on behalf of the Corporation, and may authorize any officer or any such Attorney-in-Fact to affix the corporate seal; and may with or without cause modify or revoke any such appointment or authority. Any such writings so executed by such Attorneys-in-Fact shall be binding upon the Company as if they had been duly executed and acknowledged by the regularly elected officers of the Company."

This Power of Attorney is signed and sealed by facsimile under and by the authority of the following Resolution adopted by the Board of Directors of the Company at a meeting duly called and held on the 7th day of December, 1973.

"RESOLVED, that the signature of the President or a Vice President and the seal of the Company may be affixed by facsimile on any power of attorney granted, and the signature of the Secretary or Assistant Secretary and the seal of the Company may be affixed by facsimile to any certificate of any such power and any such power of certificate bearing such facsimile signature and seal shall be valid and binding on the Company. Any such power so executed and sealed and certified by certificate so executed and sealed shall, with respect to any bond or undertaking to which it is attached, continue to be valid and binding on the Company."

IN WITNESS WHEREOF, THE CINCINNATI INSURANCE COMPANY has caused these presents to be sealed with its corporate seal, duly attested by its Vice President this 1st day of October, 2015.

The Cincinnati Insurance Company CORPORATE SEAL OHIO

THE CINCINNATI INSURANCE COMPANY

Stephen A. Jutte

Vice President

STATE OF OHIO) ss:
COUNTY OF BUTLER)

On this 1st day of October, 2015, before me came the above-named Vice President of THE CINCINNATI INSURANCE COMPANY, to me personally known to be the officer described herein, and acknowledged that the seal affixed to the preceding instrument is the corporate seal of said Company and the corporate seal and the signature of the officer were duly affixed and subscribed to said instrument by the authority and direction of said corporation.

NOTARIAL SEAL STATE OF OHIO

Mark J. Huller

MARK J. HULLER, Attorney at Law
NOTARY PUBLIC - STATE OF OHIO
My commission has no expiration date. Section 147.03 O.R.C.

I, the undersigned Secretary or Assistant Secretary of THE CINCINNATI INSURANCE COMPANY, hereby certify that the above is a true and correct copy of the Original Power of Attorney issued by said Company, and do hereby further certify that the said Power of Attorney is still in full force and effect.

GIVEN under my hand and seal of said Company at Fairfield, Ohio.
this 10th day of June 2016

The Cincinnati Insurance Company CORPORATE SEAL OHIO

Scott R Bolen

Secretary

BN-1005 (10/15)

SECTION 14

FINANCIAL

Financial Responsibility

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Environmental Protection

(4/25)

APPENDIX I

Requirement for Financial Responsibility to Plug/Abandon an Injection Well

To: WV Department of Environmental Protection
Office of Oil and Gas
601 57th Street, SE
Charleston, West Virginia 25304-2345
ATTN: Underground Injection Control Program

From: HG Energy, LLC.
5260 Dupont Road
Parkersburg, WV 26101

Date: November 7, 2017

Subject: Underground Injection Control (UIC) Permit Application
2D0610317
Requirement for Financial Responsibility

I, HG Energy, LLC., verify in accordance with 47CSR13-13.7.g., that I will maintain financial responsibility and resources to close, plug, and abandon underground injection wells(s) in a manner prescribed by the Chief of the Office of Oil and Gas.

Name: Eric Grayson

Signature:

Date: November 8, 2017

RECEIVED
Office of Oil and Gas

JUN 21 2018

WV Department of
Environmental Protection

APPENDIX I

Requirement for Financial Responsibility to Plug/Abandon an Injection Well

To: WV Department of Environmental Protection
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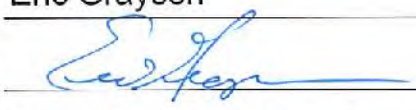
Signature: 

Date: November 8, 2017

SECTION 15

SITE SECURITY PLAN

APPENDIX J

APPENDIX J

Site Security for Commercial Facilities

Provide a detailed description of the method(s) utilized at the facility to restrict or prohibit illegal dumping of unauthorized waste or vandalism at the facility.

1. Complete enclosure of all wells, holding tank/pits and manifold assemblies within a chain link or other suitable fencing; and

2. Require that all gates and other entry points be locked when the facility is unattended; or

3. Providing tamper-proof seals for the master valve on each well (a "lock-out" or chain & padlock system would be more secure; however, these devices could create a potential safety hazard if the well needed to be quickly shut in due to an emergency); and

4. Installing locking caps on all valves and connections on holding tanks, unloading racks, and headers.

The Greer A-1 disposal facility is currently enclosed with a chain link fence. Access points (gates and other entry points) through the fencing are locked when the facility is unattended.

SECTION 16

ADDITIONAL INFORMATION

APPENDIX K

APPENDIX K

Identify permit or construction approvals received or applied for under the following programs:

Permit/approvals	ID Number
Hazardous Waste Management Program under RCRA	None
NPDES Program	None
Prevention of Significant Deterioration (PSD)	None
Nonattainment Program	None
Dredge or Fill	None
NPDES/NPDES – Stormwater	None
WVDEP – Office of Waste Management (OWM) – Solid Waste Facility	None
WVDEP – OWM – RCRA (Hazardous Waste TSD or Transporter)	None
WVDEP – OWM – UST	None
CERCLA – Superfund	None
WV Voluntary Remediation – Brownfields	None
FIFRA – Federal Insecticide, Fungicide and Rodenticide Act	None
Well Head Protection Program (WHPP)	None
Underground Injection Control (UIC)	2D0610317
Toxic Substances Control Act (TSCA)	None
Best Management Plans	None
Management of Used Oil	None
Other Relevant Permits (Specify):	

HG Energy, LLC
5260 Dupont Road
Parkersburg, WV 26101
(304) 420-1100 - Office
(304) 863-3172 - Fax

VIA UNITED POSTAL SERVICE

Mr. Justin E. Nottingham
West Virginia Department of Environmental Protection
Office of Oil and Gas
Environmental Resources Analyst
601 57th Street, S.E.
Charleston, WV 25304

December 7, 2017

RE: HG Energy UIC Permit Renewal - Greer A-1- Permit # 2D0610317

Justin,

Attached is the final analytical for the radiation analysis of the injection water along with the updated Section 9 with the data listed.

Also included are the initial pages of the application. HG paid the application fees electronically and therefore updated the initial pages of the application to reflect that payment.

Should you have any questions or require any additional information, please feel free to contact me at 304-420-1126 or by e-mail at mmcguire@hgenergyllc.com.

Sincerely,

Matthew J. McGuire, P.G.
ESHR Director

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CHECKLIST FOR FILING A UIC PERMIT APPLICATION

Please utilize this checklist to ensure you have prepared, completed, and enclosed all required documentation and payment to ensure a timely review of your submittal.

Operator	HG Energy, LLC.		
Existing UIC Permit ID Number	2D0610317	UIC Well API Number	47-061-00317

Office of Oil and Gas Office Use Only	
Permit Reviewer	
Date Received	
Administratively Complete Date	
Approved Date	
Permit Issued	

Please check the fees and payment included.

Fees		Payment Type	
UIC Permit Fee: $500	✓	Check	
Groundwater Protection Plan (GPP) Fee: $50.00	✓	Electronic	✓
		Other	

Please check the items completed and enclosed.

- ✓ Checklist
- ✓ UIC-1
  - ✓ Section 1 – Facility Information
  - ✓ Section 2 – Operator Information
  - ✓ Section 3 – Application Information
  - ✓ Section 4 – Applicant/Activity Request and Type
  - ✓ Section 5 – Brief description of the Nature of the Business
  - ✓ CERTIFICATION
- ✓ Section 6 – Construction
  - ✓ Appendix A Injection Well Form
  - ✓ Appendix B Storage Tank Inventory
- ✓ Section 7 – Area of Review
  - ✓ Appendix C Wells Within the Area of Review

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- [x] Appendix D Public Service District Affidavit
- [x] Appendix E Water Sources
- [ ] Appendix F Area Permit Wells
- [x] Section 8 – Geological Data on Injection and Confining Zones
- [x] Section 9 – Operating Requirements / Data
  - [x] Appendix G Wells Serviced by Injection Well
- [x] Section 10 – Monitoring
- [x] Section 11 – Groundwater Protection Plan (GPP)
  - [x] Appendix H Groundwater Protection Plan (GPP)
- [x] Section 12 – Plugging and Abandonment
- [x] Section 13 – Additional Bonding
- [x] Section 14 – Financial Responsibility
  - [x] Appendix I Financial Responsibility
- [x] Section 15 – Site Security Plan
  - [x] Appendix J Site Security for Commercial Wells
- [x] Section 16 – Additional Information
  - [x] Appendix K Other Permit Approvals

NOTE: For all 2D wells an additional bond in the amount of $5,000 is required.

Reviewed by (Print Name): Matthew J. McGuire

Reviewed by (Sign):

Date Reviewed: 12/7/17

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Environmental Protection

dep

SECTION 9: OPERATING REQUIREMENTS / DATA

1) Proposed Operating Data:

   A. Average daily rate or volume of fluid to be injected = 300 barrels
   B. Maximum daily rate or volume of fluid to be injected = 500 barrels
   C. Average injection pressure = 2,500 psi
   D. Maximum injection pressure = 2,682 psi

2) The list of all wells by API number to be serviced by the brine disposal well is included in **Appendix G**.

3) The physical and chemical characteristics of the injection fluid are as follows and the analytical results of the sample collected is attached:

pH	9	
Chloride	126000	mg/L
TSS	320	mg/L
TDS	234680	mg/L
Spec. Gravity	1.1558	calc.
Sulfate	760	mg/L
MBAS	0.54	mg/L
TOC	427	mg/L
Aluminum	ND	mg/L
Arsenic	ND	mg/L
Barium	5050	mg/L
Calcium	20770	mg/L
Iron	137	mg/L
Manganese	5.23	mg/L
Sodium	56900	mg/L
TPH-Diesel Range	16.3	mg/L
TPH-Oil Range	2.24	mg/L
TPH Gasoline Range	ND	mg/L
Methane	0.135	mg/L
Ethane	ND	mg/L
Propane	ND	mg/L
Butane	ND	mg/L
Benzene	ND	mg/L
Toluene	ND	mg/L
Ethylbenzene	ND	mg/L
m,p-Xylene	ND	mg/L
o-Xylene	ND	mg/L

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Total Coliform	Present	
E Coli	Absent	
Gross Alpha	7,497 (+/- 1,873)	pCi/L
Gross Beta	2,829 (+/- 975)	pCi/L
Radium 226	7,361.1 (+/- 1,090)	pCi/L
Radium 228	1,401.6 (+/- 177.11)	pCi/L

4) The following injection fluid additives will be used during operations and the Safety Data Sheet for each chemical (SDS) is attached:

   a. Scale Inhibitor at 250PPM to 500PPM
   b. Wetting Agent (Iron Oxide Control Compound) at 250PPM to 500PPM

5) The fluid in the annulus between the tubing and the casing is produced water. The fluid level is estimated to be at 2,575'. A SDS of produced water is attached.

6) **Contingency Plan**:
   In the event of a well failure, operations would immediately cease and the well would be shut in. The freshwater casing installed in the well would prevent migration of fluid into any Underground Source of Drinking Water (USDW). Production fluid to be disposed of would be transferred / rerouted to a permitted underground injection commercial disposal facility.

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DEC 8 2017
WV Department of
Environmental Protection

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

December 05, 2017

Ms. Laurie Hiles
Sturm Environmental Services
P.O. Box 650
Bridgeport, WV 26330

RE: Project: 17009
Pace Project No.: 30235725
H.G. ENERGY, LLC.

Dear Ms. Hiles:
Enclosed are the analytical results for sample(s) received by the laboratory on November 10, 2017. The results relate only to the samples included in this report. Results reported herein conform to the most current, applicable TNI/NELAC standards and the laboratory's Quality Assurance Manual, where applicable, unless otherwise noted in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Samantha Bayura

Samantha Bayura
samantha.bayura@pacelabs.com
(724)850-5622
Project Manager

Enclosures

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DEC 8 2017
WV Department of
Environmental Protection

Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

CERTIFICATIONS

Project: 17009
Pace Project No.: 30235725

H.G. ENERGY, LLC.

Pennsylvania Certification IDs

1638 Roseytown Rd Suites 2,3&4, Greensburg, PA 15601
L-A-B DOD-ELAP Accreditation #: L2417
Alabama Certification #: 41590
Arizona Certification #: AZ0734
Arkansas Certification
California Certification #: 04222CA
Colorado Certification
Connecticut Certification #: PH-0694
Delaware Certification
Florida/TNI Certification #: E87683
Georgia Certification #: C040
Guam Certification
Hawaii Certification
Idaho Certification
Illinois Certification
Indiana Certification
Iowa Certification #: 391
Kansas/TNI Certification #: E-10358
Kentucky Certification #: 90133
Louisiana DHH/TNI Certification #: LA140008
Louisiana DEQ/TNI Certification #: 4086
Maine Certification #: PA00091
Maryland Certification #: 308
Massachusetts Certification #: M-PA1457
Michigan/PADEP Certification
Missouri Certification #: 235
Montana Certification #: Cert 0082
Nebraska Certification #: NE-05-29-14
Nevada Certification #: PA014572015-1
New Hampshire/TNI Certification #: 2976
New Jersey/TNI Certification #: PA 051
New Mexico Certification #: PA01457
New York/TNI Certification #: 10888
North Carolina Certification #: 42706
North Dakota Certification #: R-190
Oregon/TNI Certification #: PA200002
Pennsylvania/TNI Certification #: 65-00282
Puerto Rico Certification #: PA01457
Rhode Island Certification #: 65-00282
South Dakota Certification
Tennessee Certification #: TN2867
Texas/TNI Certification #: T104704188-14-8
Utah/TNI Certification #: PA014572015-5
USDA Soil Permit #: P330-14-00213
Vermont Dept. of Health: ID# VT-0282
Virgin Island/PADEP Certification
Virginia/VELAP Certification #: 460198
Washington Certification #: C868
West Virginia DEP Certification #: 143
West Virginia DHHR Certification #: 9964C
Wisconsin Certification
Wyoming Certification #: 8TMS-L

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Pace Analytical Services, LLC
1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

SAMPLE SUMMARY

Project: 17009
Pace Project No.: 30235725
H.G. ENERGY, LLC.

Lab ID	Sample ID	Matrix	Date Collected	Date Received
30235725001	17009	Water	11/06/17 09:00	11/10/17 10:30

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Greensburg, PA 15601
(724)850-5600

SAMPLE ANALYTE COUNT

Project: 17009
Pace Project No.: 30235725
H.G. ENERGY, LLC.

Lab ID	Sample ID	Method	Analysts	Analytes Reported
30235725001	17009	EPA 900.0	NEG	2
		EPA 901.1	RMK	2

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REPORT OF LABORATORY ANALYSIS

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1638 Roseytown Road - Suites 2,3,4
Greensburg, PA 15601
(724)850-5600

PROJECT NARRATIVE

Project: 17009
Pace Project No.: 30235725 H.G. ENERGY, LLC.

Method: EPA 900.0
Description: 900.0 Gross Alpha/Beta
Client: Sturm Environmental Sevices
Date: December 05, 2017

General Information:
1 sample was analyzed for EPA 900 0. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

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(724)850-5600

PROJECT NARRATIVE

Project: 17009
Pace Project No.: 30235725 H.G. ENERGY, LLC.

Method: EPA 901.1
Description: 901.1 Gamma Spec
Client: Sturm Environmental Sevices
Date: December 05, 2017

General Information:
1 sample was analyzed for EPA 901.1. All samples were received in acceptable condition with any exceptions noted below or on the chain-of custody and/or the sample condition upon receipt form (SCUR) attached at the end of this report.

Hold Time:
The samples were analyzed within the method required hold times with any exceptions noted below.

Method Blank:
All analytes were below the report limit in the method blank, where applicable, with any exceptions noted below.

Laboratory Control Spike:
All laboratory control spike compounds were within QC limits with any exceptions noted below.

Matrix Spikes:
All percent recoveries and relative percent differences (RPDs) were within acceptance criteria with any exceptions noted below.

Additional Comments:

This data package has been reviewed for quality and completeness and is approved for release.

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ANALYTICAL RESULTS - RADIOCHEMISTRY

Project: 17009
Pace Project No.: 30235725 H.G. ENERGY, LLC. GREER A-1

Sample: 17009 **Lab ID: 30235725001** Collected: 11/06/17 09:00 Received: 11/10/17 10:30 Matrix: Water
PWS: Site ID: Sample Type:

Comments: • Collection date/time not listed on sample containers.

Parameters	Method	Act ± Unc (MDC) Carr Trac	Units	Analyzed	CAS No.	Qual
Gross Alpha	EPA 900.0	**7,497 ± 1,873 (1,568) C:NA T:NA**	pCi/L	11/21/17 19:00	12587-46-1	
Gross Beta	EPA 900.0	**2,629 ± 975 (1,294) C:NA T:NA**	pCi/L	11/21/17 19:00	12587-47-2	
Radium-226	EPA 901.1	**7361.100 ± 1090.000 (736.700) C:NA T:NA**	pCi/L	12/05/17 12:24	13982-63-3	
Radium-228	EPA 901.1	**1401.600 ± 177.110 (95.090) C:NA T:NA**	pCi/L	12/05/17 12:24	15262-20-1	

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 17009
Pace Project No.: 30235725 H.G. ENERGY, LLC.

QC Batch: 280959 Analysis Method: EPA 901.1
QC Batch Method: EPA 901.1 Analysis Description: 901.1 Gamma Spec
Associated Lab Samples: 30235725001

METHOD BLANK: 1379235 Matrix: Water
Associated Lab Samples: 30235725001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Radium-226	13.398 ± 170.300 (213.300) C:NA T:NA	pCi/L	12/04/17 11:20	
Radium-228	0.000 ± 11.264 (32.150) C:NA T:NA	pCi/L	12/04/17 11:20	

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Results presented on this page are in the units indicated by the "Units" column except where an alternate unit is presented to the right of the result.

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QUALITY CONTROL - RADIOCHEMISTRY

Project: 17009
Pace Project No.: 30235725 H.G. ENERGY, LLC.

QC Batch: 279312 Analysis Method: EPA 900.0
QC Batch Method: EPA 900.0 Analysis Description: 900.0 Gross Alpha/Beta
Associated Lab Samples: 30235725001

METHOD BLANK: 1371542 Matrix: Water
Associated Lab Samples: 30235725001

Parameter	Act ± Unc (MDC) Carr Trac	Units	Analyzed	Qualifiers
Gross Alpha	-0.332 ± 0.420 (1.44) C:NA T:NA	pCi/L	11/22/17 09:32	
Gross Beta	0.437 ± 0.741 (1.70) C:NA T:NA	pCi/L	11/22/17 09:32	

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REPORT OF LABORATORY ANALYSIS

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QUALIFIERS

Project: 17009
Pace Project No.: 30235725
H.G. ENERGY, LLC.

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to dilution of the sample aliquot.

ND - Not Detected at or above adjusted reporting limit.

TNTC - Too Numerous To Count

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

PQL - Practical Quantitation Limit.

RL - Reporting Limit.

S - Surrogate

1,2-Diphenylhydrazine decomposes to and cannot be separated from Azobenzene using Method 8270. The result for each analyte is a combined concentration.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

NC - Not Calculable.

SG - Silica Gel - Clean-Up

U - Indicates the compound was analyzed for, but not detected.

N-Nitrosodiphenylamine decomposes and cannot be separated from Diphenylamine using Method 8270. The result reported for each analyte is a combined concentration.

Act - Activity

Unc - Uncertainty: SDWA = 1.96 sigma count uncertainty, all other matrices = Expanded Uncertainty (95% confidence interval). Gamma Spec = Expanded Uncertainty (95.4% Confidence Interval)

(MDC) - Minimum Detectable Concentration

Trac - Tracer Recovery (%)

Carr - Carrier Recovery (%)

Pace Analytical is TNI accredited. Contact your Pace PM for the current list of accredited analytes.

TNI - The NELAC Institute.

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CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

1756237

Section A Required Client Information:

Company: Sturm Environmental
Address: PO Box 650
Bridgeport, WV 26330
Email To: [illegible]@sturmenvironmental
Phone: 304-623-6549 Fax: 304-623-6555
Requested Due Date/TAT: 11/16/17

Section B Required Project Information:

Report To: + Invoice mhaas@sturmenvironmental.com
Copy To:
Purchase Order No.: 7728
Project Name:
Project Number:

Section C Invoice Information:

Attention:
Company Name:
Address:
Pace Quote Reference:
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☒ GROUND WATER ☐ DRINKING WATER
☐ UST ☐ RCRA ☐ OTHER

Site Location STATE: WV

Section D Required Client Information

Matrix Codes MATRIX / CODE: Drinking Water DW, Water WT, Waste Water WW, Product P, Soil/Solid SL, Oil OL, Wipe WP, Air AR, Tissue TS, Other OT

SAMPLE ID (A-Z, 0-9 / ,-) Sample IDs MUST BE UNIQUE

Collected: Grab

ITEM #	SAMPLE ID	MATRIX CODE	SAMPLE TYPE (G=GRAB C=COMP)	COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Analysis Test Y/N	Gross Alpha/Beta (N)	Radium 226 (N)	Radium 228 (N)	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1	17009	WT	G	11/6/17	0900				3			X							X	X	X	N	001
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							
11																							
12																							

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ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS			
	K. Hinkel / Sturm Environmental	11/8/17	PM	[signature]	11/10/17	1030	N/A	N	N	Y
	Iced									

WO# : 30235725

30235725

SAMPLER NAME AND SIGNATURE
PRINT Name of SAMPLER: L. Bartlett M. McGuire
SIGNATURE of SAMPLER:
DATE Signed (MM/DD/YY):

Temp in °C | Received on Ice (Y/N) | Custody Sealed Cooler (Y/N) | Samples Intact (Y/N)

*Important Note: By signing this form you are accepting Pace's NET 30 day payment terms and agreeing to late charges of 1.5% per month for any invoices not paid within 30 days.

F-ALL-Q-020rev.07, 15-May-2007

Pittsburgh Lab Sample Condition Upon Receipt

Pace Analytical

Client Name: Storm Env. Project # 30235725

Courier: ☐ Fed Ex ☑ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other _____

Label ZH
LIMS Login ANK

Tracking #: 1Z8127710377759461

Custody Seal on Cooler/Box Present: ☐ yes ☑ no Seals intact: ☐ yes ☐ no

Thermometer Used N/A Type of Ice: Wet Blue (None)

Cooler Temperature Observed Temp — °C Correction Factor: — °C Final Temp: — °C

Temp should be above freezing to 6°C

Date and initials of person examining contents: ZH 11/10/17

Comments:	Yes	No	N/A	
Chain of Custody Present:	✓			1.
Chain of Custody Filled Out:	✓			2.
Chain of Custody Relinquished:	✓			3.
Sampler Name & Signature on COC:		✓		4.
Sample Labels match COC: -Includes date/time/ID Matrix: WT		✓		5. no date/time on samples
Samples Arrived within Hold Time:	✓			6.
Short Hold Time Analysis (<72hr remaining):		✓		7.
Rush Turn Around Time Requested:		✓		8.
Sufficient Volume.	✓			9.
Correct Containers Used: -Pace Containers Used:	✓	✓		10.
Containers Intact:	✓			11.
Orthophosphate field filtered			✓	12.
Hex Cr Aqueous Compliance/NPDES sample field filtered			✓	13.
Organic Samples checked for dechlorination:			✓	14.
Filtered volume received for Dissolved tests			✓	15.
All containers have been checked for preservation.	✓			16. pH ≤ 2
All containers needing preservation are found to be in compliance with EPA recommendation. exceptions: VOA, coliform, TOC, O&G, Phenolics	✓			Initial when completed ZH Date/time of preservation Lot # of added preservative
Headspace in VOA Vials (>6mm):			✓	17.
Trip Blank Present:			✓	18.
Trip Blank Custody Seals Present			✓	
Rad Aqueous Samples Screened > 0.5 mrem/hr		✓		Initial when completed: ZH Date: 11/10/17

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Client Notification/ Resolution:

Person Contacted: _____ Date/Time: _____ Contacted By: _____

Comments/ Resolution: _____

☐ A check in this box indicates that additional information has been stored in ereports.

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e. out of hold, incorrect preservative, out of temp, incorrect containers)

*PM review is documented electronically in LIMS. When the Project Manager closes the SRF Review schedule in LIMS. The review is in the Status section of the Workorder Edit Screen.

STURM ENVIRONMENTAL SERVICES

Main Office:
STURM ENVIRONMENTAL SERVICES
BRUSHY FORK ROAD
P.O. BOX 650
BRIDGEPORT, WV 26330
PHONE: 304-623-6549
FAX: 304-623-6552

STURM ENVIRONMENTAL SERVICES
610 D STREET
P.O. BOX 8337
SO. CHARLESTON, WV 25303
PHONE: 304-744-9864
FAX: 304-744-7866

REPORT TO: Client Name: HG Energy, LLC
Address: 5260 Dupont Road
City/State/Zip: Parkersburg, WV 26101
Contact Person: Matt McGuire
Telephone Number: 3044201126 Fax No.
Email Address: MMcguire@hgenergyllc.com
Sampler Name: (Print) Matt McGuire
Sampler Signature:
Project Name: Greer A-1 SWD
Special Reporting: [X] Email Results [ ] Fax Results

BILL TO: Client Name: Same
Address:
City/State/Zip:
Contact Person:
Telephone Number: Fax No.
Email Address:
Purchase Order #:
TURN AROUND TIME: [X] Standard By Nov. 16th 2017
[ ] RUSH (pre-scheduled; surcharges may apply) *Please Check One*
[ ] Date Needed

1 DAY	2 DAY	3 DAY

Sample ID / Description	COMPOSITE SAMPLE: START DATE	START TIME	END DATE	END TIME	GRAB SAMPLE: DATE	TIME	PRESERVATIVE: Ice	OTHER	HCl	NaOH	H_2SO_4 Plastic	H_2SO_4 Glass	None	HNO_3	MATRIX: Groundwater	Wastewater	Drinking Water	Sludge	Soil	Other (specify):	ANALYZE FOR: See attached	# of Bottles	Flow (gpm, cfs, mgd) circle one	Field pH	Field Conductivity	Field DO	Field Chlorine (mg/L or ug/L) circle one	Field Temp (F° or C°) circle one
Greer A-1 Injection Water					11/6/17	0900	X	X			X		X	X						X	X	12						

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Comments

Records retained for 5 years

Laboratory Comments:
Temperature Upon Receipt: 26
Bottles Preserved? Y N

Relinquished by:	Date	Time	Received by:	Date	Time
	11/6/17	1023		11/6/17	1023
Relinquished by:	Date	Time	Received by:	Date	Time

coiliert # 860 17