PAS2D217BWAR

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency

Underground Injection Control Permit Application

(Collected under the authority of the Safe Drinking Water Act. Sections 1421, 1422, 40 CFR 144)

I. EPA I.D. Number

	T/A	C
U		

Read Attached Instructions Before Starting

For Official Use Only

Application approved (mo day year)	Date received (mo day year)	Permit Number	Well ID	FINDS Number

II. Owner Name and Address

Owner Name: Bear Lake Properties, LLC
Street Address: 3000 Village Run Road, Unit 103, #223
Phone Number: (724) 444-7501
City: Wexford
State: PA
ZIP CODE: 15090

III. Operator Name and Address

Owner Name: Bear Lake Properties, LLC
Street Address: 3000 Village Run Road, Unit 103, #223
Phone Number: (724) 444-7501
City: Wexford
State: PA
ZIP CODE: 15090

IV. Commercial Facility	V. Ownership	VI. Legal Contact	VII. SIC Codes
[x] Yes [ ] No	[x] Private [ ] Federal [ ] Other	[ ] Owner [x] Operator	1389 - Oil and Gas Field Services, Not Elsewhere Classified

VIII. Well Status *(Mark "x")*

[ ] A. Operating — Date Started (mo day year):
[x] B. Modification/Conversion
[ ] C. Proposed

IX. Type of Permit Requested *(Mark "x" and specify if required)*

	Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
[x] A. Individual [ ] B. Area	1		Bittinger #2 #217

X. Class and Type of Well *(see reverse)*

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
II	D		

XI. Location of Well(s) or Approximate Center of Field or Project

Latitude Deg	Latitude Min	Latitude Sec	Longitude Deg	Longitude Min	Longitude Sec	Township and Range Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
41	59	50.2	79	32	07.5								

XII. Indian Lands *(Mark "x")*

[ ] Yes
[x] No

XIII. Attachments

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A–U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

XIV. Certification

I certify under the 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. (Ref. 40 CFR 144.32)

A. Name and Title *(Type or Print)*: Karl Kimmich, President

B. Phone No. *(Area Code and No.)*: (724) 444-7501

C. Signature: Karl C. Kimmich

D. Date Signed: 1/8/2014

EPA Form 7520-6 (Rev. 12-08)

41.997278 -79.53547

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Bittinger #2 Well
Columbus Township, Warren County, PA

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OMB No. 2040-0042 Approval Expires 12/31/2011

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Read Attached Instructions Before Starting

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Application approved (mo day year)	Date received (mo day year)	Permit Number	Well ID	FINDS Number

Owner Name			Owner Name		
Bear Lake Properties, LLC			Bear Lake Properties, LLC		
Street Address		Phone Number	Street Address		Phone Number
3000 Village Run Road, Unit 103, #223		(724) 444-7501	3000 Village Run Road, Unit 103, #223		(724) 444-7501
City	State	ZIP CODE	City	State	ZIP CODE
Wexford	PA	15090	Wexford	PA	15090

- [x] Yes
- [ ] No

- [x] Private
- [ ] Federal
- [ ] Other

- [ ] Owner
- [x] Operator

1389 - Oil and Gas Field Services, Not Elsewhere Classified

- [ ] A. Operating — Date Started (mo day year):
- [x] B. Modification/Conversion
- [ ] C. Proposed

- [x] A. Individual
- [ ] B. Area

Number of Existing Wells	Number of Proposed Wells	Name(s) of field(s) or project(s)
1		Bittinger #2

A. Class(es) (enter code(s))	B. Type(s) (enter code(s))	C. If class is "other" or type is code 'x,' explain	D. Number of wells per type (if area permit)
II	D		

Latitude			Longitude			Township and Range							
Deg	Min	Sec	Deg	Min	Sec	Sec	Twp	Range	1/4 Sec	Feet From	Line	Feet From	Line
41	59	50.2	79	32	07.5								

- [ ] Yes
- [x] No

(Complete the following questions on a separate sheet(s) and number accordingly; see instructions)

For Classes I, II, III, (and other classes) complete and submit on a separate sheet(s) Attachments A–U (pp 2-6) as appropriate. Attach maps where required. List attachments by letter which are applicable and are included with your application.

I certify under the 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. (Ref. 40 CFR 144.32)

A. Name and Title *(Type or Print)*	B. Phone No. *(Area Code and No.)*
Karl Kimmich, President	(724) 444-7501
C. Signature	D. Date Signed
Karl C. Kimmich	1/8/2014

EPA Form 7520-6 (Rev. 12-08)

Well Class and Type Codes

Class I		Wells used to inject waste below the deepest underground source of drinking water.
Type	**"I"**	Nonhazardous industrial disposal well
	"M"	Nonhazardous municipal disposal well
	"W"	Hazardous waste disposal well injecting below USDWs
	"X"	Other Class I wells (not included in Type "I," "M," or "W")
Class II		Oil and gas production and storage related injection wells.
Type	**"D"**	Produced fluid disposal well
	"R"	Enhanced recovery well
	"H"	Hydrocarbon storage well (excluding natural gas)
	"X"	Other Class II wells (not included in Type "D," "R," or "H")
Class III		Special process injection wells.
Type	**"G"**	Solution mining well
	"S"	Sulfur mining well by Frasch process
	"U"	Uranium mining well (excluding solution mining of conventional mines)
	"X"	Other Class III wells (not included in Type "G," "S," or "U")

Other Classes Wells not included in classes above.
Class V wells which may be permitted under §144.12.
Wells not currently classified as Class I, II, III, or V.

Attachments to Permit Application

Class	**Attachments**
I new well	A, B, C, D, F, H – S, U
existing	A, B, C, D, F, H – U
II new well	A, B, C, E, G, H, M, Q, R; optional – I, J, K, O, P, U
existing	A, E, G, H, M, Q, R, – U; optional – J, K, O, P, Q
III new well	A, B, C, D, F, H, I, J, K, M – S, U
existing	A, B, C, D, F, H, J, K, M – U
Other Classes	To be specified by the permitting authority

INSTRUCTIONS - Underground Injection Control (UIC) Permit Application

Paperwork Reduction Act: The public reporting and record keeping burden for this collection of information is estimated to average 224 hours for a Class I hazardous well application, 110 hours for a Class I non-hazardous well application, 67 hours for a Class II well application, and 132 hours for a Class III well application. Burden means the total time, effort, or financial resource expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal Agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822), 1200 Pennsylvania Ave., NW, Washington, DC 20460. Include the OMB control number in any correspondence. Do not send the completed forms to this address.

This form must be completed by all owners or operators of Class I, II, and III injection wells and others who may be directed to apply for permit by the Director.

I. **EPA I.D. NUMBER** - Fill in your EPA Identification Number. If you do not have a number, leave blank.

II. **OWNER NAME AND ADDRESS** - Name of well, well field or company and address.

III. **OPERATOR NAME AND ADDRESS** - Name and address of operator of well or well field.

IV. **COMMERCIAL FACILITY** - Mark the appropriate box to indicate the type of facility.

V. **OWNERSHIP** - Mark the appropriate box to indicate the type of ownership.

VI. **LEGAL CONTACT** - Mark the appropriate box.

VII. **SIC CODES** - List at least one and no more than four Standard Industrial Classification (SIC) Codes that best describe the nature of the business in order of priority.

VIII. **WELL STATUS** - Mark Box A if the well(s) were operating as injection wells on the effective date of the UIC Program for the State. Mark Box B if wells(s) existed on the effective date of the UIC Program for the State but were not utilized for injection. Box C should be marked if the application is for an underground injection project not constructed or not completed by the effective date of the UIC Program for the State.

IX. **TYPE OF PERMIT** - Mark "Individual" or "Area" to indicate the type of permit desired. Note that area permits are at the discretion of the Director and that wells covered by an area permit must be at one site, under the control of one person and do not inject hazardous waste. If an area permit is requested the number of wells to be included in the permit must be specified and the wells described and identified by location. If the area has a commonly used name, such as the "Jay Field," submit the name in the space provided. In the case of a project or field which crosses State lines, it may be possible to consider an area permit if EPA has jurisdiction in both States. Each such case will be considered individually, if the owner/operator elects to seek an area permit.

X. **CLASS AND TYPE OF WELL** - Enter in these two positions the Class and type of injection well for which a permit is requested. Use the most pertinent code selected from the list on the reverse side of the application. When selecting type X please explain in the space provided.

XI. **LOCATION OF WELL** - Enter the latitude and longitude of the existing or proposed well expressed in degrees, minutes, and seconds or the location by township, and range, and section, as required by 40 CFR Part 146. If an area permit is being requested, give the latitude and longitude of the approximate center of the area.

XII. **INDIAN LANDS** - Place an "X" in the box if any part of the facility is located on Indian lands.

XIII. **ATTACHMENTS** - Note that information requirements vary depending on the injection well class and status. Attachments for Class I, II, III are described on pages 4 and 5 of this document and listed by Class on page 2. Place EPA ID number in the upper right hand corner of each page of the Attachments.

XIV. **CERTIFICATION** - All permit applications (except Class II) 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, and by a principal executive or ranking elected official for a public agency. For Class II, the person described above should sign, or a representative duly authorized in writing.

Attachments to be submitted with permit application for Class I, II, III and other wells.

A. AREA OF REVIEW METHODS - Give the methods and, if appropriate, the calculations used to determine the size of the area of review (fixed radius or equation). The area of review shall be a fixed radius of 1/4 mile from the well bore unless the use of an equation is approved in advance by the Director.

B. MAPS OF WELL/AREA AND AREA OF REVIEW - Submit a topographic map, extending one mile beyond the property boundaries, showing the injection well(s) or project area for which a permit is sought and the applicable area of review. The map must show all intake and discharge structures and all hazardous waste treatment, storage, or disposal facilities. If the application is for an area permit, the map should show the distribution manifold (if applicable) applying injection fluid to all wells in the area, including all system monitoring points. Within the area of review, the map must show the following:

Class I

The number, or name, and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, and other pertinent surface features, including residences and roads, and faults, if known or suspected. In addition, the map must identify those wells, springs, other surface water bodies, and drinking water wells located within one quarter mile of the facility property boundary. Only information of public record is required to be included in this map;

Class II

In addition to requirements for Class I, include pertinent information known to the applicant. This requirement does not apply to existing Class II wells;

Class III

In addition to requirements for Class I, include public water systems and pertinent information known to the applicant.

C. CORRECTIVE ACTION PLAN AND WELL DATA - Submit a tabulation of data reasonably available from public records or otherwise known to the applicant on all wells within the area of review, including those on the map required in B, which penetrate the proposed injection zone. Such data shall include the following:

Class I

A description of each well's types, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require. In the case of new injection wells, include the corrective action proposed to be taken by the applicant under 40 CFR 144.55.

Class II

In addition to requirement for Class I, in the case of Class II wells operating over the fracture pressure of the injection formation, all known wells within the area of review which penetrate formations affected by the increase in pressure. This requirement does not apply to existing Class II wells.

Class III

In addition to requirements for Class I, the corrective action proposed under 40 CFR 144.55 for all Class III wells.

D. MAPS AND CROSS SECTION OF USDWs - Submit maps and cross sections indicating the vertical limits of all underground sources of drinking water within the area of review (both vertical and lateral limits for Class I), their position relative to the injection formation and the direction of water movement, where known, in every underground source of drinking water which may be affected by the proposed injection. (Does not apply to Class II wells.)

E. **NAME AND DEPTH OF USDWs (CLASS II)** - For Class II wells, submit geologic name, and depth to bottom of all underground sources of drinking water which may be affected by the injection.

F. **MAPS AND CROSS SECTIONS OF GEOLOGIC STRUCTURE OF AREA** - Submit maps and cross sections detailing the geologic structure of the local area (including the lithology of injection and confining intervals) and generalized maps and cross sections illustrating the regional geologic setting. (Does not apply to Class II wells.)

G. **GEOLOGICAL DATA ON INJECTION AND CONFINING ZONES (Class II)** - For Class II wells, submit appropriate geological data on the injection zone and confining zones including lithologic description, geological name, thickness, depth and fracture pressure.

H. **OPERATING DATA** - Submit the following proposed operating data for each well (including all those to be covered by area permits): (1) average and maximum daily rate and volume of the fluids to be injected; (2) average and maximum injection pressure; (3) nature of annulus fluid; (4) for Class I wells, source and analysis of the chemical, physical, radiological and biological characteristics, including density and corrosiveness, of injection fluids; (5) for Class II wells, source and analysis of the physical and chemical characteristics of the injection fluid; (6) for Class III wells, a qualitative analysis and ranges in concentrations of all constituents of injected fluids. If the information is proprietary, maximum concentrations only may be submitted, but all records must be retained.

I. **FORMATION TESTING PROGRAM** - Describe the proposed formation testing program. For Class I wells the program must be designed to obtain data on fluid pressure, temperature, fracture pressure, other physical, chemical, and radiological characteristics of the injection matrix and physical and chemical characteristics of the formation fluids.

For Class II wells the testing program must be designed to obtain data on fluid pressure, estimated fracture pressure, physical and chemical characteristics of the injection zone. (Does not apply to existing Class II wells or projects.)

For Class III wells the testing must be designed to obtain data on fluid pressure, fracture pressure, and physical and chemical characteristics of the formation fluids if the formation is naturally water bearing. Only fracture pressure is required if the program formation is not water bearing. (Does not apply to existing Class III wells or projects.)

J. **STIMULATION PROGRAM** - Outline any proposed stimulation program.

K. **INJECTION PROCEDURES** - Describe the proposed injection procedures including pump, surge, tank, etc.

L. **CONSTRUCTION PROCEDURES** - Discuss the construction procedures (according to §146.12 for Class I, §146.22 for Class II, and §146.32 for Class III) to be utilized. This should include details of the casing and cementing program, logging procedures, deviation checks, and the drilling, testing and coring program, and proposed annulus fluid. (Request and submission of justifying data must be made to use an alternative to packer for Class I.)

M. **CONSTRUCTION DETAILS** - Submit schematic or other appropriate drawings of the surface and subsurface construction details of the well.

N. **CHANGES IN INJECTED FLUID** - Discuss expected changes in pressure, native fluid displacement, and direction of movement of injection fluid. (Class III wells only.)

O. **PLANS FOR WELL FAILURES** - Outline contingency plans (proposed plans, if any, for Class II) to cope with all shut-ins or wells failures, so as to prevent migration of fluids into any USDW.

P. **MONITORING PROGRAM** - Discuss the planned monitoring program. This should be thorough, including maps showing the number and location of monitoring wells as appropriate and discussion of monitoring devices, sampling frequency, and parameters measured. If a manifold monitoring program is utilized, pursuant to §146.23(b)(5), describe the program and compare it to individual well monitoring.

Q. **PLUGGING AND ABANDONMENT PLAN** - Submit a plan for plugging and abandonment of the well including: (1) describe the type, number, and placement (including the elevation of the top and bottom) of plugs to be used; (2) describe the type, grade, and quantity of cement to be used; and (3) describe the method to be used to place plugs, including the method used to place the well in a state of static equilibrium prior to placement of the plugs. Also for a Class III well that underlies or is in an exempted aquifer, demonstrate adequate protection of USDWs. Submit this information on EPA Form 7520-14, Plugging and Abandonment Plan.

R. **NECESSARY RESOURCES** - Submit evidence such as a surety bond or financial statement to verify that the resources necessary to close, plug or abandon the well are available.

S. **AQUIFER EXEMPTIONS** - If an aquifer exemption is requested, submit data necessary to demonstrate that the aquifer meets the following criteria: (1) does not serve as a source of drinking water; (2) cannot now and will not in the future serve as a source of drinking water; and (3) the TDS content of the ground water is more than 3,000 and less than 10,000 mg/l and is not reasonably expected to supply a public water system. Data to demonstrate that the aquifer is expected to be mineral or hydrocarbon production, such as general description of the mining zone, analysis of the amenability of the mining zone to the proposed method, and time table for proposed development must also be included. For additional information on aquifer exemptions, see 40 CFR Sections 144.7 and 146.04.

T. **EXISTING EPA PERMITS** - List program and permit number of any existing EPA permits, for example, NPDES, PSD, RCRA, etc.

U. **DESCRIPTION OF BUSINESS** - Give a brief description of the nature of the business.

TETRA TECH

21335 Signal Hill Plaza, Suite 100, Sterling, VA 20164 703-444-7000 703-444-1685 (FAX)

TECHNICAL MEMORANDUM

TO: Dale Skoff, Tetra Tech NUS

FROM: Jeffrey Benegar

DATE: December 13, 2013

RE: Area of Review/Zone of Endangerment Analysis for Bittinger #2, #4, and #1 Well – Bear Lake Properties

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EXECUTIVE SUMMARY

This technical memorandum (TM) summarizes the analytical modeling we have performed for the area of review/zone of endangerment analysis for the scenario of injecting simultaneously at existing Bear Lake Properties UIC Class IID brine disposal wells Bittinger #1 and #4 and potential brine disposal well, Bittinger #2, all of which are located in Columbus Township, Warren County, Pennsylvania. (The Bittinger #1 and Bittinger #4 wells received their final UIC Class IID (Commercial) well permits in November 2012.) The relevant parameters for our analysis were obtained from Bear Lake Properties, LLC or estimated in the absence of any information. Our analysis is described in more detail below.

OVERVIEW AND METHODOLOGY

There are several methods proposed for calculating the zone of endangerment of an injection well. The most simplistic method is the use of a fixed radius, based on the type of injection well being permitted. Other methods involve calculation of the radius based on well and formation properties. Most regulatory agencies require the use of calculations to determine the zone of endangerment. The method used here is the graphical method first used by US EPA Region 6. It involves the calculation of the increase of pressure in the formation due to injection, then converting that pressure into equivalent feet of head. The increase in head in the formation due to injection is then compared to the equivalent head of the lowest most underground source of drinking water (USDW). When plotted graphically, the intersection of those two curves at some distance, r, determines the radius of the zone of endangerment.

The increase in pressure in the formation due to injection depends on the properties of the injection fluid and the formation, the rate of fluid injection, and the length of time of injection. The most common mathematical expression to describe this increase in pressure was developed by Matthews and Russell (1967). Matthews and Russell assume that, for a single well injecting into an infinite, homogeneous and isotropic, non-leaking formation, the increase in pressure (delta p) can be described as:

delta p = 162.6 $Q\mu$ / kh * [(log(kt / $\Phi\mu Cr^2$) – 3.23] where:

delta p = pressure change (psi) at radius, r and time, t
Q = injection rate (barrels/day)
μ = injectate viscosity (centipoise)
k = formation permeability (millidarcies)
h = formation thickness (feet)
t = time since injection began (hours)
C = compressibility (total, sum of water and rock compressibility) (psi^{-1})
r = radial distance from wellbore to point of investigation (feet)
Φ = average formation porosity (decimal)

PARAMETERS USED IN THE ANALYSIS

The following parameters were used in the zone of endangerment analysis. There are several parameters that are unknown, including injection rate and formation permeability. For injection rate, we used the average and maximum rates expected. For permeability, we estimated a value that is representative of the average of the upper and lower range of values for this parameter.

Bittinger #2 Medina Group Well
Q = 1000 (average rate) or 2000 (maximum rate) barrels/day
t = 10 years = 87,600 hours
μ = 1 centipoise
k = 100 md
h = 61 feet
C = 3.0e-06 psi^{-1}
Φ = 0.08
Specific gravity of injectate = 1.218
Surface elevation = 1621 feet
Depth to injection formation = 4279 feet
Base of lowest most USDW = 1321 feet
Initial pressure at top of injection formation = 128 psi

Bittinger #1 Medina Group Well
Q = 1000 (average rate) or 2000 (maximum rate) barrels/day*
t = 10 years = 87,600 hours
μ = 1 centipoise
k = 100 md
h = 61 feet
C = 3.0e-06 psi^{-1}
Φ = 0.08
Specific gravity of injectate = 1.218
Surface elevation = 1518 feet

Depth to injection formation = 4210 feet
Base of lowest most USDW = 1218 feet
Initial pressure at top of injection formation = 128 psi
*This well was permitted for 30,000 barrels/mo or approximately 1,000 barrels/day. A 2,000 barrels/day scenario was utilized as a conservative case in the event an injection rate increase may be approved by EPA in the future.

Bittinger #4 Medina Group Well
Q = 1000 (average rate) or 2000 (maximum rate) barrels/day*
t = 10 years = 87,600 hours
μ = 1 centipoise
k = 100 md
h = 61 feet
C = 3.0e-06 psi^{-1}
Φ = 0.08
Specific gravity of injectate = 1.218
Surface elevation = 1561 feet
Depth to injection formation = 4285 feet
Base of lowest most USDW = 1261 feet
Initial pressure at top of injection formation = 128 psi
*This well was permitted for 30,000 barrels/mo or approximately 1,000 barrels/day. A 2,000 barrels/day scenario was utilized as a conservative case in the event an injection rate increase may be approved by EPA in the future.

RESULTS

The Matthews and Russell equation was solved for various distances from the wellbore based on the parameters listed above. The distance between the Bittinger #1 and #4 well is approximately 1,300 feet. The distance between the Bittinger #1 and #2 well is approximately 2,000 feet, and the distance between the Bittinger #2 and #4 well is approximately 1,600 feet. The Matthews and Russell equation was used to calculate the increase in pressure in the formation with only one well injecting. This was done for all three Bittinger wells. Then, the calculated pressures for each Bittinger well were added together and this sum was added to the value of existing pressure in the injection formation to obtain the total pressure in the formation when all three wells are injecting.

These values were then converted to feet of head of formation brine. The values are plotted against distance from the wellbore and are shown in Figure 1 for the Bittinger wells for the two scenarios simulated (*e.g.*, 2 unknowns: 2 injection rates and 1 permeability value). The plot shows the calculated pressure surface within the injection formation, measured as feet of head of formation brine above the top of the injection formation. Also shown is the head of the lowest most USDW. Where the two lines intersect, the radius of the zone of endangerment can be estimated. The increase in head in the formation due to injection will remain below the elevation of the lowestmost USDW assuming even worst-case conditions (maximum injection rate of 2000 bpd).

CONCLUSIONS

Our analysis of the area of review/zone of endangerment for the Bittinger #1, #2, and #4 wells injecting together is based on a methodology typically used by US EPA. Based on the results, we believe the Bittinger #2 well is an excellent candidate for use as a brine disposal well. The increase in head in the formation due to injection will remain below the elevation of the lowestmost USDW. The standard fixed radius of ¼ mile can be used for the area of review/zone of endangerment for the Bittinger #2 well.

REFERENCES

Matthews, C.S., Russell, D.G., (1967) Pressure Buildup and Flow Tests in Wells, SPE Monograph Series, Volume 1, New York.

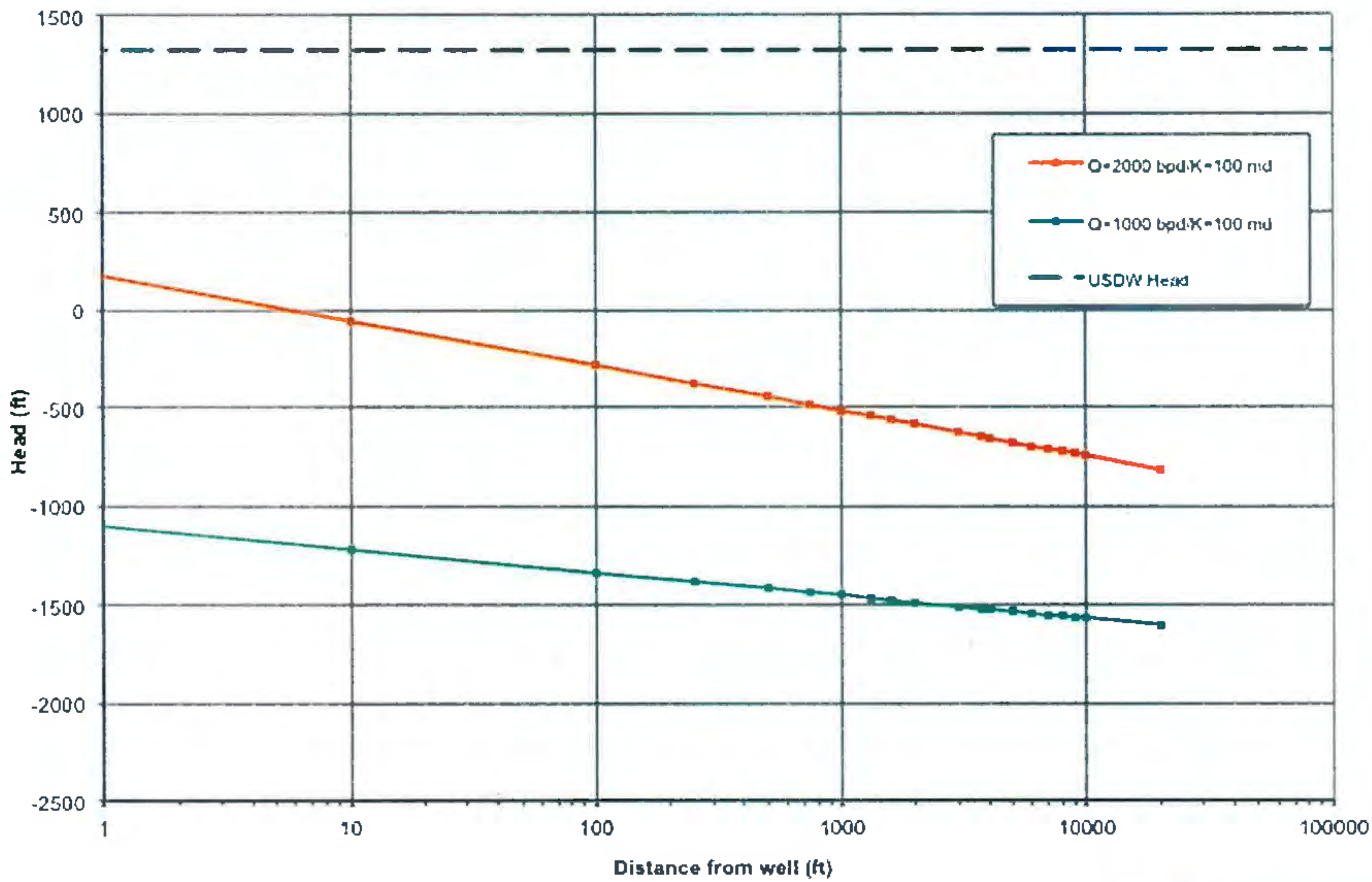


Figure 1. Feet of head of injection formation and USDW vs. distance from the well for Bittinger #1, #2, and #4 wells when all wells are injecting.

TETRA TECH, INC.

Section 2 – Maps of Well Area and Area of Review

According to publicly available records in the area, there are no intake or discharge structures, hazardous waste treatment, storage, or disposal facilities, mines, or quarries within one mile of the Bittinger #2 well. An intermittent unnamed tributary (UNT) to Tamarack Swamp is located approximately 0.5 miles southwest of the Bittinger #2 well. Tamarack Swamp is located approximately 1 mile southwest, Brokenstraw Creek is located approximately 0.7 miles west, and an UNT to Pine Valley Creek is located approximately 0.5 miles southeast of Bittinger #2.

According to publicly available records and a detailed survey inspection by foot, there are no groundwater wells or existing or abandoned oil and gas wells within the ¼ mile AOR for the Bittinger #2 well.

The names and addresses of residents located within ¼ mile of the proposed injection well are provided in Appendix A.

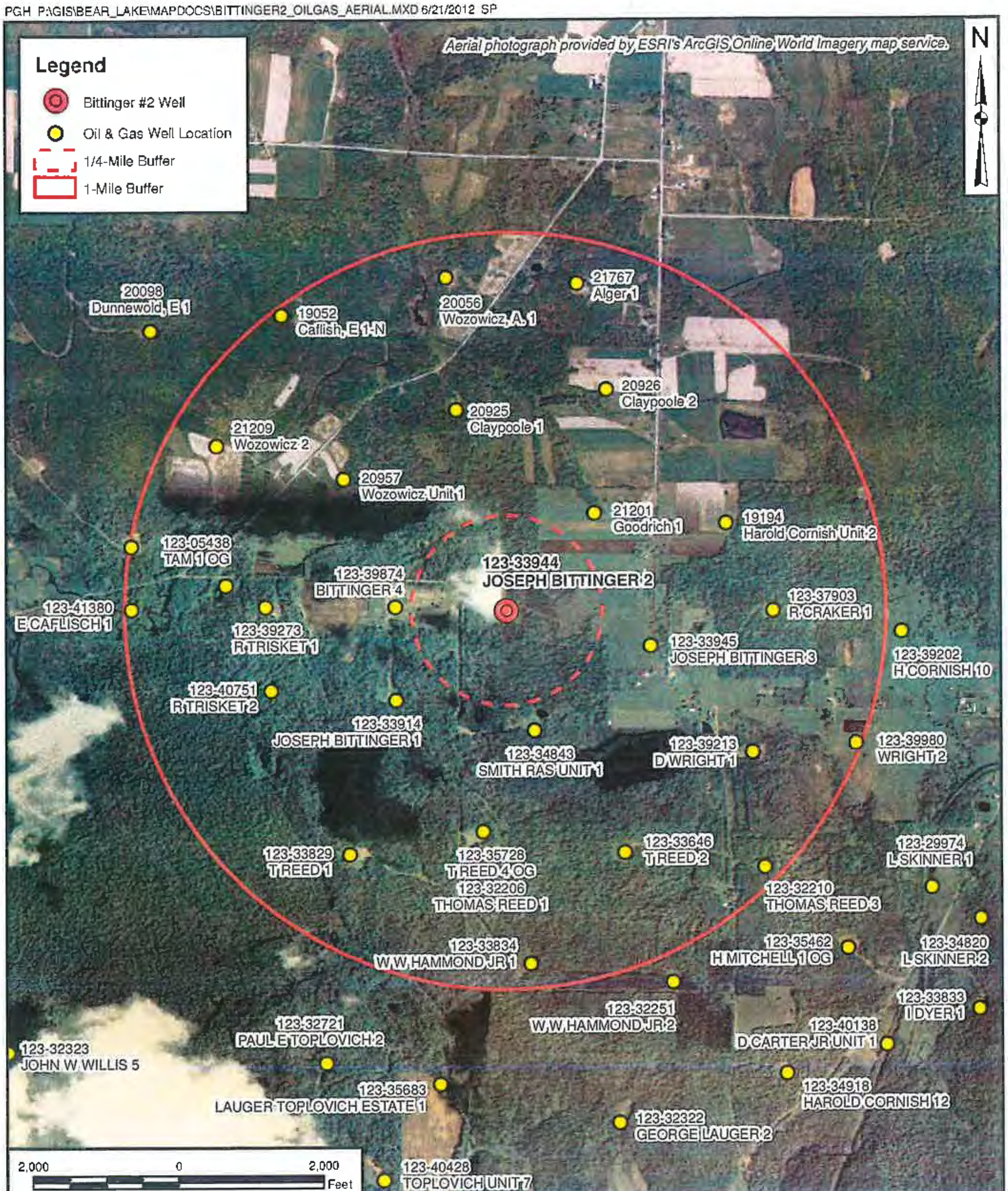
Bittinger Area; Columbus Twp; Warren County, PA
Wells w/in 0.25 mile radius of Bittinger #2

	API #	TD	Drilling Completed	Last Csg	Csg depth	Completion	Comments
Proposed Injection Well							
Bittinger #2	123-33944	4588	1/29/1984	4.5	4240	Perf'd and frac'd	
Existing / Former Oil and Gas Wells							
None							Based on review of publicly available data and survey conducted by foot.
Water Wells							
None							Based on review of publicly available data and survey conducted by foot.

AREA OF REVIEW MAPS

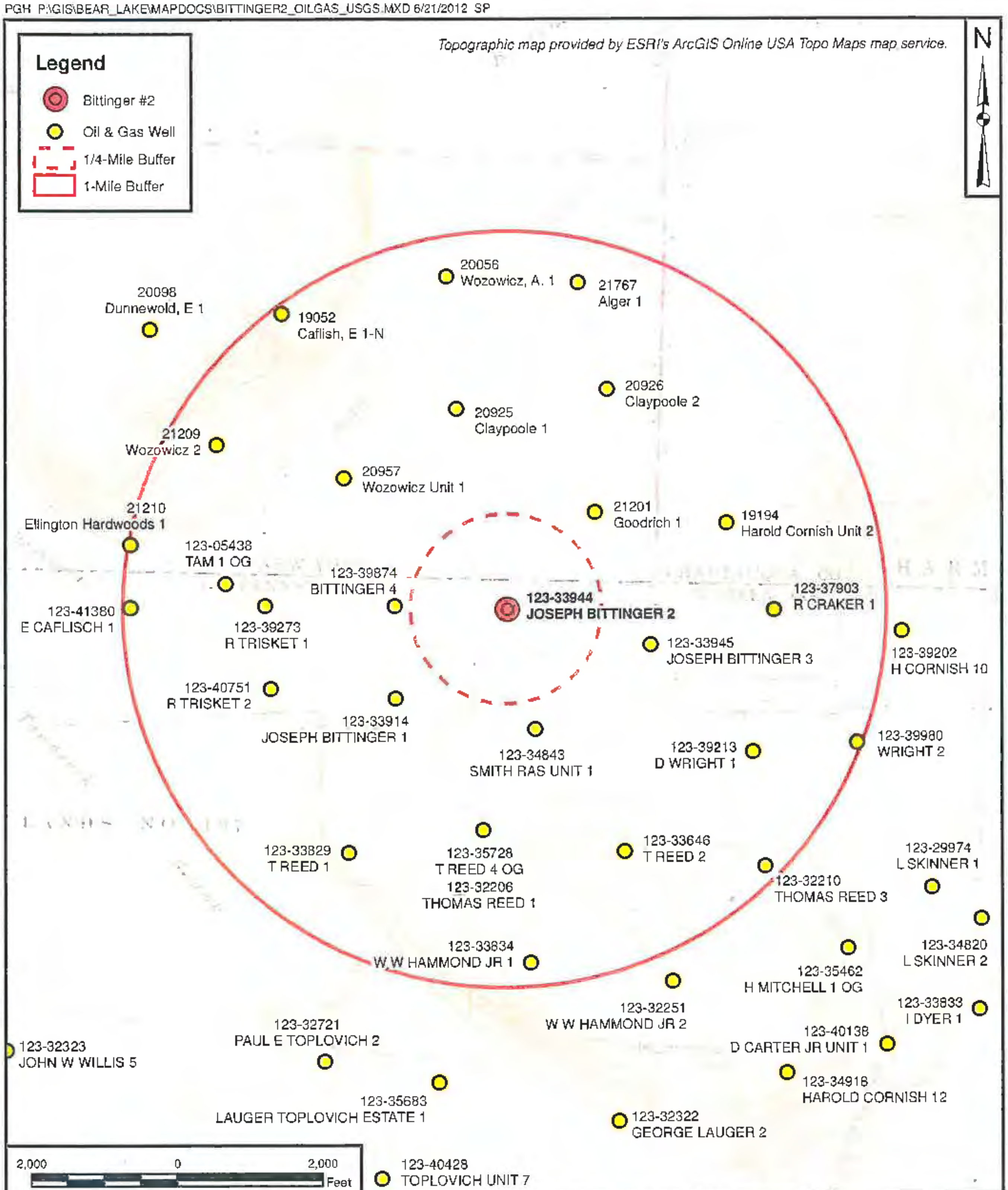
OIL AND GAS WELLS

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER2_OILGAS_AERIAL.MXD 6/21/2012 SP



TETRA TECH	OIL & GAS WELL LOCATIONS JOSEPH BITTINGER 2 WELL BEAR LAKE PROPERTIES, LLC WARREN COUNTY, PENNSYLVANIA	DRAWN BY: J .ENGLISH 05/21/12 CHECKED BY: E. BERKLITE 06/21/12 APPROVED BY: CONTRACT NUMBER: 112C04311 FIGURE NUMBER 1 REV 0

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER2_OILGAS_USGS.MXD 6/21/2012 SP



TETRA TECH

OIL & GAS WELL LOCATIONS
JOSEPH BITTINGER 2 WELL
BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA

DRAWN BY: J .ENGLISH 05/21/12
CHECKED BY: E. BERKLITE 06/21/12
APPROVED BY:

CONTRACT NUMBER: 112C04311

FIGURE NUMBER	REV
2	0

AREA OF REVIEW MAPS

GROUNDWATER WELLS

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER2_AERIAL.MXD 12/12/13 SP

TETRA TECH	WATER WELL LOCATIONS - AREA OF REVIEW BITTINGER #2 WELL BEAR LAKE PROPERTIES, LLC WARREN COUNTY, PENNSYLVANIA	DRAWN BY: J .ENGLISH 05/23/12 CHECKED BY: D. SKOFF 12/12/13 APPROVED BY: CONTRACT NUMBER: 112C04311 FIGURE NUMBER 3 — REV 0

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER2_USGS.MXD 12/12/13 SP

WATER WELL LOCATIONS - AREA OF REVIEW

BITTINGER #2 WELL

BEAR LAKE PROPERTIES, LLC

WARREN COUNTY, PENNSYLVANIA

TETRA TECH

DRAWN BY: J. ENGLISH 05/23/12
CHECKED BY: D. SKOFF 12/12/13
APPROVED BY:

CONTRACT NUMBER: 112C04311

FIGURE NUMBER	REV
4	0

Section 3 - Corrective Action Plan and Well Data

According to publicly available records of oil and gas wells and a survey conducted by foot, there are no existing, or plugged and abandoned wells within a ¼ mile radius area of review of the Bittinger No. 2 well. The Smith Ras Unit 1 and Joseph Bittinger No. 3 will be used as monitoring wells. If the fluid level in either monitoring well is observed to rise up to within 100 feet of the base of the USDW, disposal operations in the Bittinger No. 2 well will be stopped immediately, EPA will be notified, and operating conditions will be evaluated in order to control the fluid levels.

Existing Oil and Gas Wells within the Area of Review

Well completion records are required to be submitted for all wells located within the area of review in order to evaluate the need for corrective action specific to each well. As mentioned above, there are no oil and gas wells located with the AOR.

Plugged and Abandoned Wells

There are no plugged and abandoned wells located within the ¼ mile area of review for the Bittinger No. 2 well.

Section 4 - Underground Sources of Drinking Water (USDW)

The site lies within the Glaciated Plateau section of the Appalachian Plateaus Physiographic province. Both unconsolidated glacial units and bedrock are used for potable water. The uppermost unit at the site is mapped as Wisconsin age glacial kame deposits. Kame deposits consist primarily of sand and gravel interbedded with minor amounts of silt and clay (Pennsylvania Topographic and Geologic Survey, 1959). The well log for Bittinger No. 2 indicates that unconsolidated gravel is present from the surface to a depth of 12 feet below ground surface.

The uppermost bedrock beneath the site is mapped as the Devonian age Venango formation. The Venango formation consists of interbedded pebble conglomerate, crossbedded sandstone, siltstone, and shale. This unit is up to 330 feet thick in Venango County; however, only a portion of the unit is present in the site area. This unit is used as an aquifer throughout Warren County. The well log for Bittinger No. 2 indicates that Devonian age shale is present from 12 ft to a depth of 2,807 ft below ground surface. This is believed to include the Venango Formation, the Chadokoin formation, and the underlying Bradford Group. Wells deeper than approximately 100 feet deep usually encounter salt water, which is supported by the generally shallow well depths in Columbus Township. (PADER, 1982, US Geologic Survey, 2007)

The Devonian age Chadakoin formation underlies Venango formation and consists of fine-grained marine clastics (siltstone and shale) and includes a purplish pink sequence which is often used as a marker unit. This unit is up to 450 thick in Warren County.

The Pennsylvania Geologic Survey "Ground Water Inventory System" (GWIS) database was accessed to determine the sources of groundwater sources in the site area. This data base did not contain any groundwater wells within a one-quarter mile radius of Bittinger #2 well. Although there are no wells listed, the well reporting requirement was established in 1968 is not considered to be a complete record of water wells and other wells may be present. (Pennsylvania Topographic and Geologic Survey, September 15, 2010). (As discussed in the previous section on the AOR, a survey conducted by foot within the ¼ mile AOR also did not identify any water wells.)

The New York Department of Environmental Conservation (DEC) "Water Well Program Information Search Wizard" website was utilized to determine if there were any water wells in New York State within the ¼ mile AOR of the Bittinger #2 well. No water wells were identified within the AOR of the Bittinger #2 well.

Based on the available information, the glacial units and the top 100 feet of bedrock is considered the underground sources of drinking water in the site area. The well logs indicate that the glacial material is approximately 15 feet thick beneath the site. Freshwater is expected to be encountered to a depth of approximately 100 feet with increasing salinity beyond that depth. The Bittinger No. 2 well has 8 5/8 inch surface casing cemented to a depth of 428 feet below ground surface, providing a buffer of approximately 300 feet beyond the base of the underground sources of drinking water based on the well data in Columbus Township (maximum well depth of 130 feet) and the references indicating brine being encountered at depths over 100 feet within the bedrock units. In addition, production casing extends several thousands of feet below the drinking water source and is cemented approximately 1000 feet above the injection interval. (Injection well construction is described in detail in the "Well Construction" section.)

In calculating the depth to the base of the lowermost USDW, the depth of the deepest well in the area 130 feet (it is believed that the generally shallow well depth in the area was related to water quality issues based on the available literature) was doubled and rounded upward to the nearest 100 feet, providing a conservative maximum depth estimate of the underground source of drinking water of 300 feet.

References:

New York Department of Environmental Conservation website "DEC Water Well Program Information Search Wizard": http://www.dec.ny.gov/lands/33317.html

Pennsylvania Topographic and Geologic Survey, 1959. " Glacial Geology of Northwestern, PA." Bulletin G 32.

Pennsylvania Topographic and Geologic Survey, 1981. " Atlas of Preliminary Quadrangle Maps of Pennsylvania, PA." Map 61.

PADER, 1982. "Engineering Characteristics of the Rocks of Pennsylvania". Environmental Geology Report 1.

Pennsylvania Topographic and Geologic Survey, September 15/20, 2010. "Ground Water Inventory System". www.dcnr.state.pa.us/topogeo/groundwater/PAGWIS

US Geologic Survey, 2007. "Ground-Water Resources and the Hydrologic Effects of Petroleum Occurrence and Development, Warren County, Northwestern Pennsylvania." Scientific Investigations Report 2006-5263.

UNDERGROUND SOURCES OF DRINKING WATER

BEDROCK MAP

PGH:P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER_BEDROCK_2.MXD 6/19/2012 JN

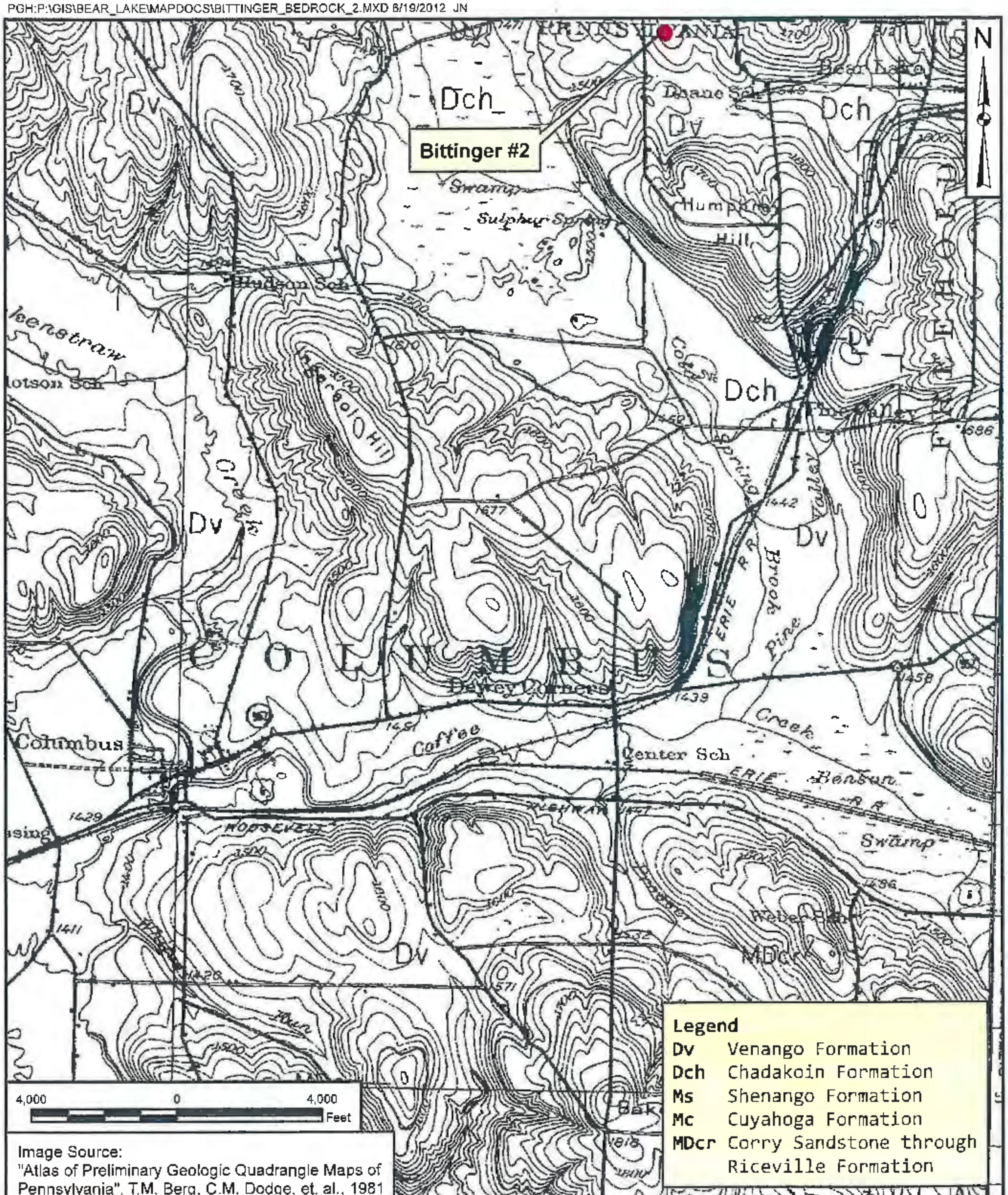


Image Source:
"Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania", T,M, Berg, C.M. Dodge, et. al., 1981

TETRA TECH

BEDROCK MAP
BITTINGER #2 WELL
BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA

DRAWN BY: J. NOVAK 06/19/12
CHECKED BY: E. BERKLITE 06/19/12
APPROVED BY:

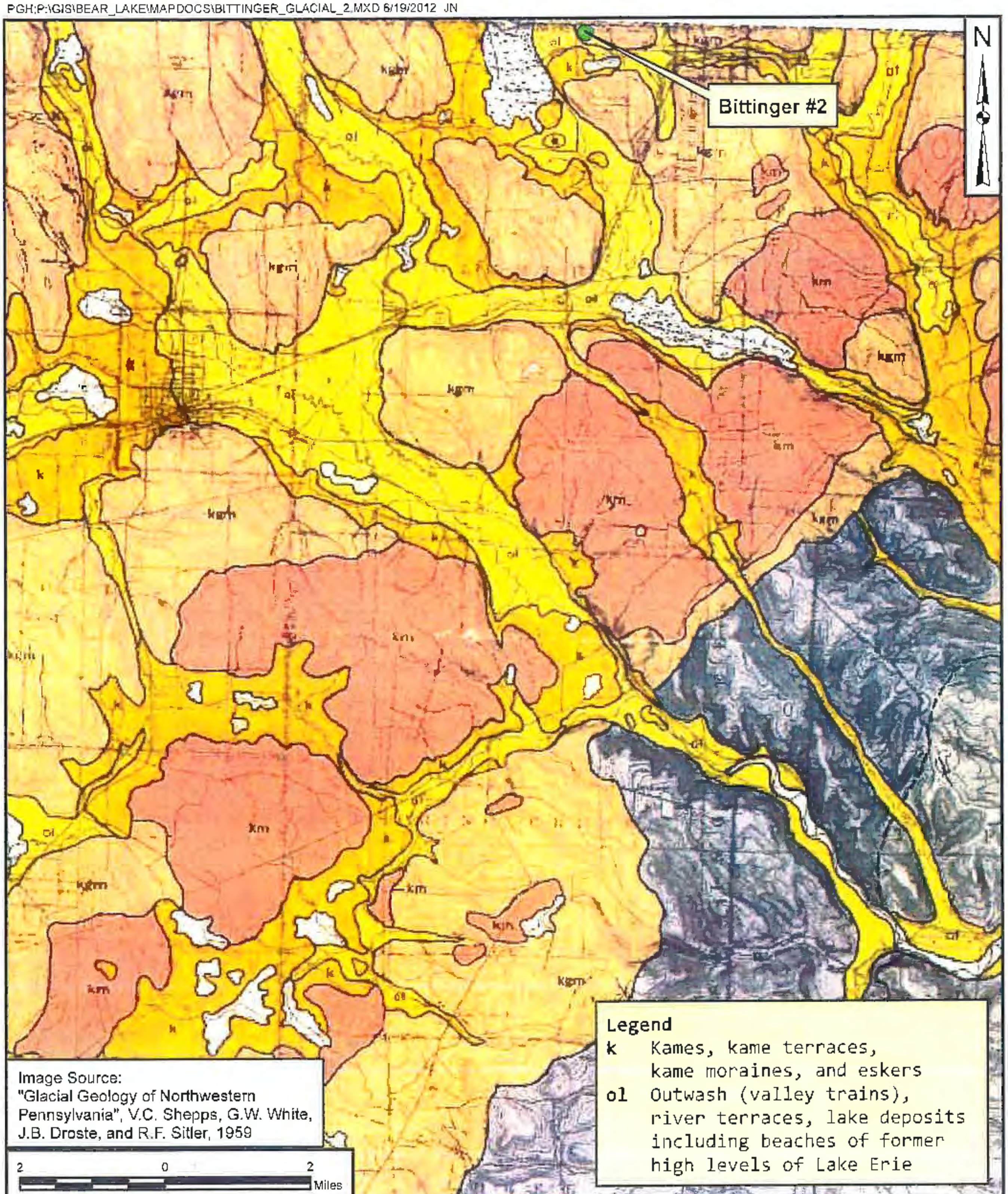
CONTRACT NUMBER: 112C04311
CTO xxxx

FIGURE NUMBER	REV
FIGURE NO.	0

UNDERGROUND SOURCES OF DRINKING WATER

GLACIAL MAP

PGH:P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER_GLACIAL_2.MXD 6/19/2012 JN



TETRA TECH	GLACIAL MAP BITTINGER #2 WELL BEAR LAKE PROPERTIES, LLC WARREN COUNTY, PENNSYLVANIA	DRAWN BY: J. NOVAK 06/19/12 CHECKED BY: E. BERKLITE 06/19/12 APPROVED BY: CONTRACT NUMBER: 112C04311 CTO xxxx FIGURE NUMBER: FIGURE NO. REV: 0

Section 5 – Geologic Data on Injection and Confining Zones

The well is designed to inject into the Grimsby and Whirlpool sandstone units of the Medina Group which occurs at depths between 4,246 and 4,427 feet below grade in the Bittinger #2 well. The Medina is a depleted reservoir in this area.

As seen on the generalized stratigraphic column (attached), most of the geologic "groups" and "formations" overlying the Medina can be considered confining units totaling approximately 1,800 feet. Although many of these units are predominantly shale, they also contain reservoir rock and are shown with shading in confining unit column. Therefore, the Lockport and the Salina are seen as the most significant confining units and are a combined 520 feet thick in the site area. As indicated, these units provide only a portion of the confining capacity and there are numerous other units that provide further protection.

Also attached are the following:

- Bittinger #2 completion record and geophysical log,
- Maximum Injection Pressure (MIP) calculations based on Instantaneous Shut-In Pressure (ISIP) data for the nearby Smith/Ras #1 well
- Smith/Ras #1 treatment reports.

Potential for Faults and Seismicity

Geologic mapping performed at the Bear Lake Properties site as part of natural gas exploration and development in the Medina Group sandstone units has not identified evidence of significant faulting (e.g., duplicated intervals evident in log analysis, unusual thickening or thinning of intervals, etc.). Likewise the production of large volumes of natural gas from the Medina Group indicates the lack of significant faults which would allow for migration of the entrapped gas out of the Medina. It is also noted that the Medina Group wells at the site are largely depleted resulting in lower than natural rock pressures. Injecting brine at or below the proposed maximum injection pressure would therefore not likely result in "overpressuring" faults (if any do exist in the area) and causing movement. Finally, it is highly unlikely that injection at the site would engage any deep, Pre-Cambrian basement faults. According to the PA DCNR "Precambrian Basement Map of the Appalachian Basin and Piedmont Province in Pennsylvania" http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_016250.pdf) the depth to basement in the site vicinity is estimated at approximately 2,500 meters (or 8,200 feet) below sea level. The base of the Medina Group at the Bear Lake Properties site is approximately 2,800 ft. below sea level, or approximately a mile above Pre-Cambrian basement. In summary, no significant faults have been identified, or otherwise indicated to exist, in the Bear Lake Properties vicinity which would have potential to cause seismicity or allow migration of injected brine.

GEOLOGIC DATA

GENERALIZED STRATIGRAPHIC COLUMN

Generalized Stratigraphic Column
Bittinger No 2
Warren County, PA

Age	Group	Formation	Predominant Rock Type	Total Depth to Base(Feet)	Thickness Feet	Confining Zone
Glacial Units				12	12	
Upper Devonian	Venango		Shale/sandstone	2807	2795	
Upper Devonian		Chadakoin	Shale			
Upper Devonian	Bradford		Shale			
Upper Devonian	Elk		Shale			
Upper Devonian		Java	Shale			
Upper Devonian		West Falls	Shale			
Upper Devonian		Sonyea	Shale			
Upper Devonian		Genesee	Shale			
Upper Devonian		Tully Limestone	Limestone	2915	108	
Upper Devonian	Hamilton	Mahantango	Shale, some sandstone	3084	169	
Upper Devonian	Hamilton	Marcellus Shale	Shale			
Middle Devonian		Onondaga	Limestone	3256	172	
Unconformity Interval				3270	14	
Upper Silurian		Salina - including Akron-Berite, Camillus, Syracuse, Vernon	Evaporites/Dolomite	3955	685	
Upper Silurian		Lockport Dolomite	Dolomite	4123	168	
Lower Silurian	Clinton	Rochester Shale, Irondequoit-Reynales Dolomite	Sandstone	4246	122	
Lower Silurian		Medina, inlcuding the Grimsby and Whirlpool Sandstones	Sandstone/Shale	4427	181	

Notes

= Black shading Indicates that this unit is considered to be a confining zone
= Diagonal shading Indicates that this unit is a confining unit that also contains producing zones within it
= No shading indicates that this unit is a producing zone and is not considered to be a confining unit

GEOLOGIC DATA

BITTINGER #2 COMPLETION RECORD

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS MANAGEMENT

DEP USE ONLY	Inspection Record # 2196197
Complaint Record #	Enforcement Record #

INSPECTION REPORT

[illegible]	Warren District Office [illegible] Phone [illegible]	Permit or Reg. #	123-33944
[illegible]	[illegible]	Project #	
[illegible]	[illegible]	Farm Name & Well #	Bittinger 2
Oper Name	Bear Lake Properties, LLC	County	Warren
Address	3000 Village Run Rd.	Municipality	Columbus
	Wexford PA 15090	Latitude:	° ' " N
	DEP ID #	Longitude:	° ' " W

Inspection Code:
- ☐ BDREL – Bond Release
- ☐ CEI – Compliance Evaluation
- ☐ COMPL – Complaint Inspection
- ☐ DRALT – Drilling or Alteration
- ☐ FUI - Follow Up
- ☐ PLUG – Plugging
- ☐ RDSPR – Road Spreading
- ☐ RESTR – Site Restoration
- ☒ RTNC - Routine

Other: ☐ Permit Expired ☐ Alt/Meth. ☐ Annulus Open ☐ Cement Returns ☐ Recommend Bond Release

Location	Insp.	Violation
Site ID Sign		
Well Tag		
Distance Restrict		
E/S Plan on Site		
Administrative		
Encroachments		
Site Restoration		
Abandoned		
Drilling-Plugging		
Notification		
B.O.P.		
Casing		
Monument		
Waste Mgmt.		
Top Hole Water		
Fluids Mgmt.		
Impoundment/pit		
Pollution Prevent.		
Residual Waste		

Driller's Log Information Depth:

Fresh Water Amt / Depth	Salt Water Amt / Depth	Coal Thickness / Depth	Formations Oil / Depth	Gas / Depth

Drilling / Plugging

Filling Material & Plugs	From	To	Casing & Tubing Size	Pulled	Left

Compliance Assistance	Code	Code	Inspection Results	Code
				NOVIO

Remarks: Performing bond log at this time. T.O.C. on production casing is located at 3190' from surface.

Sample No.	Location/Description	DEP Rep:	
		(signature)	Date: 08/13/2013
		(print name) Marshall Wurst	Time:11:00

☐ White – Regional File ☐ Yellow – Operator ☐ Pink – Inspector ☐ Goldenrod – Company File

Columbus

ER-OG-4: Rev. 2/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
DIVISION OF OIL AND GAS REGULATION
PITTSBURGH, PENNSYLVANIA 15222

123 33 944
Office Use Only

RE

(c)

990 S 42°00'00"
9700 W 79°30'00"

WELL RECORD

123 - 33944

CSO

PERMIT NO. WAR 33944 PROJECT NO. DEEP TYPE OF WELL GAS

COLUMBUS FIELD, DEWEY CORNERS POOL - DEU

WELL OPERATOR: U.S. ENERGY DEVELOPMENT CORPORATION		TELEPHONE NO. 716-856-9764		
ADDRESS: 670 STATLER BUILDING, BUFFALO, NEW YORK		ZIP 14202-9990		
FARM NAME: BITTENGER	FARM NO. #2	SERIAL NO.		ACRES 160
TOWNSHIP: COLUMBUS	COUNTY: WARREN			
DRILLING COMMENCED: 1/22/84	DRILLING COMPLETED: 1-29-84			
ELEVATION: 1621'	QUADRANGLE: COLUMBUS	☒ 7½'	☐ 15'	

CASING AND TUBING RECORD

PIPE SIZE	AMOUNT IN WELL	MATERIAL BEHIND PIPE: CEMENT (SKS.)	MATERIAL BEHIND PIPE: GEL (SKS.)	PACKER: TYPE	PACKER: SIZE	PACKER: DEPTH	DATE RUN
8 5/8"	428'	150					1/24/84
4 1/2"	4240'			Tension	4 1/2" x 7 5/8"	4240'	1/29/84

T.D.	D.D.	D.P.I.	Class	O G	
4588		4415	D	/	/

PERFORATION RECORD

DATE	INTERVAL PERFORATED FROM	TO
not applicable		

STIMULATION RECORD

DATE	INTERVAL TREATED	AMOUNT FLUID	AMOUNT SAND	INJECTION RATE
~~not applicable~~				

NATURAL OPEN FLOW: 554 MCF	NATURAL ROCK PRESSURE: 1100 — 72 HRS.
AFTER TREATMENT OPEN FLOW: N/A	AFTER TREATMENT ROCK PRESSURE: HRS. DAYS

REMARKS: DRILLER'S T.D. 4574' MEDINA

WOW LOGGER'S T.D. 4588'

AND GAS REGULATION
1984 JUN -6 PM 12:13
DER-TGS

RECEIVED
OCT 1 1984
PA GEOLOGICAL SURVEY
(Oil & Gas Geology Division)

(INFORMATION ON REVERSE SIDE)

CRO
7-15-84

ER-OG-4: Rev. 3/80
(pg 2)

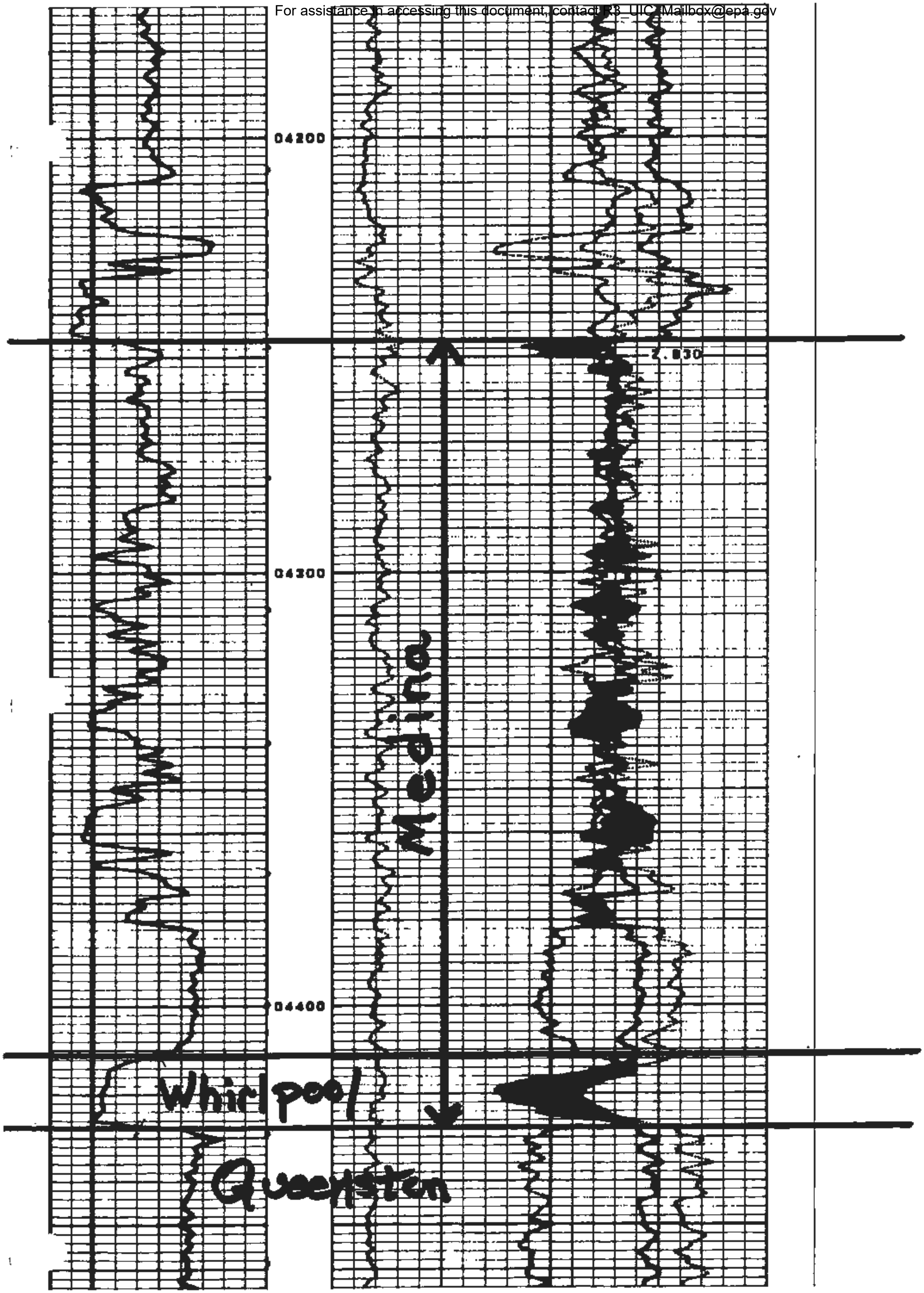
FORMATIONS

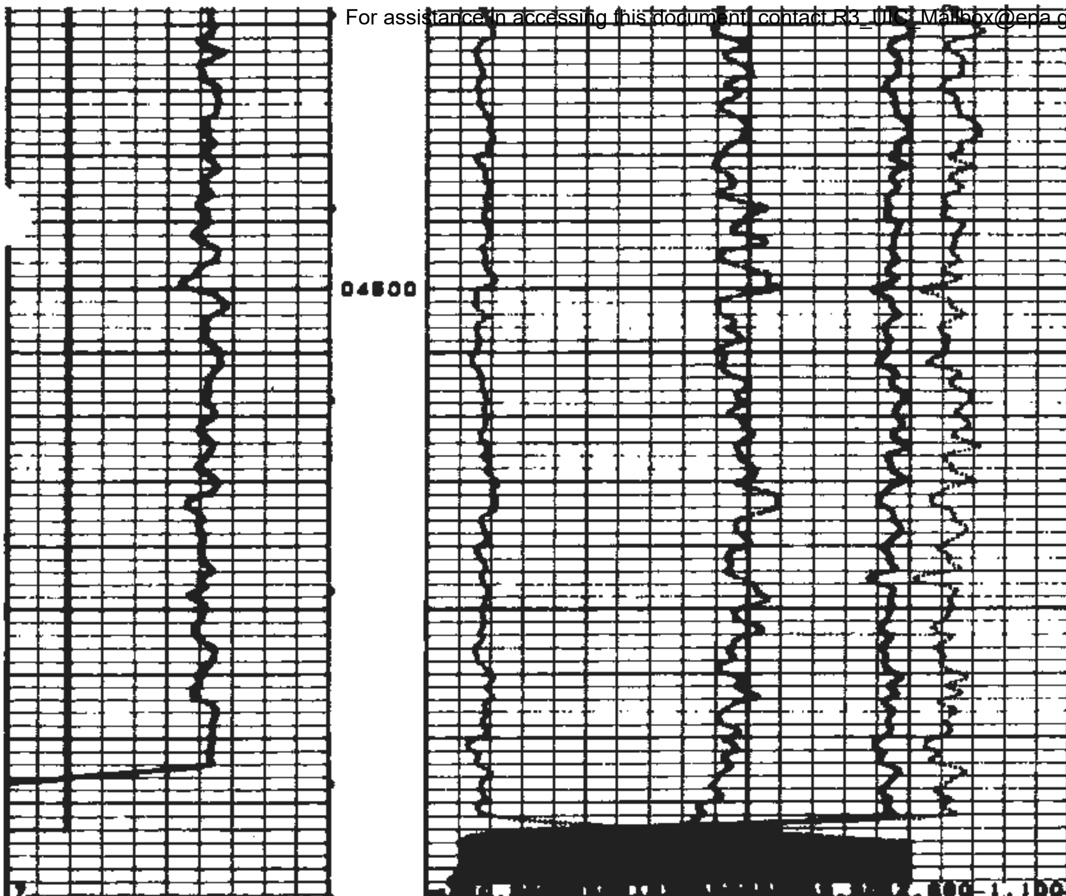
NAME	TOP	BOTTOM	GAS AT	OIL AT	WATER AT (FRESH OR SALT WATER)	SOURCE OF DATA
UNCONSOLIDATED GRAVEL	0'	12'				Driller's
DEVONIAN SHALE	12'	2807'			FRESH @ 109'	RECORD
"TULLY" LS.	2807'	2915'				AND
HAMILTON SHALES	2915'	3084'				GEOPHYSICAL
ONONDAGA	3084'	3256'				LOGS
UNCONFORMITY INTERVAL	3256'	3270'				
AKRON-BERTIE	3270'	3357'				
CAMILLUS	3357'	3421'				
SYRACUSE	3421'	3639'				
SALT ZONE	3618'	3816'			SALT @ 3710'	
VERNON	3639'	3955'				
LOCKPORT	3955'	4123'				
ROCHESTER	4123'	4209'				
IRONDEQUOIT-REYNALES	4209'	4246'				
GRIMSBY	4246'	4362'				
POWER GLEN	4362'	4411'				
WHIRLPOOL	4411'	4427'	4415'			
QUEENSTON	4427'	T.D.				
T.D.	4574'					

MAY 25, 1984
DATE

Douglas K. Walch
APPROVED BY

GEOPHYSICIST
TITLE


04200
2.830
04300
Medina
04400
Whirlpool
Queenston



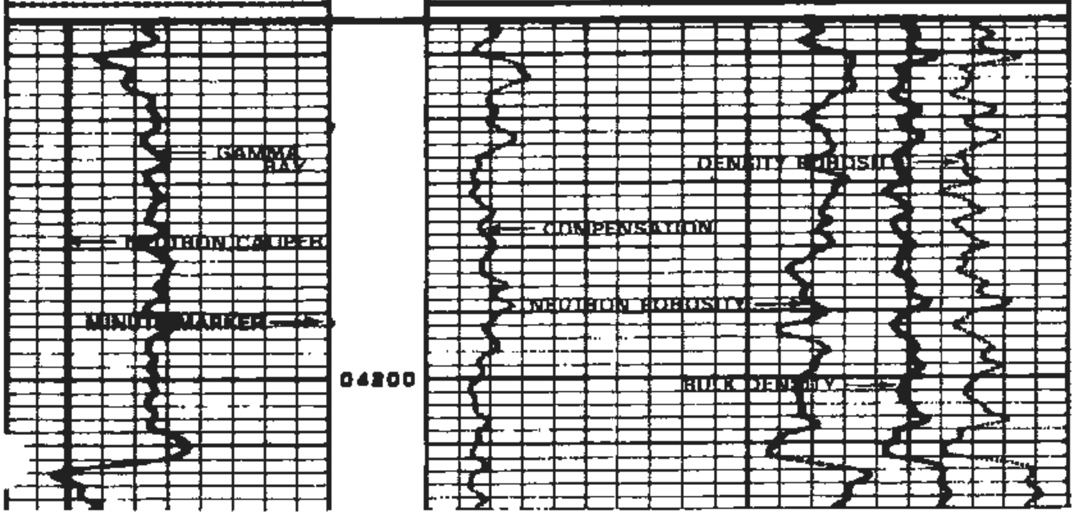
-0.05	Δρ	0.45
0	GR API	200
30	φ(SNL)	-10
200	GR API	400
30	φ(CDL)	-10
6	Y - CAL	16
2	ρ(B)	3

01-29-84 01:14 4988.0 271730 0008-02 0 4

REPEAT SECTION

01-28-84 01:09 4144.5 271730 0008-02 0 3

-0.05	Δρ	0.45
0	GR API	200
30	φ(SNL)	-10
200	GR API	400
30	φ(CDL)	-10
6	Y - CAL	16
2	ρ(B)	3



GEOLOGIC DATA

MAXIMUM INJECTION PRESSURE CALCULATIONS

Maximum Injection Pressure (MIP) Calculations for Bear Lake Properties Well (Bittinger #2)

1) Frac Gradient (FG) Based on Nearby Smith/Ras #1 Well

FG = [ISIP + (.433 X SG X D)] /D
Where:
ISIP = 2200 psi
SG = 1.0 (frac fluid)
D = 4391

Well	ISIP (psi)	Hydrostatic Factor (psi/ft)	SG	D (ft)	Fracture Gradient (psi/ft)
Smith/Ras #1	2200	0.433	1	4391	0.934

2) Maximum Injection Pressure (MIP) Calculation for Bittinger #2 Well Using FG from Smith/Ras #1 Frac

MIP = [FG - (.433XSG)] X D
FG = 0.933
SG = 1.218 (brine)

Depth:
Medina Top: 4246

		Hydrostatic Factor (psi/ft)	SG	D (ft)	Fracture Gradient (psi/ft)	MIP (Surface)
Bittinger #2	-	0.433	1.218	4246	0.934	**1727**

GEOLOGIC DATA

SMITH/RAS #1 WELL DATA

Well Name & No. SMITH/RAS #1 Loc. ______

Permit No. ______ COLUMBUS Twp., WARREN Co., [redacted] PA

PERFORATION RECORD

Company N.L. McCullough Formation Medina/Whirlpool Date 6/26/84

Pumped in 500 gal. acid and 500 gal. water, ran Gamma Ray and collar log.
PBTD 4487 ft. Perf. as follows:

4279 - 4316 w/ ______ shots - 4382 - 4393 w/ ______ shots
4305 - 4318 w/ ______ shots - 4389 - ______ w/ ______ shots
4309 - 4334 w/ ______ shots - 4391 - ______ w/ ______ shots

Size of shots .42 Total Shots 10

FRAC JOB

Company Dowell Schlumberger Date 6/27/84

Loaded hole. Broke formation @ 2100 # Back to 950 #. Pumped in 500 gals. 15% HCL Acid @ 20 BPM @ 3300 #, waited 5 min. & fraced as follows:

	BBLS./[redacted].		SAND # Per Gal.	SAND Size	BPM	Press.
1.	0-144		PAD	- - - -	20	3500
2.	144-339		2#	20/50	21	3350
3.	339-420		3#	20/50	21	3250
4.	420-611		4#	20/50	20	3500
5.	611-675		Flush	- - - -	14.5	3500
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						

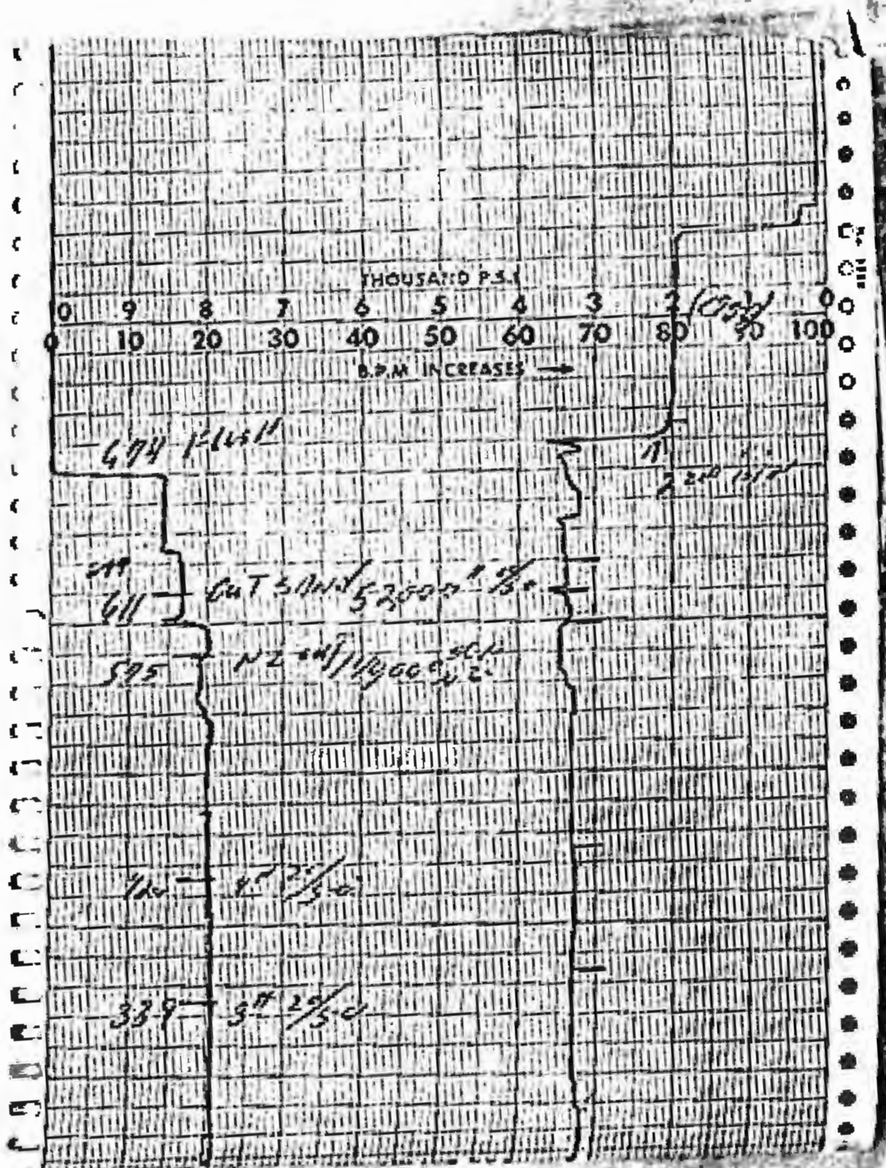
ISIP 2200 # 5 MIN. 1950 # Job complete 12:26 P.M.

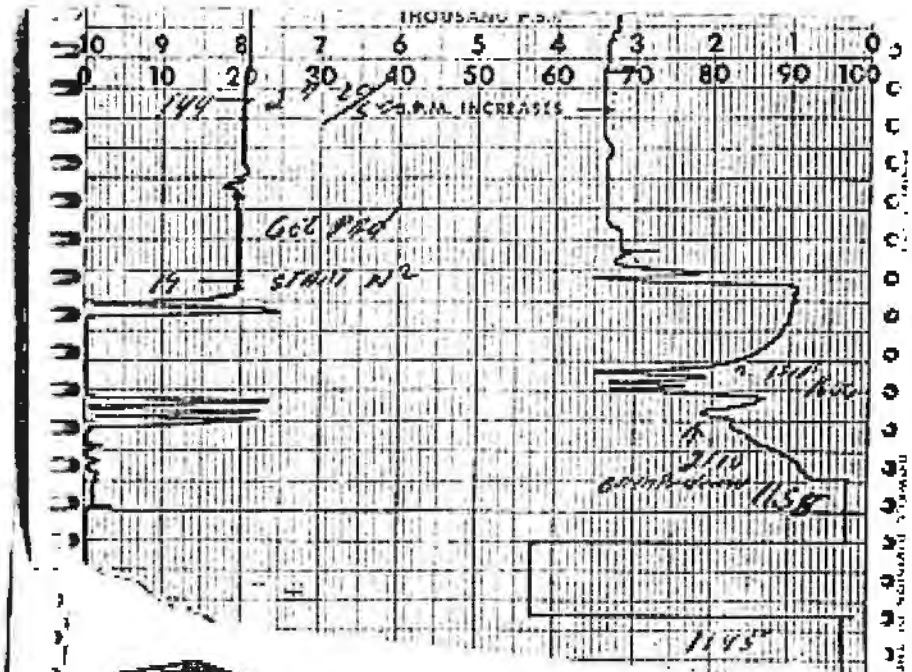
Open to pit 1:26 P.M. Flowed back 24 hrs. Total water 675 bbls.
52,000 # 20/[redacted]50 & - - - - # 80/100. Avg. pump rate 21 BPM @ 3369 # Press.
HHP used 1734. Nitrogen used 140,000.

REMARKS: At 540 BBLS cut N_2 due to high pressure - at 611 BBLS cut sand due to high pressure - well screened off - 4 BBLS short of flush to perfs.

ENGINEER

7-6-84


THOUSAND P.S.I
10 9 8 7 6 5 4 3 2 0
0 10 20 30 40 50 60 70 80 90 100
B.P.M INCREASES
674 Flush
611
Cut Sand
575
339



DOWELL DIVISION OF DOW CHEMICAL U.S.A.

RECORDED SERVICE

TREATMENT NO. 01-[illegible]-9044

TYPE OF SERVICE wF 30 [illegible] 2

DATE 6/27/84

OWNER: U. S. [illegible]	WELL NAME AND NUMBER: Smith [illegible] #1
OWNER'S REPRESENTATIVE: [illegible]	SERVICE ENGINEER: D. [illegible]

REMARKS: [illegible] 15 [illegible] [illegible]-53 [illegible] 150 [illegible] 1400 [illegible]

Section 6 - Operating Data

The proposed commercial brine disposal well will primarily be utilized to inject produced and flowback water from wells completed in the Marcellus Shale, the Medina Group and other natural gas and oil producing formations. Other oil and gas related wastewaters associated with the production of oil and natural gas or natural gas storage operations, which are approved by EPA for injection under a UIC Class II D injection well, may also be injected. According to Title 40 Chapter I Sec. 144.6 (b)(1), such fluids include those "Which are brought to the surface in connection with natural gas storage operations, or conventional oil or natural gas production and may be commingled with waste waters from gas plants which are an integral part of production operations, unless those waters are classified as a hazardous waste at the time of injection."

Injection Rate

Injection rate and pressure data collected to date for the nearby Bittinger #4 permitted brine disposal well indicate the well is capable of a sustainable injection rate of approximately 1,000 bbls/day, while operating within the maximum injection pressure permit limit. This is consistent with the permitted injection rate of 30,000 bbls/month for this well. Considering the proximity of the Bittinger #2 well to the Bittinger #4 well (approximately1500 ft from the Bittinger #2) and the similarity in the injection interval based on log analysis, it is anticipated that the Bittinger #2 well can also be operated at this injection rate while staying below the proposed MIP. An injection rate of 30,000 bbls/month is therefore also proposed for this well.

Maximum Allowable Surface Injection Pressure (MASIP) and Average Surface Injection Pressure

MASIP calculations based on EPA approved equations are included in the "Geologic Data" section of this application. Based on these calculations, the proposed MASIP is 1727 psi. It is estimated that the average surface injection pressure will be approximately 1000 psi.

Laboratory Analysis of Injection Fluid Samples

Laboratory analytical results for samples representative of the types of brine which will be injected into the proposed injection well are attached. Samples were collected from produced water generated from gas wells in the vicinity of the injection well as well as Marcellus brine from a brine processing facility.

Monitoring of Injection Fluid Samples and Well

The following identifies the UIC Class II underground injection well regulatory requirements and operational procedures which will be conducted to meet the subject requirements:

1. **Monitoring of the nature of injected fluids at time intervals sufficiently frequent to yield data representative of their characteristics**. An initial sample of fluid will be collected and analyzed from initial loads proposed for disposal from new disposal customers. In addition, samples will be collected for analysis from new types of sources (e.g., from different geologic formations, geographic regions, etc.) which would be expected to differ significantly from brine previously characterized for disposal at the facility. Samples will be analyzed for the following parameters at a minimum: specific gravity, total dissolved solids and pH.

2. **Observation of injection pressure, flow rate, and cumulative volume at least weekly based on the regulatory requirements for produced fluid disposal operations.** Injection pressures, annular pressure, injection rate, and cumulative volume will be continuously monitored and recorded electronically.

3. **A demonstration of mechanical integrity pursuant to 40 CFR Sec. 146.8 at least once every two years during the life of the injection well.** A mechanical integrity test will be performed prior to initiating injection and at least once every two years.

4. **Maintenance of the results of all monitoring until the next permit review.** All monitoring records will be maintained throughout the life of the well.

Reporting requirements consist of the following:

An annual report will be submitted to EPA summarizing the results of the required monitoring, including monthly records of injected fluids, and any major changes in characteristics or sources of injected fluid.

Proposed Annulus Fluid

The proposed annulus fluid for the proposed injection well will consist of fresh water and a water soluble corrosion inhibitor. The corrosion inhibitor will be mixed in accordance with the manufacturer's recommendations then loaded into the well annulus prior to conducting injection operations. Product information for the type of corrosion inhibitor which will be utilized is attached. A similar type product may be used instead of the example product referenced.

Facility Layout and Operation

The attached drawing shows the following elements of the existing Bear Lake Properties brine disposal well facility and proposed brine storage area:

- Existing permitted brine offloading facility located at the corner of State Route 4004 and State Line Road;
- The proposed brine storage facility (located near the Bittinger #2 well) which is connected to the unloading area by underground double-walled piping;
- The two existing permitted UIC Class IID wells (Bittinger #1 and #4); and,
- The Bittinger #2 well.

It is noted that the proposed brine storage facility, which will have a 3,000 barrel capacity, is the subject of a PADEP residual waste transfer facility permit application. A drawing showing details of this proposed facility is also attached.

As of the date of this application, brine from approved waste sources is transported by truck to the Bear Lake Properties offload facility. After the origin and transport manifests are inspected and approved by Bear Lake Properties personnel, the brine is pumped from the trucks at the offload facility via dual (secondary containment) pipeline to the permitted Bittinger #4 UIC Class IID well for disposal via an injection pump at the Bittinger #4 well location.

In November 2013, Bear Lake Properties submitted a residual waste transfer facility permit application for a proposed brine storage facility (discussed above) to be located near the Bittinger #2 well. The proposed facility will have a brine storage capacity of 3,000 bbls. Following the issuance of the waste transfer facility permit and construction of the brine storage facility, brine will be pumped from the offload station via the dual (secondary containment) pipeline to the storage tanks at the brine storage facility. The brine will then be pumped from the brine storage facility via high pressure dual (secondary containment) pipelines to the three brine disposal wells (i.e., Bittinger #2, Bittinger #1 and Bititnger #4) for injection.

The storage tanks in the brine storage area will be located within a diked containment area with the containment area sized to account for the entire volume of the largest container, plus 10%. Automatic shut-off valves will be incorporated into the tank design to prevent overflow during filling operations. The facility will be surrounded by a fence having locking entrance and exit gates. A security camera will also be strategically situated on the site.

OPERATING DATA

TYPICAL BRINE LABORATORY ANALYSIS

~~835~~ 835

Microbac

®Microbac Laboratories, Inc.

BRADFORD DIVISION
P.O. BOX 489
BRADFORD PA 16701
(814)368-6087

http://www.microbac.com

AUG 2001

CHEMISTRY • MICROBIOLOGY • FOOD SAFETY • CONSUMER PRODUCTS
WATER • AIR • WASTES • FOOD • PHARMACEUTICALS • NUTRACEUTICALS

CERTIFICATE OF ANALYSIS

KCS LENAPE RESOURCES CORP.

9489 ALEXANDER ROAD

ALEXANDER NY 14005

LAUGER-TOMLINICH

Permit No
Cust P.O.

Date Reported 8/10/01
Date Received 7/13/01
Order No 9931-00207
Invoice No 008010
Cust # K011
Sampled Date 7/09/01
Sampled Time 00:00
Sample Id

Subject: LION ENERGY - BRINE SAMPLE SUBMITTED 7/13/01

SMP	TEST	METHOD	RESULT	UNITS	DATE	TECH
1	LION ENERGY - BRINE SAMPLE					
	BY WGT SALTS IN BRINE				7/23/01	ERI
	[illegible]CIUM		33,600	MG/L	7/23/01	ERI
	CHLORIDE		195,000	MG/L	7/23/01	ERI
	POTASSIUM		1910	MG/L	7/23/01	ERI
	MAGNESIUM		3330	MG/L	7/23/01	ERI
	SODIUM		80,700	MG/L	7/23/01	ERI
	SPECIFIC GRAVITY		1.216		7/23/01	ERI
	CALCIUM CHLORIDE		7.65	% BY WGT.	7/23/01	ERI
	SODIUM CHLORIDE		16.82	% BY WGT.	7/23/01	ERI
	POTASSIUM CHLORIDE		0.30	% BY WGT.	7/23/01	ERI
	MAGNESIUM CHLORIDE		1.07	% BY WGT.	7/23/01	ERI
	TOTAL CHLORIDES		25.84	% BY WGT.	7/23/01	ERI
	CALCIUM CHLORIDE		0.776	LBS/GAL.	7/23/01	ERI
	SODIUM CHLORIDE		1.707	LBS/GAL.	7/23/01	ERI
	POTASSIUM CHLORIDE		0.030	LBS/GAL.	7/23/01	ERI
	MAGNESSIUM CHLORIDE		0.109	LBS/GAL.	7/23/01	ERI
	TOTAL CHLORIDES		2.62	LBS/GAL	7/23/01	ERI
	WEIGHT OF 1 GALLON OF BRINE		10.15	LBS/GAL	7/23/01	ERI

ANALYSIS BY NYS LAB: 10121

$$S.G. = \frac{10.15\ \#/GAL}{8.33\ \#/GAL} = \underline{1.21}$$

Certificate Of Analysis Continued On Next Page

Client Sample Results

Client: Bear Lake Properties, LLC
Project/Site: Injection Well Permitting

TestAmerica Job ID: 180-17986-1

'ient Sample ID: CW 011013 | **Lab Sample ID: 180-17986-1**

Date Collected: 01/10/13 13:30
Date Received: 01/11/13 09:30

Matrix: Water

Method: 200.8 - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Barium	5200000	B	5000	44	ug/L		01/16/13 09:44	01/16/13 18:31	5
Iron	1600	J B	5000	230	ug/L		01/12/13 12:22	01/14/13 21:03	100
Magnesium	2300000	B	10000	200	ug/L		01/12/13 12:22	01/14/13 21:03	100
Manganese	10000	B	500	3.7	ug/L		01/12/13 12:22	01/14/13 21:03	100
Sodium	32000000	B	10000	270	ug/L		01/12/13 12:22	01/14/13 21:03	100

General Chemistry

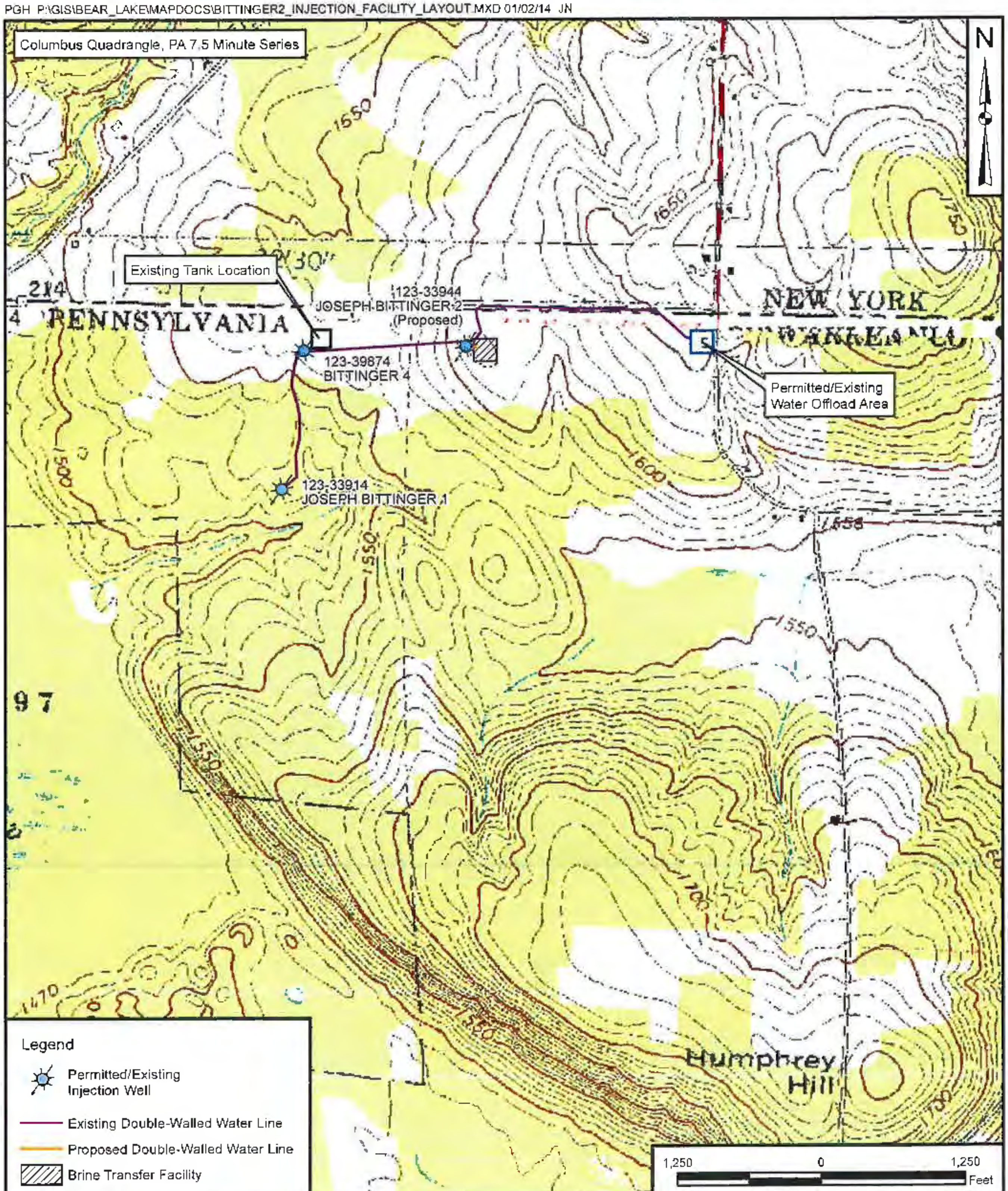
Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride	130000		1000	200	mg/L			01/12/13 11:36	1000
Alkalinity	6.5	B	5.0	0.41	mg/L			01/14/13 08:06	1
Bicarbonate Alkalinity as CaCO3	6.5	B	5.0	0.41	mg/L			01/14/13 08:06	1
Carbonate Alkalinity as CaCO3	ND		5.0	0.41	mg/L			01/14/13 08:06	1
Hardness	74000		2500	770	mg/L			01/14/13 09:05	500
Total Dissolved Solids	200000		1000	1000	mg/L			01/11/13 14:39	1
Total Organic Carbon - Duplicates	63		40	7.5	mg/L			01/21/13 11:02	40

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
pH	6.23	HF	0.100	0.100	SU			01/15/13 09:50	1
Specific Conductance	440000		1600	1600	umhos/cm			01/11/13 18:45	1600
Total Solids	220000		10	10	mg/L			01/15/13 15:50	1

OPERATING DATA

SURFACE FACILITY SCHEMATIC

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BITTINGER2_INJECTION_FACILITY_LAYOUT.MXD 01/02/14 JN



TETRA TECH

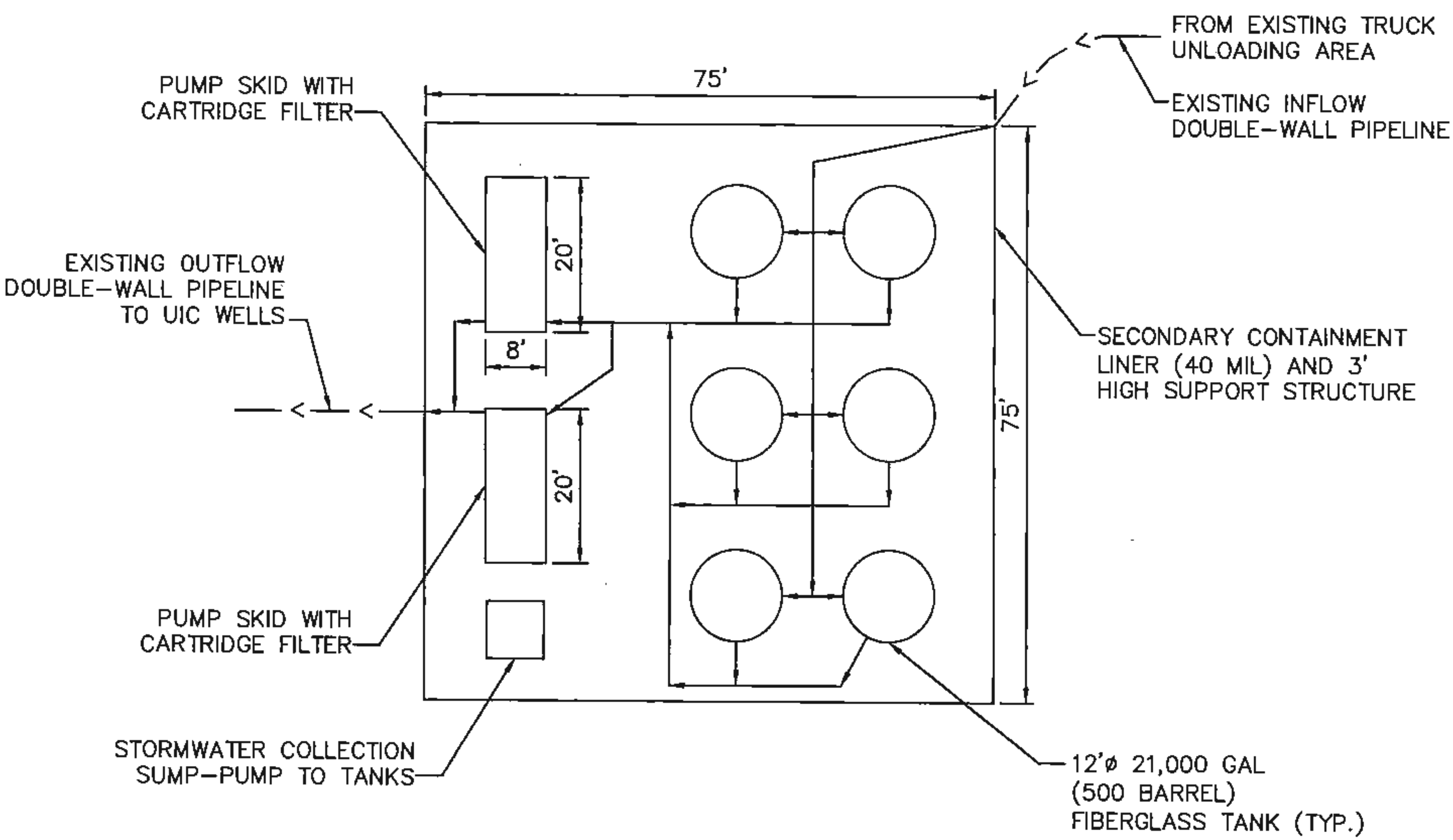
INJECTION FACILITY LAYOUT
BITTINGER #2 WELL
BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA

DRAWN BY: S. PAXTON 10/15/13
CHECKED BY: D. SKOFF 01/02/14
APPROVED BY:

CONTRACT NUMBER: 11C05908

FIGURE NUMBER

REV
0



TETRA TECH
WWW.TETRATECH.COM
661 ANDERSEN DRIVE – FOSTER PLAZA 7
PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

BEAR LAKE PROPERTIES, LLC
COLUMBUS TOWNSHIP, WARREN COUNTY, PA

GENERAL ARRANGEMENT
BEAR LAKE PROPERTIES
BRINE TRANSFER FACILITY

DATE:	10/28/13
PROJECT NO.:	112C05908
DESIGNED BY:	
DRAWN BY:	CK
CHECKED BY:	
SHEET:	1 OF 1

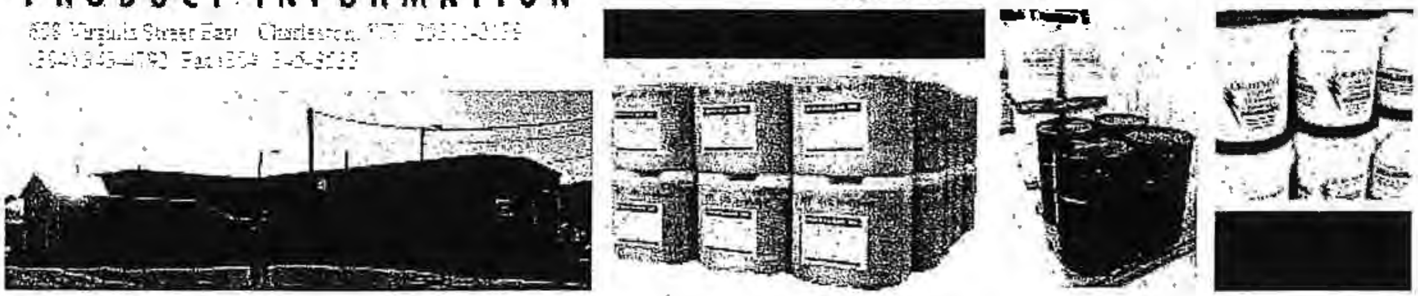
FORM O-1

OPERATING DATA

TYPICAL CORROSION INHIBITOR

AQUACLEAR
PRODUCT INFORMATION

[illegible] Virginia Street East Charleston, [illegible]
[illegible] Fax [illegible]



Corrosion Inhibitor SticksT

WHAT ARE CORROSION INHIBITOR STICKST?
Corrosion Inhibitor SticksT are water soluble or oil soluble sticks that contain a blend of Imidazolines which have excellent filming characteristics and low emulsion tendencies. This unique blend gives effective corrosion control for most oil field corrosion problems.

CORROSION INHIBITOR STICK™ USES
Corrosion Inhibitor Sticks ™ are primarily used to control common corrosion problems found in producing oil and gas well systems. They can be used to treat hard to reach 'dead' areas such as the annulus space above the packer, rat-hole, or the bottom of water supply tanks.

ADVANTAGES OF CORROSION INHIBITOR STICKST
Corrosion Inhibitor SticksT can provide corrosion control throughout the entire production system. Regular usage will help control corrosion at the point they begin - down-hole.

They are available in two different formulations (oil soluble and water dispersable) or (water soluble and oil dispersable). The oil soluble type is soluble in oil, condensate and wet gas and can slowly disperse inhibitor into the water phase. The water soluble type is soluble in water and can slowly disperse inhibitor into the oil phase.

Corrosion Inhibitor SticksT can effectively inhibit corrosion in wells that produce both water and distillate or oil phases. In this case, it may be desirable to treat the well with both types of sticks by first dropping water soluble sticks and allowing them to fall through the oil into the water, thus dissolving and releasing inhibitor in

TREATMENT DETERMINATION
The number of Corrosion Inhibitor SticksT used is based on the volume of total fluid produced (oil or condensate plus water). Field experience indicates that for most corrosive environments the best results are achieved by using a larger initial slug treatment (80 PPM daily) until the problem is under control then reduce to smaller periodic treatments (40 PPM daily) thereafter. EXAMPLE: An initial slug treatment of 80 PPM would require 0.64 lbs of Corrosion Inhibitor Stick™ per 24 BBL (1000 gallons) of total fluid produced.

COR. INH. STICK™ SIZES	STICKS PER BBL
SENIOR (1 5/8 " x 18")	**1 per 58 bbls**
JUNIOR (1 3/8 " x 16 ")	**1 per 40 bbls**
JUNIOR (1 1/4" x 15")	**1 per 29 bbls**
THRIFTY (1" x 15")	**1 per 18 bbls**
MIDGET (5/8" x 15")	**1 per 7 bbls**

NOTE: To successfully control any corrosion problem, the inhibitor insertion into the fluid stream must be constant. For intermittent treatment or extreme corrosive environments increase the number of sticks accordingly.

THE MOST COMMON PROCEDURE for producing wells is to shut-in well and drop sticks through lubricator. Leave well shut until sticks fall to the bottom. The time in minutes for the sticks to fall to the bottom (assuming well is shut-in with fluid at surface) is equal to the depth divided by 100. (Time, min. = Depth, ft / 100).
FOR WATER INJECTION SYSTEMS drop the sticks into the water supply tank to inhibit more of the system.

the water column). Then drop the oil soluble sticks which will "FLOAT" at where the oil and water contact thus slowly dissolving and releasing inhibitor in the oil column.

The sticks are economical when compared to conventional corrosion control operations and therefore save investment in pumps, drums of chemical, and equipment maintenance.

Corrosion Inhibitor SticksT may be used in wells with bottom hole temperatures (BHT) of up to 375 degrees Fahrenheit.

PRODUCTION SPECIFICATIONS

OIL SOLUBLE: The stick will dissolve in 20 to 120 minutes (in moving diesel) depending on temperature, salt content, and relative fluid motion. The stick will melt at 135 degrees Fahrenheit and the specific gravity is 0.95.

WATER SOLUBLE: The stick will dissolve in 12 to 24 hours (in 60,00 PPMmoving brine water) depending on temperature, salt content, and relative fluid motion. The stick will melt at 125 degrees Fahrenheit and the specific gravity is 1.10.

PRODUCT PACKAGING

SENIOR	**1.55 lb/stick**	**24/case**	**31/pail**	**48/chest**
JUNIOR(1)	**1.20 lb/stick**	**36/case**	**n/a**	**72/chest**
JUNIOR(2)	**0.76 lb/stick**	**36/case**	**52/pail**	**72/chest**
THRIFTY	**0.49 lb/stick**	**49/case**	**72/pail**	**98/chest**
MIDGET	**0.19 lb/stick**	**108/case**	**204/pail**	**216/chest**

WHERE TO BUY

All good oil field supply stores carry Aqua-Clear, Inc. Corrosion Inhibitor Sticks™, but you can also buy direct from us.

Ordering Information

Should you wish to speak to a sales representative about any of our products, you can call or email Tommy Halloran Jr., Ronald "Buster" Wilson, or Russell Cook directly:

Tommy Halloran Jr.
W 304-343-4792
H 304-345-5152
C 304-546-8526
tom@aquaclear-inc.com

Ronald "Buster" Wilson
W 304-546-8518
H 304-965-7996
Fax 304-965-2713
buster@aquaclear-inc.com

Russell Cook
W 304-546-2940
H 304-842-7050
Fax 304-842-7050
russell@aquaclear-inc.com

WELL CONSTRUCTION

INJECTION WELL CONFIGURATION

Figure 1
Well Construction Diagram

Bear Lake Properties, LLC
Bittinger #2
Columbus Township
Warren County, PA
37-123-33944

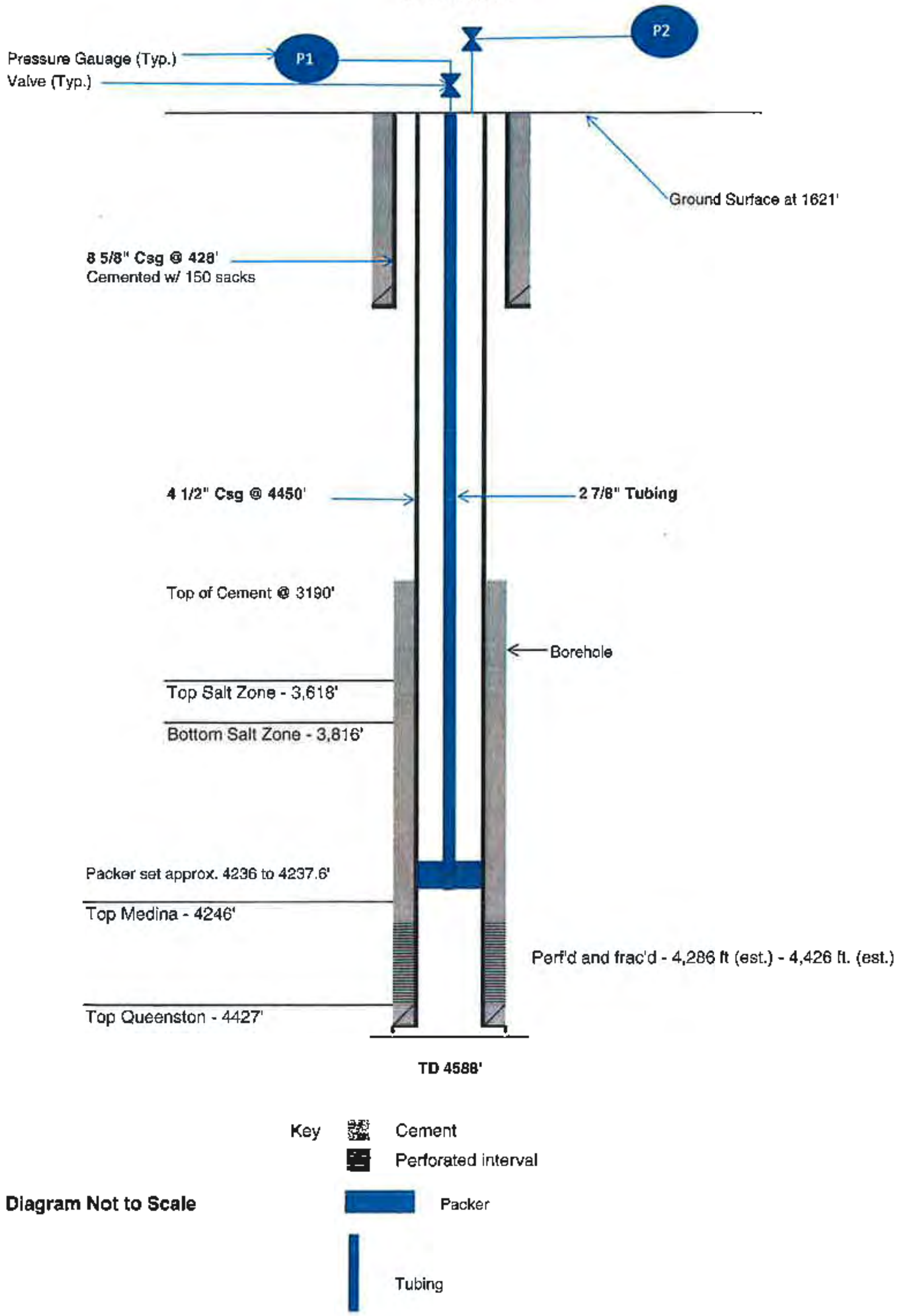


Diagram Not to Scale

WELL CONSTRUCTION

BITTINGER #2 COMPLETION RECORD

5500-FM-OG0016a Rev. 5/2004 For assistance in accessing this document, contact R3_UIC_Mailbox@epa.gov

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF OIL AND GAS MANAGEMENT

DEP USE ONLY	Inspection Record # 2196197
Complaint Record #	Enforcement Record #

INSPECTION REPORT

DEP Office	Warren District Office Phone 814-723-32[illegible]	Permit or Reg. #	123-33944
Address	321 North State Street Fax 814-723-[illegible]	Project #	
	Warren PA 16365	Farm Name & Well #	Bittinger 2
Oper Name	Bear Lake Properties, LLC	County	Warren
Address	3000 Village Run Rd.	Municipality	Columbus
	Wexford PA 15090	Latitude:	° ' " N
	DEP ID #	Longitude:	° ' " W

Inspection Code:
- ☐ BDREL – Bond Release
- ☐ CEI – Compliance Evaluation
- ☐ COMPL – Complaint Inspection
- ☐ DRALT – Drilling or Alteration
- ☐ FUI - Follow Up
- ☐ PLUG – Plugging
- ☐ RDSPR – Road Spreading
- ☐ RESTR – Site Restoration
- ☒ RTNC - Routine

Other: ☐ Permit Expired ☐ Alt/Meth. ☐ Annulus Open ☐ Cement Returns ☐ Recommend Bond Release

Location	Insp.	Violation
Site ID Sign		
Well Tag		
Distance Restrict		
E/S Plan on Site		
Administrative		
Encroachments		
Site Restoration		
Abandoned		
Drilling-Plugging		
Notification		
B.O.P.		
Casing		
Monument		
Waste Mgmt.		
Top Hole Water		
Fluids Mgmt.		
Impoundment/pit		
Pollution Prevent.		
Residual Waste		

Driller's Log Information — Depth:

Fresh Water Amt / Depth	Salt Water Amt / Depth	Coal Thickness / Depth	Formations Oil / Depth	Formations Gas / Depth

Drilling / Plugging

Filling Material & Plugs	From	To	Casing & Tubing Size	Pulled	Left

Compliance Assistance	Code	Code	Inspection Results	Code
				NOVIO

Remarks: Performing bond log at this time. T.O.C. on production casing is located at 3190' from surface.

Sample No.	Location/Description	DEP Rep.	
		(signature)	Date: 08/13/2013
		(print name) Marshall Wurst	Time: 11:00

Page 1 of __

☐ White – Regional File ☐ Yellow – Operator ☐ Pink – Inspector ☐ Goldenrod – Company File

Columbus

ER-OG-4: Rev. 2/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
DIVISION OF OIL AND GAS REGULATION
PITTSBURGH, PENNSYLVANIA 15222

123 33944 (c)

Office Use Only

RE

990 S 42°00'00"
9700 W 79°30'00"

WELL RECORD

123 - 33944

CSO

PERMIT NO. WAR 33944 PROJECT NO. DEEP TYPE OF WELL GAS

COLUMBUS FIELD, DEWEY CORNERS POOL - DEU

WELL OPERATOR U.S. ENERGY DEVELOPMENT CORPORATION		TELEPHONE NO. 716-856-9764		
ADDRESS 670 STATLER BUILDING, BUFFALO, NEW YORK		ZIP 14202-9990		
FARM NAME BITTENGER	FARM NO. #2	SERIAL NO.		ACRES 160
TOWNSHIP COLUMBUS	COUNTY WARREN			
DRILLING COMMENCED 1/22/84	DRILLING COMPLETED 1-29-84			
ELEVATION 1621'	QUADRANGLE COLUMBUS	☒ 7½'	☐ 15'	

CASING AND TUBING RECORD

PIPE SIZE	AMOUNT IN WELL	MATERIAL BEHIND PIPE CEMENT (SKS.)	GEL (SKS.)	PACKER TYPE	SIZE	DEPTH	DATE RUN
8 5/8"	428'	150					1/24/84
4 1/2"	4240'			Tension	4 1/2" x 7 5/8"	4240'	1/29/84

T.D.	D.D.	D.P.I.	Class	O G	L...
4588		4415	D	/	/

PERFORATION RECORD

DATE	INTERVAL PERFORATED FROM	TO
not applicable		

STIMULATION RECORD

DATE	INTERVAL TREATED	AMOUNT FLUID	AMOUNT SAND	INJECTION RATE
~~not applicable~~				

NATURAL OPEN FLOW 554 MCF	NATURAL ROCK PRESSURE 1100 — 72 HRS.
AFTER TREATMENT OPEN FLOW N/A	AFTER TREATMENT ROCK PRESSURE HRS. DAYS

REMARKS: DRILLER'S T.D. 4574' MEDINA

WOW LOGGER'S T.D. 4588'

AND GAS REGULATION
1984 JAN -6 PM 12:15

RECEIVED
OCT 1 1984
DER-TGS
PA GEOLOGICAL SURVEY
(Oil & Gas Geology Division)

(FORMATION ON REVERSE SIDE)

C/AO
7-15-84

ER-OG-4: Rev. 2/80
(pg 2)

FORMATIONS

NAME	TOP	BOTTOM	GAS AT	OIL AT	WATER AT (FRESH OR SALT WATER)	SOURCE OF DATA
UNCONSOLIDATED GRAVEL	0'	12'				Driller's
DEVONIAN SHALE	12'	2807'			FRESH @ 109'	RECORD
"TULLY" LS.	2807'	2915'				AND
HAMILTON SHALES	2915'	3084'				GEOPHYSICAL
ONONDAGA	3084'	3256'				LOGS
UNCONFORMITY INTERVAL	3256'	3270'				
AKRON-BERTIE	3270'	3357'				
CAMILLUS	3357'	3421'				
SYRACUSE	3421'	3639'				
SALT ZONE	3618'	3816'			SALT @ 3710'	
VERNON	3639'	3955'				
LOCKPORT	3955'	4123'				
ROCHESTER	4123'	4209'				
IRONDEQUOIT-REYNALES	4209'	4246'				
GRIMSBY	4246'	4362'				
POWER GLEN	4362'	4411'				
WHIRLPOOL	4411'	4427'	4415'			
QUEENSTON	4427'	T.D.				
T.D.	4574'					

MAY 25, 1984
DATE

Douglas K. Walch
APPROVED BY

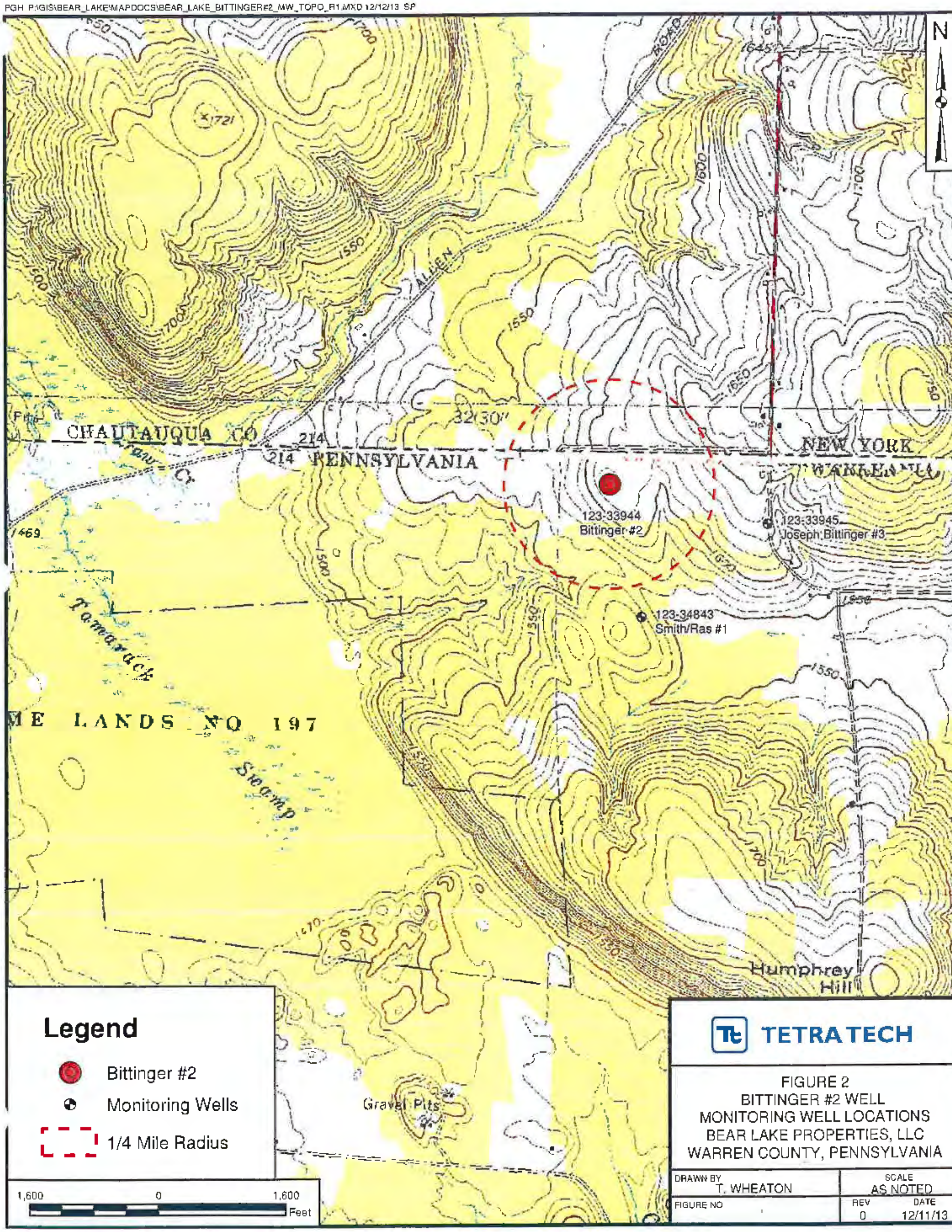
GEOPHYSICIST
TITLE

Section 8 - Monitoring Program

The fluid levels in the following nearby depleted Medina natural gas wells will be measured and recorded semi-annually, at a minimum. The monitoring well locations are shown on the attached figure.

Injection Well	Monitoring Well	Approximate Distance and Direction From Injection Well
Bittinger #2	Joseph Bittinger #3	2,000 ft to the southeast
	Smith/Ras Unit 1	1,600 ft to the south

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BEAR_LAKE_BITTINGER#2_MW_TOPO_R1.MXD 12/12/13 SP



TETRA TECH

FIGURE 2
BITTINGER #2 WELL
MONITORING WELL LOCATIONS
BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA

DRAWN BY	SCALE
T. WHEATON	AS NOTED
FIGURE NO	REV: 0 / DATE: 12/11/13

Section 9 - Plugging and Abandonment Plan

At the point when the well is no longer used, the well will be abandoned in accordance with EPA and PADEP regulations. With regard to PADEP regulations, this currently includes providing a "Notice of Intent to Plug a Well" no less than 3 days and no more than 30 days prior to abandoning the well, to allow a PADEP inspector to be present during the plugging procedure. The PADEP may waive the notification period. The notification will include well location plat, well logs, production logs, injection logs, construction details, and proposed abandonment method. After receiving approval from PADEP to proceed, the well will be abandoned and the abandonment procedures will be documented on a "Certificate of Plugging".

The USEPA will be notified of the plugging activity at least 45 days prior to commencing activities. This notification will include USEPA Form No. 7514-20. A proposed plugging plan (Form 7514-20) is attached based on the current PADEP and USEPA regulations. However, this may be modified prior to plugging in order to meet the requirements at the time of the plugging activity. A contractor cost estimate to perform plugging and abandonment according to the proposed plugging plan is attached. The contractor estimate is $30,000 for these services.

PLUGGING AND ABANDONMENT PLAN

PLUGGING AND ABANDONMENT ESTIMATED COSTS

DLH ENERGY SERVICE

PO Box 40, 5296 Bly Hill Road
Ashville, NY 14710
Phone 716-410-0204 or 716-410-0028
Fax 716-526-4080

October 13, 2010

To: Mr. Karl Kimmich
Bear Lake Properties, LLC

Re: Estimated plugging cost

The estimated cost to plug to abandon your Bittinger # 1and 4 wells is $30,000.00 per well.

Please see attached itemized estimate.

Thank You for the opportunity to be of service to Bear Lake Properties.

Regards,
Chuck DuBose
DLH Energy Service, LLC

DLH Energy Service, LLC

Project	Projected Plug to Abandon Cost			Date:	10/12/2010
AFE Number:		Lease Name: Bittinger		Well Number: 1 & 4	
Billing Code No.	Description of the Billing Codes	Contractor's Company Name	Contractor's Bid Cost	In - House Cost	Cost Per Billing Code No.
100-01	Intang - Legal				$0.00
100-02	Intang - Engineering				$0.00
100-03	Intang - Geology				$0.00
100-04	Intang - Supervision		$1,000.00		$1,000.00
100-05	Intang - Permits			$500.00	$500.00
100-06	Intang - Surveying				$0.00
100-07	Intang - Water Testing				$0.00
100-08	Intang - Environmental Assessment				$0.00
100-09	Intang - Road & Loc. Construction	Roustabout	$1,000.00		$1,000.00
100-10	Intang - Timbering				$0.00
100-11	Intang - Drilling				$0.00
100-12	Intang - Cement Casing		$9,100.00		$9,100.00
100-13	Intang - Wire line Logging		$6,500.00		$6,500.00
100-14	Intang - Notching				$0.00
100-15	Intang - Perforating				$0.00
100-16	Intang - Fracturing				$0.00
100-17	Intang - Water Pumping				$0.00
100-18	Intang - Water Hauling		$1,600.00		$1,600.00
100-19	Intang - Service Rig Notching				$0.00
100-20	Intang - Service Rig Frac				$0.00
100-21	Intang - Water Disposal		$1,000.00		$1,000.00
100-22	Intang - Service Rig Completion	Plugging	$4,100.00		$4,100.00
100-23	Intang - Trucking		$1,700.00		$1,700.00
100-24	Intang - Dozer / Excavator		$500.00		$500.00
100-25	Intang - Site Restoration		$500.00		$500.00
100-26	Intang - Gathering Line Installation				$0.00
100-27	Intang - Electric line / Transformer Install				$0.00
100-28	Intang - Well head / Jack Install				$0.00
100-29	Intang - Rentals tanks/frac pipe/tbg				$0.00
100-30	Intang - Frac Packer Re - Dress				$0.00
100-31	Intang - Prod Equip & Tank Battery Install				$0.00
100-32	Intang - MISC		$2,500.00		$2,500.00
200-01	Tang - Materials Road & Location				$0.00
200-02	Tang - Casing Conductor				$0.00

200-03	Tang - Casing Surface				$0.00
200-04	Tang - Casing Production				$0.00
200-05	Tang - Frac Packer				$0.00
200-06	Tang - Tubing				$0.00
200-07	Tang - Rods				$0.00
200-08	Tang - Rod Pump/Downhole Equip				$0.00
200-09	Tang - Well head / Valves / Fittings				$0.00
200-10	Tang - Pump Jack				$0.00
200-11	Tang - Electric Motor / Panel				$0.00
200-12	Tang - Plumbing Fittings / Valves				$0.00
200-13	Tang - Tank Battery				$0.00
200-14	Tang - Oil / Water Separator				$0.00
200-15	Tang - Gas Separator				$0.00
200-16	Tang - Gathering Line Material				$0.00
200-17	Tang - Electric Line				$0.00
200-18	Tang - Gas Sales Meter				$0.00
200-19	Tang - Pump Off Controller				$0.00
200-20	Tang - MISC				$0.00
	Contractor's Total Costs		$29,500.00		
		In House Total Costs		$500.00	
			Grand Total		**$30,000.00**

UNIVERSAL
WELL SERVICES, INC.

Mr. Dale Skoff
Tetra Tech
661 Anderson Drive
Foster Plaza 7
Pittsburgh, Pa. 15220

Dear Dale,

This bid is the Approximate Cost and Procedure to plug this well. Actual plug as follows

4286 to 4085 feet	Cement plug to plug off perforations	32 Sacks
4085 to 2000 feet	Bentonite gel 6% spacer	
2000 feet	cut 4 ½ inch casing or above salt	
2000 to 1900 feet	Cement plug	30 Sacks
1900 to 900 feet	Bentonite gel 6% spacer	
900 to 750 feet	Cement plug over shale zone	43 Sacks
750 to 550 feet	Bentonite gel 6% spacer	
550 to 450 feet	Cement plug 50 ft in open hole 50 ft inside 8 5/8 casing	30 Sacks
450 to 50 feet	fill up with pea gravel	
50 to 0 feet	Cement plug to surface	15 Sacks

P.S. If there is any Ononadaga in this well it will require a plug also.
Bentonite is mixed 100 lbs to 6 bls water

Sincerley,

David Cook
Field Sales Rep.

Prepared for
Tetra Tech
661 Anderson Drive
Foster Plaza 7
Pittsburgh, Pa. 15220
December 7, 2010
Bid #0006133

UNIVERSAL WELL SERVICES, INC.
A PATTERSON-UTI ENERGY COMPANY

Prepared by
Daniel R Simmons
159 Northwood Dr.
Meadville, PA 16335
(814) 337-1115
Dan.Simmons@univwell.com

Plug to abondon well.
Plug to abandon Medina well in N. Warren county.

Product #	Description	Qty	Units of Sale	Unit Price	Total Price
A0035	MISCELLANEOUS PUMP 1ST 4 HRS	1.0	EA	$2,410.00	$2,410.00
T0002	EQUIPMENT MILEAGE CHARGE	40.0	TRK/MI	$7.50	$300.00
M0001	CEMENT - CLASS A	150.0	SK	$17.50	$2,625.00
M0040	BENTONITE GEL	25.0	CWT	$33.50	$837.50
M0050	UNICELE	25.0	LB	$4.00	$100.00
F0032	CEMENT BLENDING CHARGE	150.0	SK	$2.35	$352.50
T0003	CEMENT DELIVERY CHARGE	540.0	SK-MI/10	$1.10	$594.00
				Gross Price:	**$7,219.00**
				20.00% Special Discount Applied:	**$5,775.20**

Comments:

- Plug to abandon Medina well in northern Warren county. We would use Class A cement. Overtime would start after 4 hour at the rate of $590.00 per hour. The lease name is Bittinger # 4.
- Payment Terms: 30days with credit
- This price quote is valid through 12/31/2010. Actual job scheduling is based upon equipment availability.

PLUGGING AND ABANDONMENT PLAN

EPA FORM 7520-14

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility	Name and Address of Owner/Operator
Bear Lake Properties, LLC Columbus Township, PA	Bear Lake Properties, LLC 3000 Village Run Road, Unit 103, #223, Wexford, PA 15090

Locate Well and Outline Unit on Section Plat - 640 Acres

N / W / E / S

State	County	Permit Number
PA	Warren	

Surface Location Description

___ 1/4 of ___ 1/4 of ___ 1/4 of ___ 1/4 of Section ___ Township ___ Range ___

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ___ ft. frm (N/S) ___ Line of quarter section
and ___ ft. from (E/W) ___ Line of quarter section.

TYPE OF AUTHORIZATION

- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name Bittinger

WELL ACTIVITY

- [ ] CLASS I
- [ ] CLASS II
  - [x] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number Bittinger #4

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
13 3/8			30	
8 5/8			506	
4 1/2			2455 (after cutting)	

METHOD OF EMPLACEMENT OF CEMENT PLUGS

- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inches)	4 1/2	7 7/8	7 7/8	8 5/8	8 5/8		
Depth to Bottom of Tubing or Drill Pipe (ft	4286	2000	900	550	50		
Sacks of Cement To Be Used (each plug)	32	30	43	30	14		
Slurry Volume To Be Pumped (cu. ft.)	37.8	35.4	50.7	35.4	16.5		
Calculated Top of Plug (ft.)	4085	1900	750	450	0		
Measured Top of Plug (if tagged ft.)	4085	1900	750	450	0		
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6	15.6	15.6		
Type Cement or Other Material (Class III)	Class A	Class A	Class A	Class A	Class A		

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
506	2000 (open hole - csg cut)		

Estimated Cost to Plug Wells

$30,000

Certification

I certify under the 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. (Ref. 40 CFR 144.32)

Name and Official Title (Please type or print)	Signature	Date Signed
Karl Kimmich, President	Karl C. Kimmich	12/07/2010

Section 10 - Necessary Resources

Bear Lake Properties, LLC will obtain a Letter of Credit to verify that they have the resources necessary to plug and abandon the well. This documentation will be provided under a separate cover at a later date.

Section 11 - Plan for Well Failures

The pressure in the annulus between the tubing and production (4 ½ inch) casing in the injection well will be continuously monitored. The annulus between the 4 ½ and 8 5/8 inch casing will be visually monitored. Should a pressure increase occur in the annulus between the tubing and production casing or visual observations of the annulus between the 4 ½ and 8 5/8 inch casing indicate mechanical integrity problems, injection will cease and EPA will be verbally notified within 24 hours and notified in writing within 7 days. The cause of the potential mechanical integrity problem will be investigated by Bear Lake Properties and remedial measures implemented following discussions with EPA on the proposed approach.

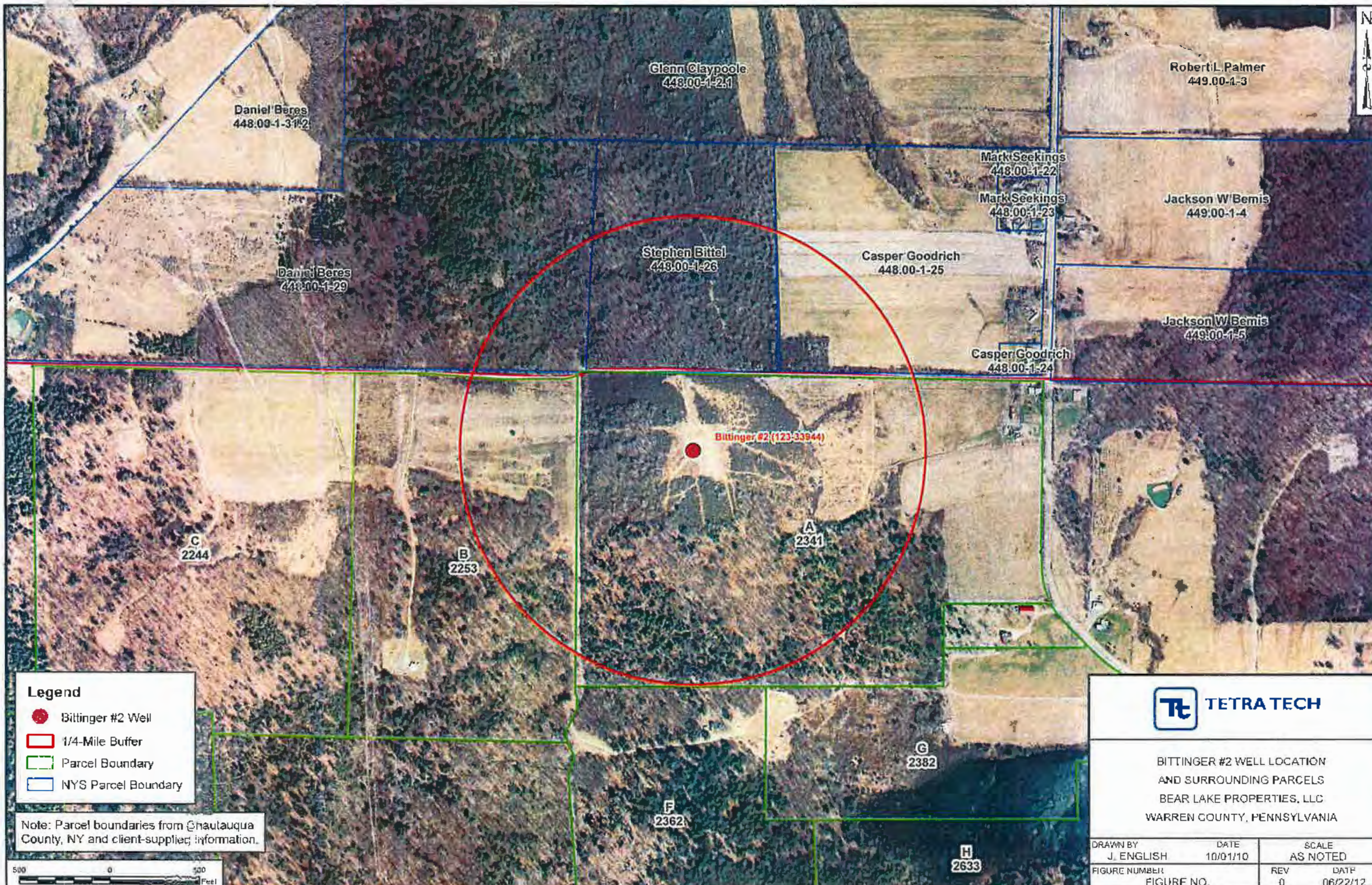
Appendix A

Appendix A contains the names and address of residents located within ¼ mile of the proposed injection well.

Landowners Within 1/4 Mile of Bittinger #2 Well

Pennsylvania Landowners			
	PARCEL #	OWNER	ADDRESS
A	2341	Bear Lake Properties, LLC	3010 Village Run, Suite 103, Wexford, PA 15090
B	2253	Miles and Joyce Sampsel	8353 Pagan Road, Erie, PA 16509
F	2362	Jack and Marilyn McCoy	P.O. Box 112, Columbus, PA 16405

New York Landowners		
OWNER	PARCEL #	ADDRESS
Daniel Beres	448.00-1-29	4318 Oakwood Ave Blasdell NY 14219
Stephen Bittel	448.00-1-26	230 Elmhurst Cir Cranberry Twp Pa 16066
Casper Goodrich	448.00-1-25	5 Weeks Rd Panama NY 14767


N
Glenn Claypoole
448.00-1-2.1
Robert L Palmer
449.00-1-3
Daniel Beres
448.03-1-31.2
Mark Seekings
448.00-1-22
Mark Seekings
448.00-1-23
Jackson W Bemis
449.00-1-4
Stephen Bittel
448.00-1-26
Casper Goodrich
448.00-1-25
Daniel Beres
448.00-1-29
Jackson W Bemis
449.00-1-5
Casper Goodrich
448.00-1-24
Bittinger #2 (123-33944)
A
2341
B
2253
C
2244
G
2382
F
2362
H
2633
Legend
Bittinger #2 Well
1/4-Mile Buffer
Parcel Boundary
NYS Parcel Boundary
Note: Parcel boundaries from Chautauqua County, NY and client-supplied information.
500
0
500
Feet
TETRA TECH
BITTINGER #2 WELL LOCATION
AND SURROUNDING PARCELS
BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA
DRAWN BY
J. ENGLISH
DATE
10/01/10
SCALE
AS NOTED
FIGURE NUMBER
FIGURE NO.
REV
0
DATE
06/22/12

COPY

*Noted on P3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

PAS2D 217 BWAR

022714

Karl Kimmich, President
Bear Lakes Properties, LLC
3000 Village Run Road
Wexford, PA 15090

RE: Notice of Deficiency; Bittinger #2 Underground Injection Control Class II Commercial Disposal Well Application; Town of Wexford, Warren County, Columbus Township, Pennsylvania.

Dear Mr. Kimmich;

Upon initial review of the Underground Injection Control (UIC) Class IID permit application for Bittinger #2, multiple deficiencies were identified. Please correct the deficiencies listed below. If you have any questions please contact Brian Poe of the UIC program at 215-814-5471 or poe.brian@epa.gov.

Notice of Deficiency

1. Since P-205 will be permitted individually and a copy of the application will be placed in a public location and may be reviewed by the public, it is imperative that all referenced material be included and all calculations be shown and clear. While EPA does have the permit applications for Bittinger #1 and #4 on file, the public does not and therefore can't reference the information included in these applications.
2. In Section 1,."Area of Review Methods and Calculations":
   a. The application shows the equation and parameters that are used but the calculations have not been supplied. Please provide actual calculations.
   b. "Parameters used in the calculations"; the application indicates the initial pressure at the top of the injection formation equals 128 psi. PADEP's Well Record states an initial pressure of 1100psi. Please verify the current formation pressure with calculations or a description of how the value was achieved, and a written summary of why it is much lower than the initial formation pressure.
   c. The application states that the permeability was derived by "estimating a value that is representative of the average of the upper and lower range of values for this parameter". Please provide a detailed explanation how permeability, and porosity values were derived for the Medina, include descriptions of the Grimsby, Power Glenn and Whirlpool.
3. Section 3,"Corrective Action Plan". The application states the names of the proposed monitoring wells. If Section 8, "Monitoring Program", is modified please update Section 3.
4. Section 5, "Geologic Data on Injection and Confining Zones".

b. **Please submit a way to automatically detect a significant pressure change within the annulus and shut in the injection well if a significant pressure change is automatically detected.**

Thank you,

Brian Poe

• Karl Kimmich contacted me to discuss N of D on Wednesday March 19, 2014
- #5 a. = only problem they had. Did not want or care to define. As long as they do not exceed Max Inj. Pres. & monthly volume they are fine.

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:
Karl Kimmich
Bear Lakes Properties, LLC
3000 Village Run Road
Wexford, PA 15090

COMPLETE THIS SECTION ON DELIVERY

A. Signature
X Maxwell Heintzelman ☐ Agent ☐ Addre

B. Received by (Printed Name) Maxwell Heintzelman

C. Date of Del 3-6-14

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☑ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchar
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? (Extra Fee) ☐ Yes

2. Article Number
(Transfer from service label) 7001 0360 0001 5504 8725

PS Form 3811, February 2004 Domestic Return Receipt 102595-02-M

U.S. Postal Service
CERTIFIED MAIL RECEIPT
(Domestic Mail Only: No Insurance Coverage Provided)

7001 0360 0001 5504 8725

Postage	$
Certified Fee	
Return Receipt Fee (Endorsement Required)	
Restricted Delivery Fee (Endorsement Required)	
Total Postage & Fees	$

Postmark Here

Sent To Bear Lakes - Karl Kimmich
Street, Apt. No.; or PO Box No. 3000 Village Run Rd
City, State, ZIP+4 Wexford, PA 15090

PS Form 3800, January 2001 See Reverse for Instructions

Printed on 100% recycled/recyclable paper with 100%
Customer Service Hotli

TETRA TECH

April 25, 2014

Mr. Brian Poe
United States Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

RE: Notice of Deficiency; Bittinger #2 Underground Injection Control Class II Commercial Disposal Well Application Columbus Township, Warren County, Pennsylvania

Dear Mr. Poe:

In response to the USEPA Region III comment letter, dated February 27, 2014 on the subject UIC Class II-D Well permit application, this letter summarizes each comment and Bear Lake Properties, LLC's (Bear Lake Properties') response.

Comment:

1. Since P-205 will be permitted individually and a copy of the application will be placed in a public location and may be reviewed by the public, it is imperative that all referenced material be included and all calculations be shown and clear. While EPA does have the permit applications for Bittinger #1 and #4 on file, the public does not and therefore can't reference the information included in these applications.

Response:

All referenced material in the application has been included in the application and all calculations clearly shown.

Comment:

2. In Section 1, "Area of Review Methods and Calculations":
   a. The application shows the equation and parameters that are used but the calculations have not been supplied. Please provide actual calculations.
   b. "Parameters used in the calculations"; the application indicates the initial pressure at the top of the injection formation equals 128 psi. PADEP's Well Record states an initial pressure of 1100 psi. Please verify the current formation pressure with calculations or a description of how the value was achieved, and a written summary of why it is much lower than the initial formation pressure.
   c. The application states that the permeability was derived by "estimating a value that is representative of the average of the upper and lower range of values for this parameter". Please provide a detailed explanation how permeability, and porosity values were derived for the Medina, include descriptions of the Grimsby, Power Glenn and Whirlpool.

Response:

a. Calculations for the Area of Review determination are attached.

b. The value for the initial pressure at the top of the injection formation of 128 psi was based on the bottom hole pressure measurement made prior to initiation of injection operations on the Bittinger #4 well, located approximately ¼ mile to the west. The current injection pressure at the top of the injection formation is much lower than the initial formation pressure due to the large volume of natural gas produced from the Medina-Whirlpool at the Bittinger #2 and nearby wells, which have been producing gas since the mid-1980s. As indicated on the attached table summarizing well production data for the Bittinger #2

Tetra Tech, Inc.
661 Andersen Drive, Pittsburgh, PA 15220
Tel 412.921.7090 Fax 412.921.40404 www.tetratech.com

and six nearby wells, the cumulative total production among the seven wells is over 1.75 BCF gas.

c. Considering the project area is known to have some of the best reservoir development in the Medina-Whirlpool play, an average permeability of 100 md was utilized based on professional experience. In addition, the injection rate and pressure data gathered so far for the Bittinger #1 and #4 wells, which as discussed below are very similar in geologic characteristics to the Bittinger #2 well, indicate the Medina-Whirlpool interval in these wells has significant permeability conducive to injecting 1000 bbls/d per well under permitted pressures. To be conservative, the Area of Review determination analysis was performed for this response using a permeability value of 20 md, which represents an 80% reduction from the original permeability estimate. As indicated by the attached graph showing the model output, even at 20 md the Zone of Endangering Influence is less than ¼ mile, resulting in the default ¼ mile AOR. It is also noted that during disposal operations, Bear Lake Properties will monitor pressures and fluid levels in nearby depleted gas wells, all of which have adequately cemented surface casing >150 below the base of the lowest most USDW. Also attached is a copy of revised Figure 1 of the original AOR/Zone of Endangerment Analysis technical memo included in Section 1 of the application. The revised graph indicates the same AOR determination (i.e., the default ¼ mile) as the original graph.

Comment:

3. Section 3, "Corrective Action Plan". The application states the names of the proposed monitoring wells. If Section 8, "Monitoring Program" is modified, please update Section 3.

Response:

For reasons discussed below, Section 8 was not modified.

Comment:

4. Section 5, "Geologic Data on Injection and Confining Zones".
   a. The application generically states which formations the well is designed to inject into. Please provide a detailed description of the geology of the Medina, including the Grimsby, Power Glenn and Whirlpool. The geological data summary should discuss lithology, dimension, permeability, porosity, history of production, discussion of formation pressure, etc.
   b. Please include a representative geologic cross section with a detailed written summary. If using data from other wells to model Bittinger #2, please select a section line that shows the relationship. A separate cross section may be necessary to show representative monitoring wells.
   c. "Potential for Faults and Seismicity". Please provide data on the production that has taken place in the proposed injection formations to explain the drop formation pressure over time and the relationship this pressure reduction has on seismic activity.

Response:

a. The formations the well is designed to inject into are described in detail in the attached report prepared by Billman Geologic Consultants entitled, "Geologic Review of the Bittinger Area, Planned SWD Site", dated August 2, 2010, and the cover letter dated April 5, 2014 discussing the Bittinger #2 well geologic characteristics. The report discusses the characteristics of the Medina Group formations including the Grimsby, Power Glenn and Whirlpool. Production data for the Bittinger #2 are summarized on the attached table (referenced above) along with six other nearby wells. Cumulative gas production from the Bittinger #2 well is over 255 MMCF. As mentioned above, total production from all seven wells is over 1.75 BCF. The impact of removal of this large volume of gas is, as expected, a decrease in reservoir pressure. Estimated formation permeability was discussed in response to comment 2c.

b. The Billman Geologic Consultants report includes cross-sections in the vicinity of the Bittinger #2 well. As indicated in the cover letter to the report, the formation characteristics (lithology, thickness, porosity, etc.) of the Medina Group rocks in Bittinger #2 well are very similar to those of the nearby wells including proposed monitoring wells.

c. A detailed review of the zone of injection and data on geologic strata surrounding the zone of injection for the proposed brine disposal well, indicates the following supporting evidence that seismicity is highly unlikely: 1.) The detailed geologic cross-sections (Appendix 2 of the Billman Geologic Consultants Report) and isopach and structural mapping completed by Billman Geologic Consultants show no evidence of faulting in the study area. 2.) Historic production of over 1.75 billion cubic feet of gas among the Bittinger #1, #2, #3 and #4, Smith Ras #1 and Trisket #1 and #2 wells and unknown volumes of formation brine from the proposed zone of injection near the Bittinger 2 has depleted the zone of almost 90% of its original reservoir pressure. The disposal operations will re-fill this void space over the life of the project. 3.) A review of the PA DCNR "Earthquake Epicenters in and Near Pennsylvania" (attached Figure 1) indicates that there have been no recorded seismic events within 25 miles of the disposal project area since 1724, the start of the reporting period.

<u>Comment:</u>

5. Section 6, "Operation Data – Injection Rate".
   a. The application requests an injection rate of 30,000 barrels per day. Please confirm that a "day" equals 24 hours for proper rate determination.
   b. Bittinger #4 is used to represent the injection rate and pressure data for Bittinger #2. Please provide a detailed summary and supporting operational data defending the use of Bittinger #4 as model for Bittinger #2.

<u>Response:</u>

a. The application Section 6 under "Injection Rate" states that "An injection rate of 30,000 bbls/month is therefore also proposed for this well."

b. The USEPA annual report for the Bittinger #4 well is attached. As indicated, injection operations at the Bittinger #4 well began in February 2013. The maximum monthly injection volume for the year was 10,973 bbls (October 2013) which occurred under an average injection pressure of 685 psi, which is well under the permitted Maximum Injection Pressure (MIP)(Surface) of 1,726 psi. The Bittinger #4 well did not achieve the 30,000 bbls/month limit due to market conditions which precluded having such a volume of brine available for injection. Based on the response of the Bittinger #4 well, we believe it is capable of routinely injecting 30,000 bbls/month. As discussed in the Billman Geologic Consultants report, the geologic characteristics of the Medina Group rocks in Bittinger #4 are very similar to those of Bittinger #2 based on log analysis. Likewise cumulative gas production from the two wells is in the same general range. For these reasons, we believe the Bittinger #4 is an analogous well to the Bittinger #2 well and likely to have similar injection potential.

<u>Comment:</u>

6. Section 7, "Well Construction".
   a. The information submitted is incomplete. Please provide the cement ticket for the surface casing which documents cement returns and full copies of the geophysical logging sweet for the well. If a cement bond log has not been completed on the long string casing, one will need to be performed. Calculations showing cement returns may be necessary if sufficient data is not available.

b. Please provide driller's core logs for Bittinger #2, #3, & #4, Smith Ras Unit 1, R Trisket 1, R Trisket 2, and Goodrich 1.

Response:

a. A cement ticket documenting cement returns to surface could not be obtained for the Bittinger #2 well; however, the attached calculations of cement volume indicates there was adequate cement to return to surface. A cement bond log was run for the long string casing on August 13, 2013 and witnessed by PADEP staff. The cement bond log indicated a cement top of 3,190 feet (approximately 1,100 ft above the injection interval). The cement bond log and PADEP inspection report are attached.
b. No driller's core logs are available for any of the wells referenced in the comment. The attached Billman Geologic Report (mentioned above) discusses the geology of the Bittinger #2 area in detail based on available wireline porosity log review and other data.

Comment:

7. Section 8, "Monitoring Section".
   a. This section needs greater explanation. Two monitoring wells on a single side of a well are insufficient unless there is supporting information. Monitoring well selection must be representative and data must be submitted to show that they are representative.

Response:

* a. The proposed monitoring wells, Bittinger #3 and Smith Ras Unit 1, are strategically located east and south of Bittinger #2 at a distance of approximately 2,000 ft and 1,600 ft, respectively. As discussed in detail in the attached Billman Geologic Consultants report, the Medina-Whirlpool interval in the monitoring wells is very similar in geologic characteristics to the Bittinger #2. Although the Bittinger #1 and #4 wells are located nearby to the west and east, these wells are permitted operating injection wells and therefore not suitable for monitoring purposes. Note that there are two additional active monitoring wells to the west of active disposal wells Bittinger #1 and Bittinger #4.

Comment:

8. Section 9, "Plugging and Abandonment".
   a. The 7520-14 form submitted is for Bittinger #4 and dated 2010. Please provide the correctly dated and signed 7520-14 form for Bittinger #2.
   b. The application did not include the plugging and abandonment schematic showing cement plugs in proper locations. Please provide a proper plugging schematic with detailed procedures.

Response:

a. The signed 7520-14 form for Bittinger #2 is attached.
b. The plugging and abandonment schematic showing cement plugs and detailed procedures are also attached.

Comment:

9. Section 10, "Necessary Resources".
   a. Please submit an updated Letter of Credit and include the Plugging and Abandonment costs for Bittinger #2.

Response:

a. The Plugging and Abandonment cost estimate for Bittinger #2 is attached along with a Letter of Credit amendment, signed on behalf of Bear Lake Properties. Please have the Letter of Credit amendment executed on behalf of EPA and submitted to Tri-State Capital Bank, which will then issue the Letter of Credit.

Comment:

10. Section 11, "Plans for Well Failure".
    a. The plan for well failure that was submitted provides a general explanation of how well failures will be addressed. Please include a detailed explanation of how both annuluses will be monitored and how injection well failures will be identified in a timely manner and dealt with.
    b. Please submit a way to automatically detect a significant pressure change within the annulus and shut in the injection well if a significant pressure change is automatically detected.

Response:

a. Attached revised Section 11, "Plan for Well Failure" includes a detailed explanation of how both annuluses will be monitored and how injection well failures will be identified in a timely manner and addressed.
b. Attached revised Section 11 also describes how a significant pressure change within the annulus will be automatically detected and the injection well subsequently shut in.

Please feel free to contact me with any questions at (412) 921-4006 or via email at dale.skoff@tetratech.com.

Sincerely,

Dale E. Skoff

Dale E. Skoff, PG
Sr. Project Manager

Enclosures:

cc: Karl Kimmich – Bear Lake Properties
John Holko – Bear Lake Properties

 From NofD

Example calculation for Bittinger #2 well with #1 and #4 operating

Matthews and Russell assume that, for a single well injecting into an infinite, homogeneous and isotropic, non-leaking formation, the increase in pressure (delta p) can be described as:

delta p = 162.6 $Q\mu$ / kh * [(log(kt / $\Phi\mu Cr^2$) – 3.23] where:

calculate at quarter mile from well:
delta p = pressure change (psi) at radius, r and time, t
Q = injection rate (barrels/day) = 1000
μ = injectate viscosity (centipoise) = 1.0
k = formation permeability (millidarcies) = 100
h = formation thickness (feet) = 61
t = time since injection began (hours) = 87,600 (10 years)
C = compressibility (total, sum of water and rock compressibility) (psi^{-1}) = 3.0E-06
r = radial distance from wellbore to point of investigation (feet) = 1320 (quarter mile)
Φ = average formation porosity (decimal) = 0.08

delta p = 162.6 (1000*1.0)/(100*61)*[(log(100*87600/0.08*1.0*3.0E-06*1320^2)-3.23]
delta p = 109 psi

Now add contributions from #1 and #4 and initial pressure in reservoir:
Distance between #2 and #1 is approximately 2000 feet, delta p @2000 feet = 99 psi
Distance between #2 and #4 is approximately 1600 feet, delta p @1600 feet = 105 psi
Initial pressure, p(i), in reservoir = 128 psi

total p @1320 feet = 109 + 99 +105 + 128 = 441 psi

Convert to feet of head:

Surface elev. = 1621 feet
Depth to inj. zone = 4279 feet
Sp.gr. = 1.218

Head = Surface elev. – (Depth to inj.zone – total p/(0.433*sp.gr.))
Head = 1621 – (4279 – 441/(0.433*1.218))
Head = -1822 feet

In summary, at a ¼ mile distance from the Bittinger #2 well the modeled brine hydraulic head elevation is -1822 ft MSL while the base of the lowest most USDW is estimated at 1321 feet MSL. The estimated lowest most USDW is 3143 feet above the modeled hydraulic head at the ¼ mile distance, resulting in utilizing the default ¼ mile AOR.

Additional Info

Area of Review Analysis Graphs

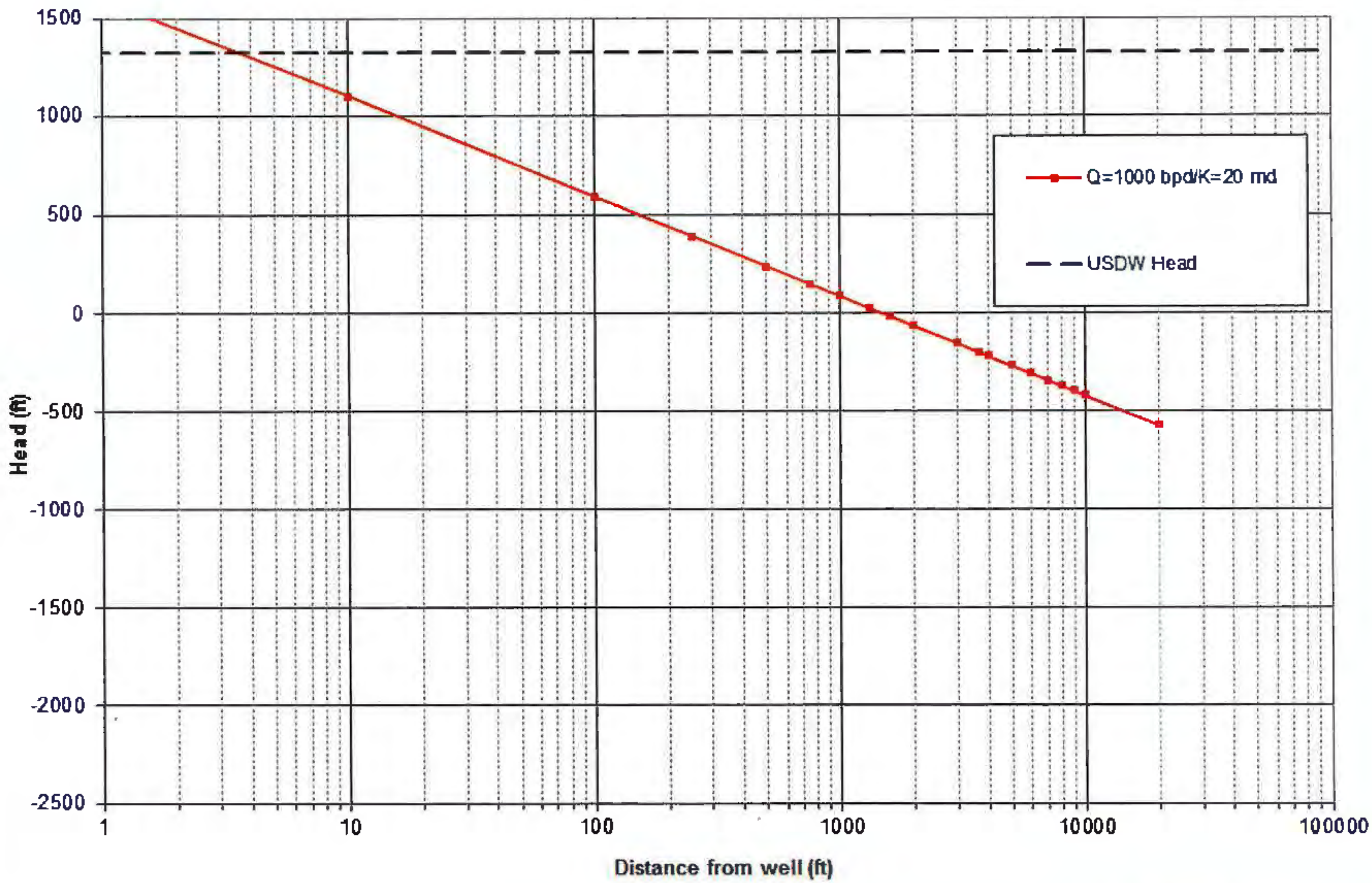


Figure X. Feet of head of injection formation and USDW vs. distance for Bittinger #2 when all wells (Bittinger #2, #1, and #4) are injecting, lower K scenario

TETRA TECH, INC.

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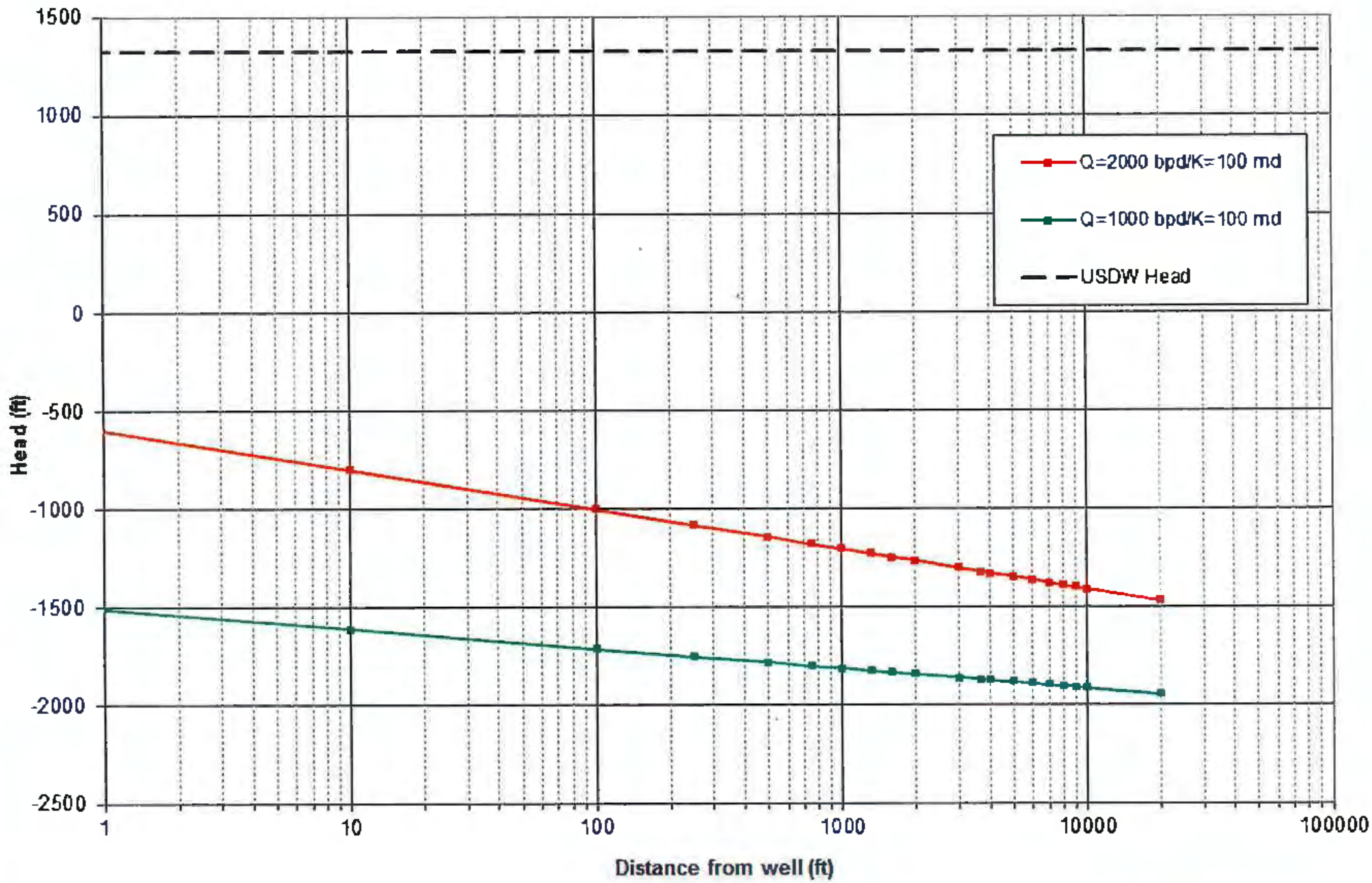


Figure 1. Feet of head of injection formation and USDW vs. distance for Bittinger #2 when all wells (Bittinger #2, #1, and #4) are injecting.

TETRA TECH, INC.

Form No. [illegible]

* To show that the Medina is a depleted formation & that the formation pressure has dropped significantly

* depleted [illegible] = less formation pressure = decreased [illegible] of seismic event

*

Well Production Data = explains the significant decrease in formation pressure.

Permit	Company	Year	Product	Quantity (MCF)	Brine	Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-33944	US ENERGY DEV CORP	1984	GAS	5,812		0	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1985	GAS	22,275		0	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1986	GAS	30,101		336	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1987	GAS	23,479		336	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1988	GAS	47,976		347	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1989	GAS	50,332		352	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1990	GAS	39,609		346	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1991	GAS	21,121		347	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1992	GAS	6,351		323	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1993	GAS	3,039		339	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1994	BRINE		22		WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	US ENERGY DEV CORP	1994	GAS	1,402		319	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	BELDEN & BLAKE CORP	2000	GAS	698		366	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	BELDEN & BLAKE CORP	2001	GAS	67		365	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	BELDEN & BLAKE CORP	2002	GAS	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	BELDEN & BLAKE CORP	2002	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	RANGE RESOURCES APPALACHIA LLC	2002	GAS	5		31	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	RANGE RESOURCES APPALACHIA LLC	2003	GAS	701		334	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	RANGE RESOURCES APPALACHIA LLC	2004	GAS	718		365	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	RANGE RESOURCES APPALACHIA LLC	2005	GAS	670		334	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	RANGE RESOURCES APPALACHIA LLC	2006	GAS	374		334	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	TRINITY ENERGY CORP	2007	GAS	102		122	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	LION ENERGY CO LLC	2008	GAS	193		365	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
123-33944	LION ENERGY CO LLC	2009	GAS	30		30	WARREN	COLUMBUS	JOSEPH BITTINGER	2	COLUMBUS	DEWEY CORNERS	29-Jan-84
			Total	**255,055**	**22**								

Permit	Company	Year	Product	Quantity	Brine	Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-33945	US ENERGY DEV CORP	1986	GAS	32,248		336	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1987	GAS	36,330		336	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1988	GAS	48,995		345	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1989	GAS	42,806		332	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1990	GAS	26,642		343	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1991	GAS	13,848		347	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1992	GAS	5,278		315	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1993	GAS	4,826		360	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1994	BRINE		73		WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	US ENERGY DEV CORP	1994	GAS	1,810		363	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2001	GAS	66		365	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2002	GAS	40		365	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2002	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2005	GAS	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2005	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2006	GAS	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2006	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2008	GAS	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
123-33945	BELDEN & BLAKE CORP	2008	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	3	COLUMBUS	DEWEY CORNERS	19-Oct-84
			Total	**212,890**	**73**								

Permit	Company	Year	Product	Quantity	Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-39273	US ENERGY DEV CORP	1985	GAS	23,500	0	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84

123-39273	US ENERGY DEV CORP	1986	GAS	29,581		308	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1987	GAS	26,012		322	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1988	GAS	34,866		307	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1989	GAS	60,104		352	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1990	GAS	29,211		335	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1991	GAS	6,338		293	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1992	GAS	3,309		321	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	1993	GAS	1,474		165	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2000	GAS	519		240	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2001	GAS	1,166		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	BELDEN & BLAKE CORP	2001	GAS	15		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2002	GAS	684		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2003	GAS	527		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2004	GAS	1,073		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2005	GAS	1,485		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2006	BRINE		5		WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2006	GAS	1,068		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2007	BRINE		5		WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	US ENERGY DEV CORP	2007	GAS	398		240	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	LION ENERGY CO LLC	2008	GAS	201		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
123-39273	LION ENERGY CO LLC	2009	GAS	596		365	WARREN	COLUMBUS	R TRISKET	1	COLUMBUS	DEWEY CORNERS	14-Dec-84
			Total	222,127	10								

Permit	Company	Year	Product	Quantity		Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-39874	US ENERGY DEV CORP	1987	GAS	11,653		112	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1988	GAS	100,800		352	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1989	GAS	100,330		355	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1990	GAS	60,844		342	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1991	GAS	35,401		324	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1992	GAS	13,041		315	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1993	GAS	6,946		360	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1994	BRINE		137		WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	US ENERGY DEV CORP	1994	GAS	5,778		361	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	BELDEN & BLAKE CORP	2000	GAS	92		365	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	BELDEN & BLAKE CORP	2001	GAS	21		365	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	BELDEN & BLAKE CORP	2002	GAS	551		273	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	BELDEN & BLAKE CORP	2002	OIL	0		0	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	RANGE RESOURCES APPALACHIA LLC	2003	GAS	5		62	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	RANGE RESOURCES APPALACHIA LLC	2004	GAS	79		242	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	RANGE RESOURCES APPALACHIA LLC	2005	GAS	308		214	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	TRINITY ENERGY CORP	2007	GAS	32		122	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	LION ENERGY CO LLC	2008	BRINE		38		WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	LION ENERGY CO LLC	2008	GAS	388		365	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
123-39874	LION ENERGY CO LLC	2009	GAS	219		180	WARREN	COLUMBUS	BITTINGER	4	COLUMBUS	DEWEY CORNERS	20-Aug-87
			Total	336,487	175								

Permit	Company	Year	Product	Quantity		Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-40751	US ENERGY EXPLORATION CORP	1990	GAS	41,981		315	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	US ENERGY DEV CORP	1991	GAS	47,292		357	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	US ENERGY DEV CORP	1992	GAS	25,943		322	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	US ENERGY DEV CORP	1993	GAS	17,584		359	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90

123-40751	US ENERGY DEV CORP	1994	BRINE		137		WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	US ENERGY DEV CORP	1994	GAS	19,177		363	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2000	BRINE		5		WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2000	GAS	5,514		366	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2001	BRINE		17		WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2001	GAS	4,531		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2002	GAS	2,340		273	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	BELDEN & BLAKE CORP	2002	OIL	0		0	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2002	GAS	205		31	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2003	BRINE		45	365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2003	GAS	1,594		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2004	GAS	1,422		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2005	GAS	1,554		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	RANGE RESOURCES APPALACHIA LLC	2006	GAS	1,414		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	TRINITY ENERGY CORP	2007	GAS	278		122	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	LION ENERGY CO LLC	2008	GAS	869		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
123-40751	LION ENERGY CO LLC	2009	GAS	1,506		365	WARREN	COLUMBUS	R. TRISKET	2	COLUMBUS	DEWEY CORNERS	5-Jan-90
			Total	**173,205**	**204**								

Permit	Company	Year	Product	Quantity		Days	County	Municipality	Farm_Name	Farm_Well_No	Field	Pool	Completion Date
123-34843	US ENERGY DEV CORP	1985	GAS	17,683		0	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1986	GAS	31,402		336	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1987	GAS	29,357		322	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1988	GAS	50,639		338	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1989	GAS	52,016		344	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1990	GAS	21,148		330	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1991	GAS	8,423		327	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1992	GAS	1,513		291	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1993	GAS	2,088		268	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	US ENERGY DEV CORP	1994	GAS	1,781		363	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	LION ENERGY CO LLC	2008	GAS	270		365	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
123-34843	LION ENERGY CO LLC	2009	GAS	644		365	WARREN	COLUMBUS	SMITH- RAS	1	COLUMBUS	DEWEY CORNERS	26-Mar-84
			Total	**216,965**									
123-33914	US ENERGY DEV CORP	1984	GAS	5893		0	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1985	GAS	14431.49		0	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1986	GAS	44172.28		336	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1987	GAS	21594.73		336	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1988	GAS	51243.65		356	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1989	GAS	67741.18		364	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1990	GAS	66748.67		352	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1991	GAS	38209		350	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1992	GAS	13492		320	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1993	GAS	6206		352	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	US ENERGY DEV CORP	1994	GAS	2570		341	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	BELDEN & BLAKE CORP	2000	GAS	559		366	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	BELDEN & BLAKE CORP	2001	GAS	438		365	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	BELDEN & BLAKE CORP	2002	GAS	372		273	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	BELDEN & BLAKE CORP	2002	OIL	0		0	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	RANGE RESOURCES APPALACHIA LLC	2002	GAS	46		31	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	RANGE RESOURCES APPALACHIA LLC	2003	GAS	257.85		182	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83

123-33914	RANGE RESOURCES APPALACHIA LLC	2004	GAS	313.84		244	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	RANGE RESOURCES APPALACHIA LLC	2005	GAS	47.28		212	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	RANGE RESOURCES APPALACHIA LLC	2006	GAS	4.33		151	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	TRINITY ENERGY CORP	2007	GAS	64		365	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	LION ENERGY CO LLC	2008	BRINE		38		WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	LION ENERGY CO LLC	2008	GAS	392		365	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
123-33914	LION ENERGY CO LLC	2009	GAS	90		120	WARREN	COLUMBUS	JOSEPH BITTINGER	1	COLUMBUS	DEWEY CORNERS	29-Dec-83
			Total	**334,886**	**38**								
		Total All 7 wells		**1,751,614**									

 Additional Info

Billman Geologic Consultants Report

BILLMAN GEOLOGIC CONSULTANTS, INC.

TO: MR KARL KIMMICH, LION ENERGY COMPANY, LLC

FROM: DAN A. BILLMAN, PG, CPG, BILLMAN GEOLOGIC CONSULTANTS, INC.

SUBJECT: GEOLOGIC REVIEW OF THE BITTINGER #2, PROPOSED SWD WELL

DATE: 04/05/2014

CC:

This memo is to be read in conjunction with the report entitled, "Geologic Review of the Bittinger Area, Planned SWD Site", dated 8/2/2010., Written by Dan A. Billman of Billman Geologic Consultants, Inc.

Billman Geologic Consultants, Inc. (BGC) was requested by Lion Energy Company, LLC to review the geology of a proposed SWD well at the Bittinger #2 (123-33944). The well is located in Columbus Township, Warren County, Pennsylvania. Specifically, the area is located in and around the Bittinger, Smith and Reed properties; collectively referred to as the "Bittinger SWD site". Figure 1 depicts the well base map of the Bittinger #2 area.

The Bittinger #2 (123-33944) was initially drilled by U.S. Energy Development and later acquired by Lion Energy, when Lion Energy acquired the field from Belden and Blake, Corp. The well was originally drilled to a total depth of 4,574', into the Queenston Shale Formation. The well was naturally completed in the Medina Sandstone and Whirlpool Sandstone. The well had a natural reported open flow 554 mcf/d and a reported natural rock pressure of 1,100 psi, recorded after a buildup of 72 hours (refer to completion reports included as Appendix 1 of this memo).

Geologic Analysis of Data Associated with the Bittinger SWD Site

The initial report of the Bittinger SWD area discusses the geology of both the Medina Sandstone and Whirlpool Sandstone. The Bittinger #2 well is located approximately 1,200' west of the Bittinger #4 and located approximately 1,500' northeast of the Bittinger #1. After review of the logs and completion reports (Appendix 1) of the Bittinger #2, both the Medina (Grimsby) and Whirlpool Sandstones are similar to the correlative formations within the Bittinger #1 and Bittinger #4 wells.

BGC completed a review of the logs associated with the Bittinger #2 (123-33944), as well as the Bittinger #1 (123-33914), #4 (123-39874) and other wells in the immediate area (Table 1 of the original report). The Medina Sandstone (Grimsby Sandstone) has 38' of formation equal or greater than 6% porosity, while the average for the area was

39.2'. Likewise, The Whirlpool Sandstone has 12' of formation equal or greater than 6% porosity, while the average for the area was 11.1'. For both sandstone formations, the characteristics are very typical for the area.

In the Bittinger #2, there is approximately 625' between the top of the Medina (Grimsby) Sandstone and the top of the Upper Silurian Salina Formation. The Salina Formation is a series of evaporates (including salt and anhydrite), shale and carbonate formations, which based on lithology should have low permeability and have characteristics of a good confining interval. Given the ductile nature of the salt and anhydrite, natural fractures tend not to propagate vertically up to and through the Salina Formation. Also, between the Medina (Grimsby) Sandstone and the Salina Formation are other potential confining intervals, including the Vernon and Rochester Shales and the Packer Shell (Irondequoit and Reynales Dolomites). Another shale interval, the Power Glen Shale (occasionally referred to as the Cabot Head Shale) lies between the Medina (Grimsby) Sandstone and Whirlpool Sandstone.

Conclusions

The Bittinger #2 (123-33944) appears to have a very porous Whirlpool Sandstone interval to allow for saltwater injection and storage. The formation was naturally completed and therefore, it is assumed to have sufficient natural (unstimulated) porosity and permeability development. The Bittinger #2 SWD site is located in an area of minimal tectonic influence (i.e. folding and faulting of the rock), other than the gentle dip of the formation to the southeast (refer to mapping included in the original report). Given the nature of the Salina Formation (i.e. bedded salts and anhydrites) above the SWD interval, minimal through-going, vertical fractures are expected to exist in the Bittinger #2 SWD site area.

BGC has not verified ownership of Lion's properties or completed a site visit as part of the geologic review of the area.

Respectfully submitted by:

Dan A. Billman

Dan A. Billman, PG, CPG
President, Billman Geologic Consultants, Inc.

DISCLAIMER

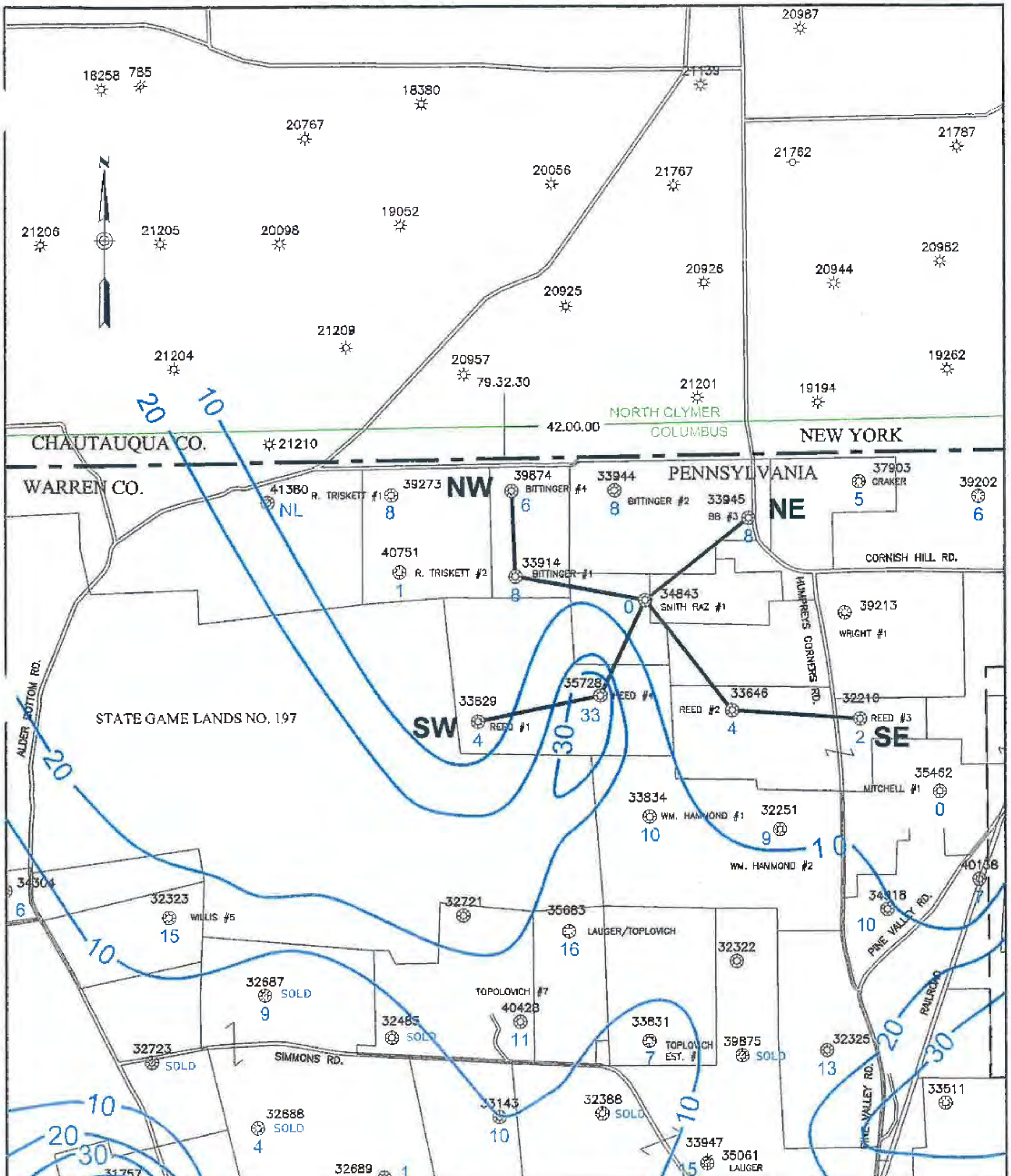
This document includes forward-looking statements as well as historical information. Forward-looking statements include, but are not limited to statements relating to geological and seismic data interpretations, prospect reserve estimates and prospect risk. Although BGC believes that its expectations reflected in these forward-looking statements are reasonable, such statements involve risks and uncertainties, and no assurance can be given that actual results will be consistent with these forward-looking statements. Investment in oil and gas exploration is high risk by its very nature. Important factors that could cause actual results to differ from these forward-looking statements include, but are not limited to: erroneous interpretations of the seismic and geological data; the inability to acquire leases on identified prospects; mechanical problems while drilling and producing wells which prevent completion of a well or result in plugging of a well; dry holes; less reserves than originally estimated due to poor sand development or drainage by offsetting wells; non-commercial wells; and the variations in future gas pricing. BGC cannot and has not beyond normal due diligence care standards confirmed the accuracy and completeness of all the information we have reviewed in the course of this consulting engagement. Data for this review has been provided by Tetra Tech, NUS, Lion Energy, LLC or is publicly available and BGC, Inc. cannot be held responsible for errors in this provided data. Further, we express no opinion regarding any legal or securities issues. BGC shall assume no liability whatsoever for the use or reliance there upon by Tetra Tech, NUS, Lion Energy, LLC, their clients and/or their investors, of information, opinions and interpretations provided by BGC. BGC reserves the right to adjust these findings and interpretations with the discovery of relevant data or future production data.

Appendix 2:

Cross-sections, Isopach and Structural Mapping

Bittinger SWD Site

For assistance in accessing this document, contact R3_UIC_Mailbox@epa.gov

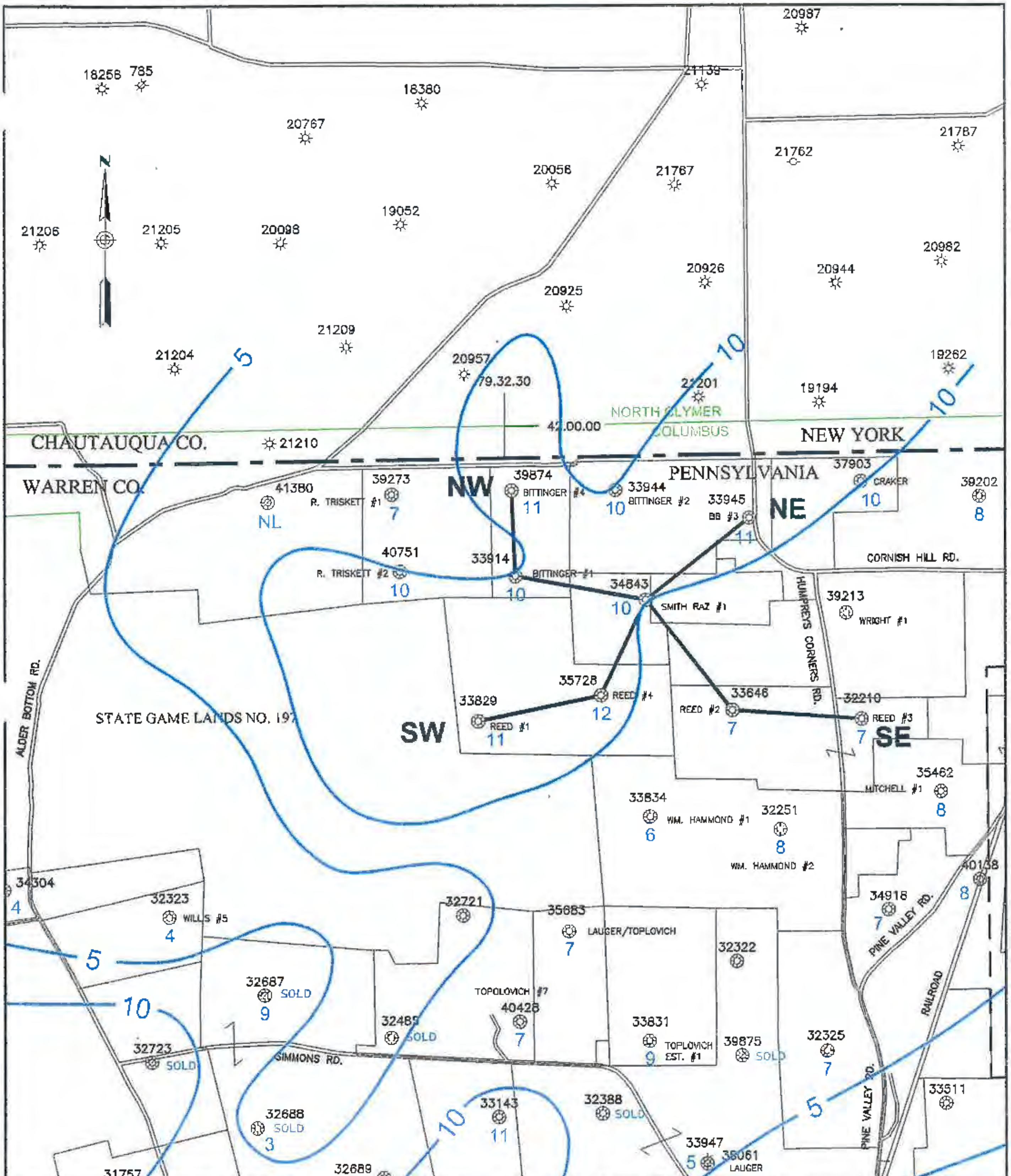


LION ENERGY CO., LLC
Columbus Twp., Warren Co., Pennsylvania
USGS 7 1/2' Quadrangle Columbus, PA
Isopach Medina SS 8% Log Porosity
Contour Interval = 10 Ft.
Date: 12/27/2010

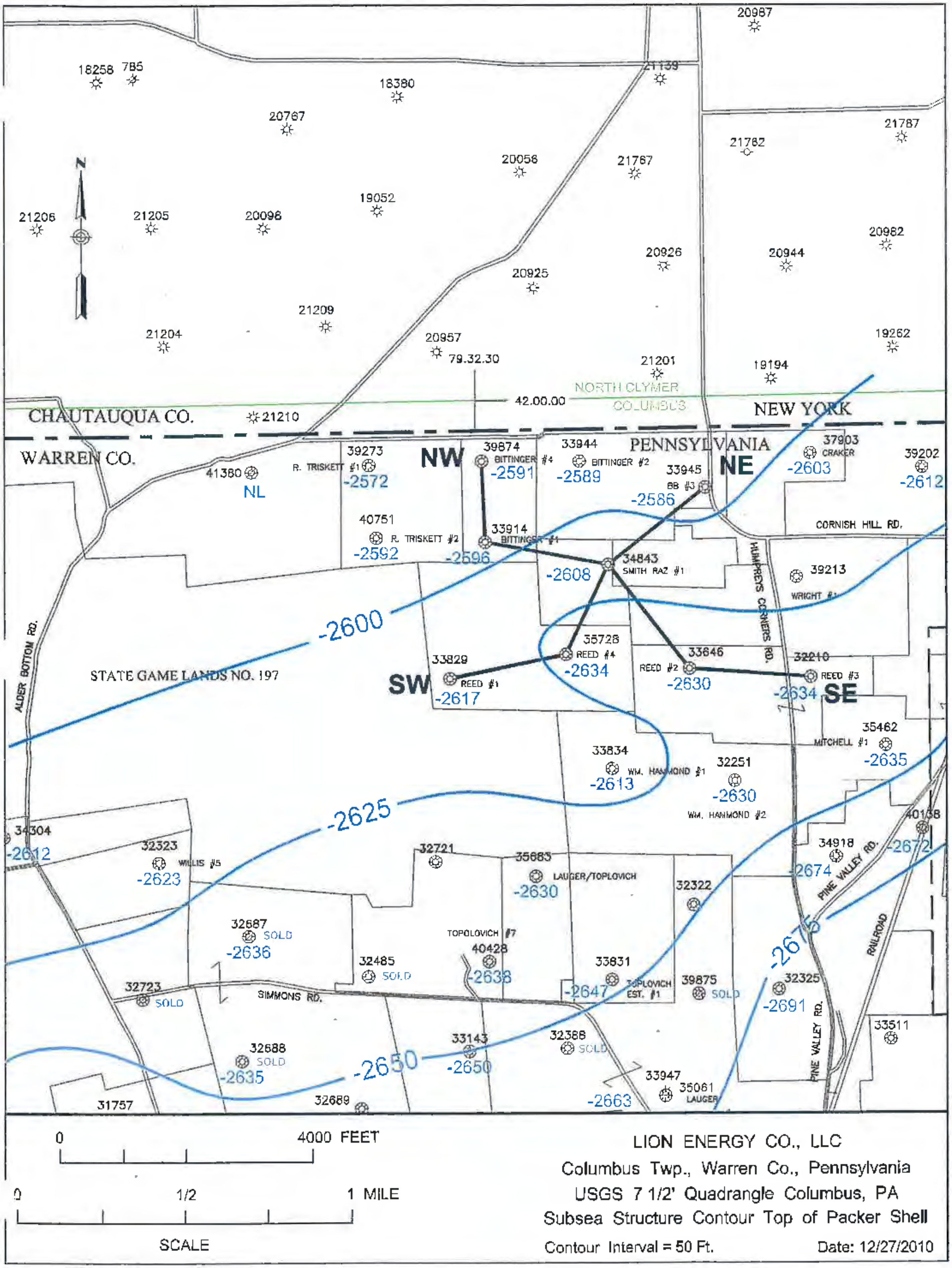
0 — 4000 FEET

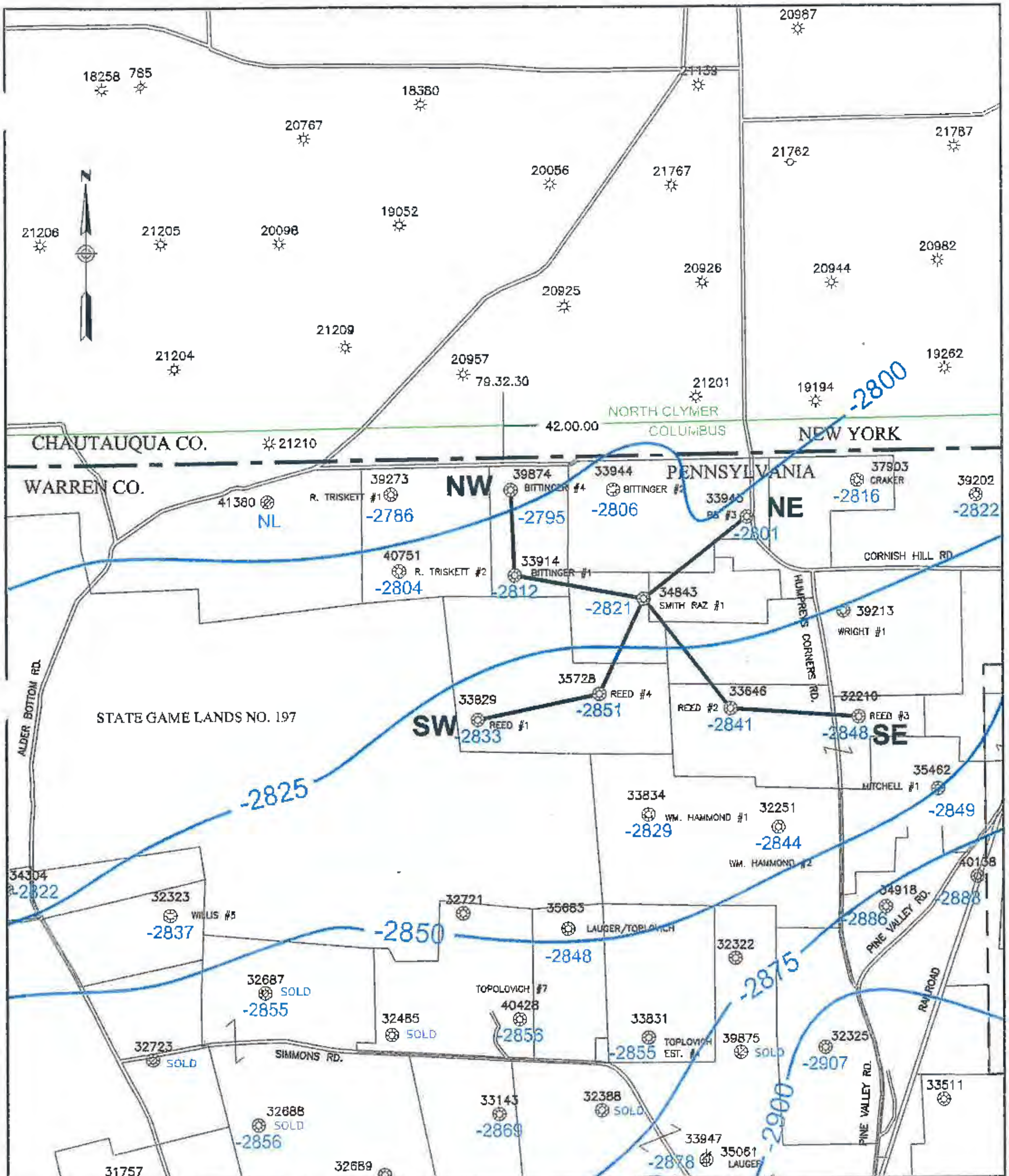
0 — 1/2 — 1 MILE

SCALE



LION ENERGY CO., LLC
Columbus Twp., Warren Co., Pennsylvania
USGS 7 1/2' Quadrangle Columbus, PA
Isopach Whirlpool SS 8% Log Porosity
Contour Interval = 5 Ft.
Date: 12/27/2010


N
CHAUTAUQUA CO.
WARREN CO.
NEW YORK
PENNSYLVANIA
NORTH CLYMER
COLUMBUS
42.00.00
79.32.30
NW
NE
SW
SE
NL
STATE GAME LANDS NO. 197
ALDER BOTTOM RD.
CORNISH HILL RD.
HUMPHREYS CORNERS RD.
SIMMONS RD.
PINE VALLEY RD.
RAILROAD
-2600
-2625
-2650
-2675
R. TRISKETT #1
-2572
BITTINGER #4
-2591
BITTINGER #2
-2589
BB #3
-2586
CRAKER
-2603
-2612
R. TRISKETT #2
-2592
BITTINGER #1
-2596
SMITH RAZ #1
-2608
WRIGHT #1
REED #4
-2634
REED #1
-2617
REED #2
-2630
REED #3
-2634
MITCHELL #1
-2635
WM. HAMMOND #1
-2613
WM. HAMMOND #2
-2630
WILLIS #5
-2623
LAUGER/TOPLOVICH
-2630
TOPOLOVICH #7
-2638
TOPLOVICH EST. #1
-2647
-2674
-2672
-2691
-2636
-2635
-2650
-2663
SOLD
LAUGER
0
4000 FEET
0
1/2
1 MILE
SCALE
LION ENERGY CO., LLC
Columbus Twp., Warren Co., Pennsylvania
USGS 7 1/2' Quadrangle Columbus, PA
Subsea Structure Contour Top of Packer Shell
Contour Interval = 50 Ft.
Date: 12/27/2010



0 — 4000 FEET

0 — 1/2 — 1 MILE

SCALE

LION ENERGY CO., LLC

Columbus Twp., Warren Co., Pennsylvania

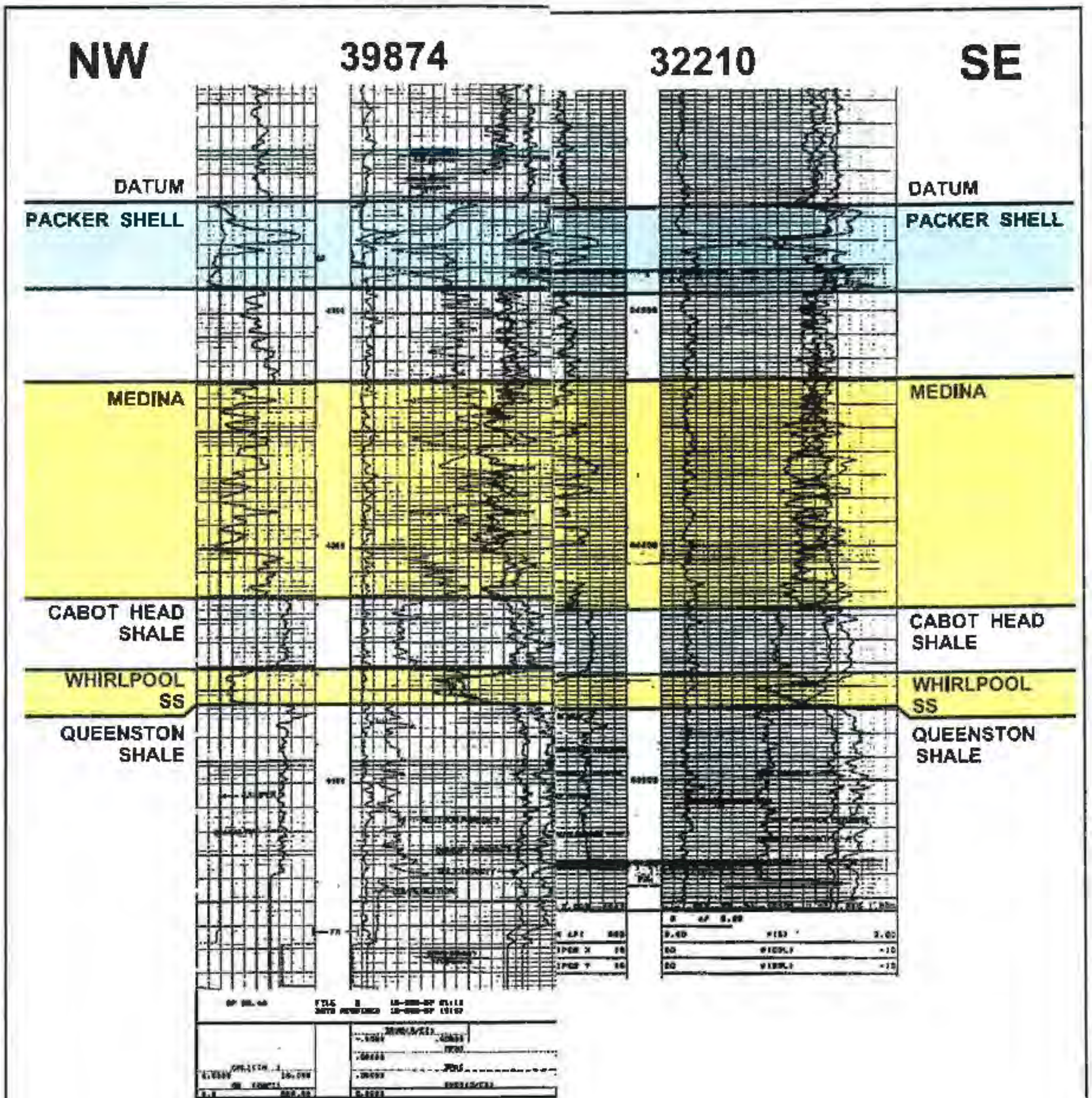
USGS 7 1/2' Quadrangle Columbus, PA

Subsea Structure Contour Top of Queenston Shale

Contour Interval = 50 Ft.

Date: 12/27/2010

Bittinger #4 T. Reed #3



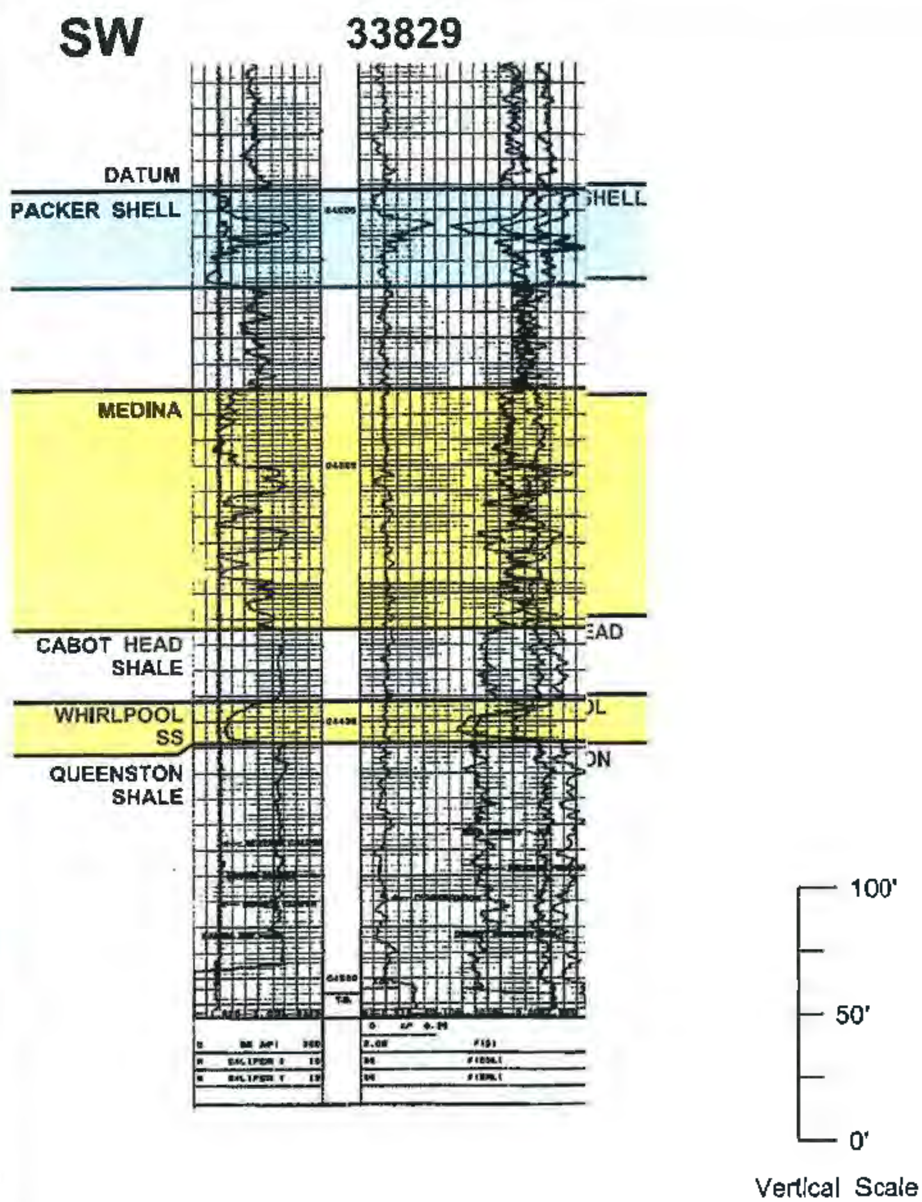
LION ENERGY CO., LLC

Cross Section NW - SE

:olumbus Twp., Warren Co., PA

:e: 12/27/2010

T. Reed #1



LION ENERGY CO., LLC

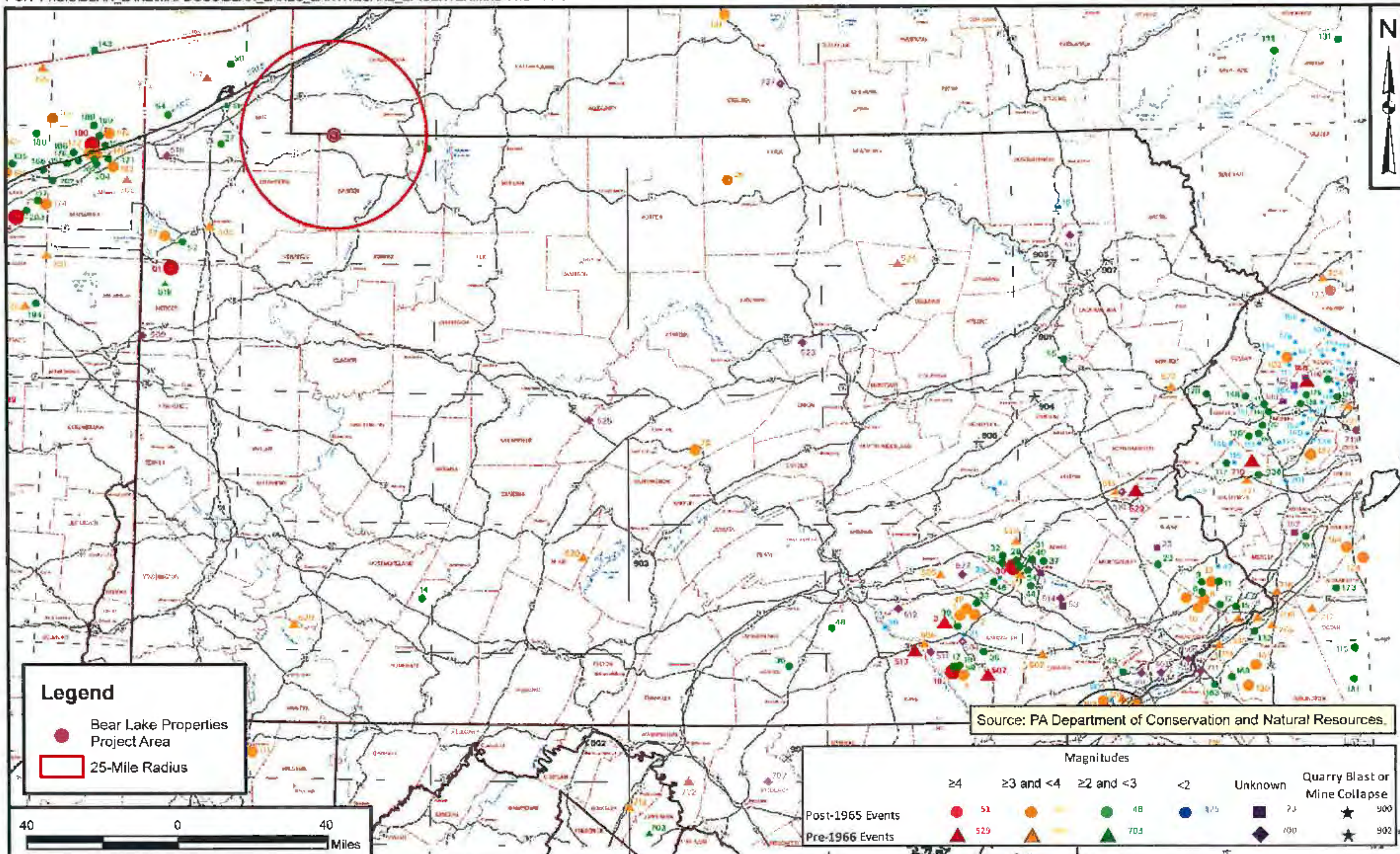
Cross Section SW - NE

olumbus Twp., Warren Co., PA

e: 12/27/2010

Earthquake Occurrences in PA Map
(Source: PA DCNR)

PGH P:\GIS\BEAR_LAKE\MAPDOCS\BEAR_LAKES_EARTHQUAKE_EPICENTER.MXD 03/21/14 JEE



EARTHQUAKE OCCURRENCES IN PENNSYLVANIA

BEAR LAKE PROPERTIES, LLC
WARREN COUNTY, PENNSYLVANIA

TETRA TECH

DRAWN BY: J. ENGLISH 03/19/14
CHECKED BY: D. SKOFF 03/21/14
APPROVED BY:

CONTRACT NUMBER: 112C02984

FIGURE NUMBER: FIGURE 1

REV: 0

Bittinger #4 Annual Disposal Report

OMB No. 2040-0042 Approval Expires 11/30/2014

EPA

United States Environmental Protection Agency
Washington, DC 20460

ANNUAL DISPOSAL/INJECTION WELL MONITORING REPORT

Name and Address of Existing Permittee
Bear Lake Properties, LLC
3000 Village Run Road, Unit 103, #223, Wexford, PA 15090

Name and Address of Surface Owner
Miles Sampsel
82530 Pangan Rd., Erie, PA 16509

Locate Well and Outline Unit on Section Plat - 640 Acres

N W E S

State: Pennsylvania
County: Warren
Permit Number: PAS2D215 BWAR

Surface Location Description
1/4 of 1/4 of 1/4 of 1/4 of Section Township Range

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ft. frm (N/S) Line of quarter section
and ft. from (E/W) Line of quarter section.

WELL ACTIVITY
- [x] Brine Disposal
- [ ] Enhanced Recovery
- [ ] Hydrocarbon Storage

TYPE OF PERMIT
- [x] Individual
- [ ] Area

Number of Wells 1

Lease Name: Bittinger Well Number: 4

MONTH YEAR	INJECTION PRESSURE AVERAGE PSIG	INJECTION PRESSURE MAXIMUM PSIG	TOTAL VOLUME INJECTED BBL	TOTAL VOLUME INJECTED MCF	TUBING -- CASING ANNULUS PRESSURE (OPTIONAL MONITORING) MINIMUM PSIG	TUBING -- CASING ANNULUS PRESSURE (OPTIONAL MONITORING) MAXIMUM PSIG
January-2013	Not Operating					
February-2013	0	0	2031	0	175	175
March-2013	0	0	1647	0	120	120
April-2013	159	580	8817	0	0	500
May-2013	235	660	7400	0	0	260
June-2013	15	40	2990	0	0	50
July-2013	155	610	5952	0	0	210
August-2013	5	10	3738	0	40	200
September-2013	395	1180	7020	0	0	420
October-2013	685	1400	10973	0	0	100
November-2013	689	1400	7865	0	0	230
December-2013	678	1400	7258	0	0	500

Certification

I certify under the 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 possiblity of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*: John C. Holko, Vice President
Signature:
Date Signed: 01/27/14

EPA Form 7520-11 (Rev. 12-11)

Bittinger #2 Cement Calculations

Bittinger #2 Surface cement calculation:

Surface hole size: 12-1/4"*
Suface cement volume: 150 sx Class A*
Surface casing: 428' of 8-5/8"

Class A cement yield: 1.18 cu. ft. per sack
Annular volume between 12-1/4" O.H. and 8-5/8" casing: 0.4127 cu. ft. per ft.

Cement volume required: 428' x 0.4127 cu. ft. per ft. **= 176.6 cu. ft.**

Cement volume pumped: 150 sx class A x 1.18 cu. ft./sk **= 177 cu. ft.**

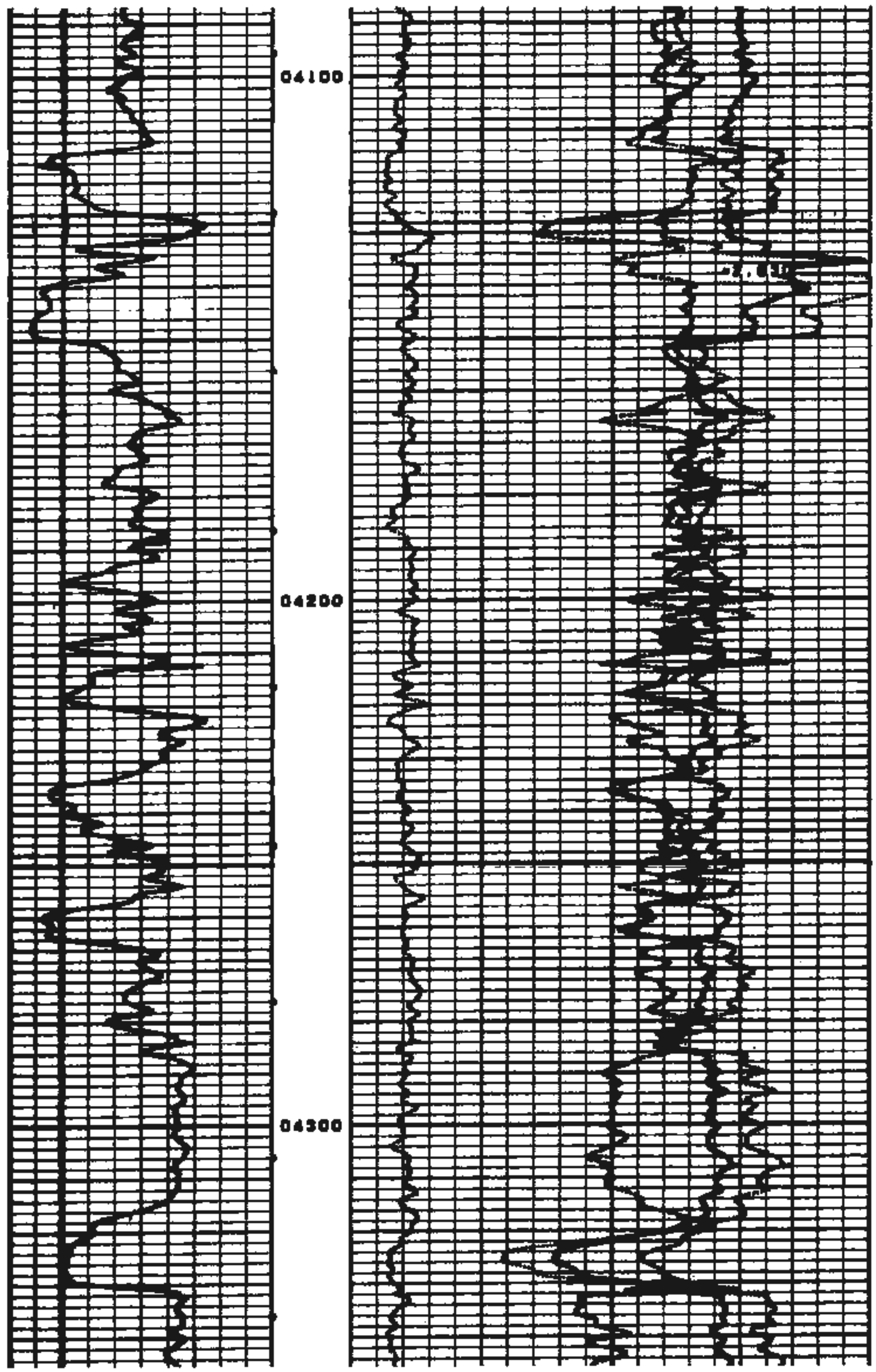
- *surface casing hole size and cement type based upon detail offset well surface cement ticket of the Smith-Ras #1 well – cement ticket attached in this section. This offset well was drilled by the same operator in the same approximate time period as the Bittinger 2.

Well	Permit #	Spud Date	Operator	Dirller	Surf. Hole Diameter	Depth (ft.) 8-5/8"	Volume Cement State Rpt.	Cementing Contractor	Volume Cement (as per cementing record)
Bittinger #2	33944	1/22/1984	US Energy	N.A.	N.A.	428	150 sx	Dowell	Not Available
Smith Ras #1	34843	3/21/1984	US Energy	Ramco	12-1/4"	394	150 sx	Dowell	150 sx class A w./3%CaCl, 50# celloflake

Appendix 1:

Log Data and Completion Reports for the Wells Being Permitted as Salt Water Disposal Wells

Gamma Ray, Density Neutron Log -- Bittinger #1 (123-33914)



Completion Report (page 1) -- Bittinger #1 (123-33914)

ER-OG-4: Rev. 2/80

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
DIVISION OF OIL AND GAS REGULATION
PITTSBURGH, PENNSYLVANIA 15222

123-33914 (c)

Office Use Only

2260 S 42°00'00"
11205 W 79°30'00"

WELL RECORD

123-33914

PERMIT NO. ~~WAR-33914~~ | PROJECT NO. DEEP | TYPE OF WELL: gas

COLUMBUS FIELD, DEWEY CORNERS POOL - DEV

WELL OPERATOR: U.S. ENERGY DEVELOPMENT CORPORATION			TELEPHONE NO.: (716) 856-9764	
ADDRESS: 670 Statler Building, Buffalo, New York			ZIP: 14202	
FARM NAME: BITTINGER	FARM NO.: #1	SERIAL NO.:		ACRES: 60
TOWNSHIP: Columbus	COUNTY: Warren			
DRILLING COMMENCED: 12-20-83	DRILLING COMPLETED: 12-29-83			
ELEVATION: 1518'	QUADRANGLE: Columbus	☒ 7½'	☐ 15'	

CASING AND TUBING RECORD

PIPE SIZE	AMOUNT IN WELL	MATERIAL BEHIND PIPE: CEMENT (SKS)	MATERIAL BEHIND PIPE: GEL (SKS)	PACKER: TYPE	PACKER: SIZE	PACKER: DEPTH	DATE RUN
8-5/8"	401'	225					12/22/83
4-1/2"	4416'	150	150				12/26/83

T.D.	D.D.	D.P.I.	Class	O	G	Lease
4467		4327	D		7	2

PERFORATION RECORD / STIMULATION RECORD

DATE	INTERVAL PERFORATED FROM	TO	DATE	INTERVAL TREATED	AMOUNT FLUID	AMOUNT SAND	INJECTION RATE
3/8/84	4210'	4327'	3/9/84	4210-4327'	897 bbls.	70000#	17 BPM

NATURAL OPEN FLOW: 300 MCF	NATURAL ROCK PRESSURE: Not taken — HRS. DAYS
AFTER TREATMENT OPEN FLOW: 5,600 MCF	AFTER TREATMENT ROCK PRESSURE: 1250 — 72 HRS. ~~DAYS~~

REMARKS: MEDINA

Driller's TD 4467'

Logger's TD 4431'

(FORMATION ON REVERSE SIDE)

RECEIVED OCT 1 1984 PA GEOLOGICAL SURVEY (Oil & Gas Geology Division)

DER-TCS 1984 MAR 23 AM 11 40

CAO 8-21-84

Completion Report (page 2) -- Bittinger #1 (123-33914)

ER-OG-4: Rev. 2/80
(pg 2)

FORMATIONS

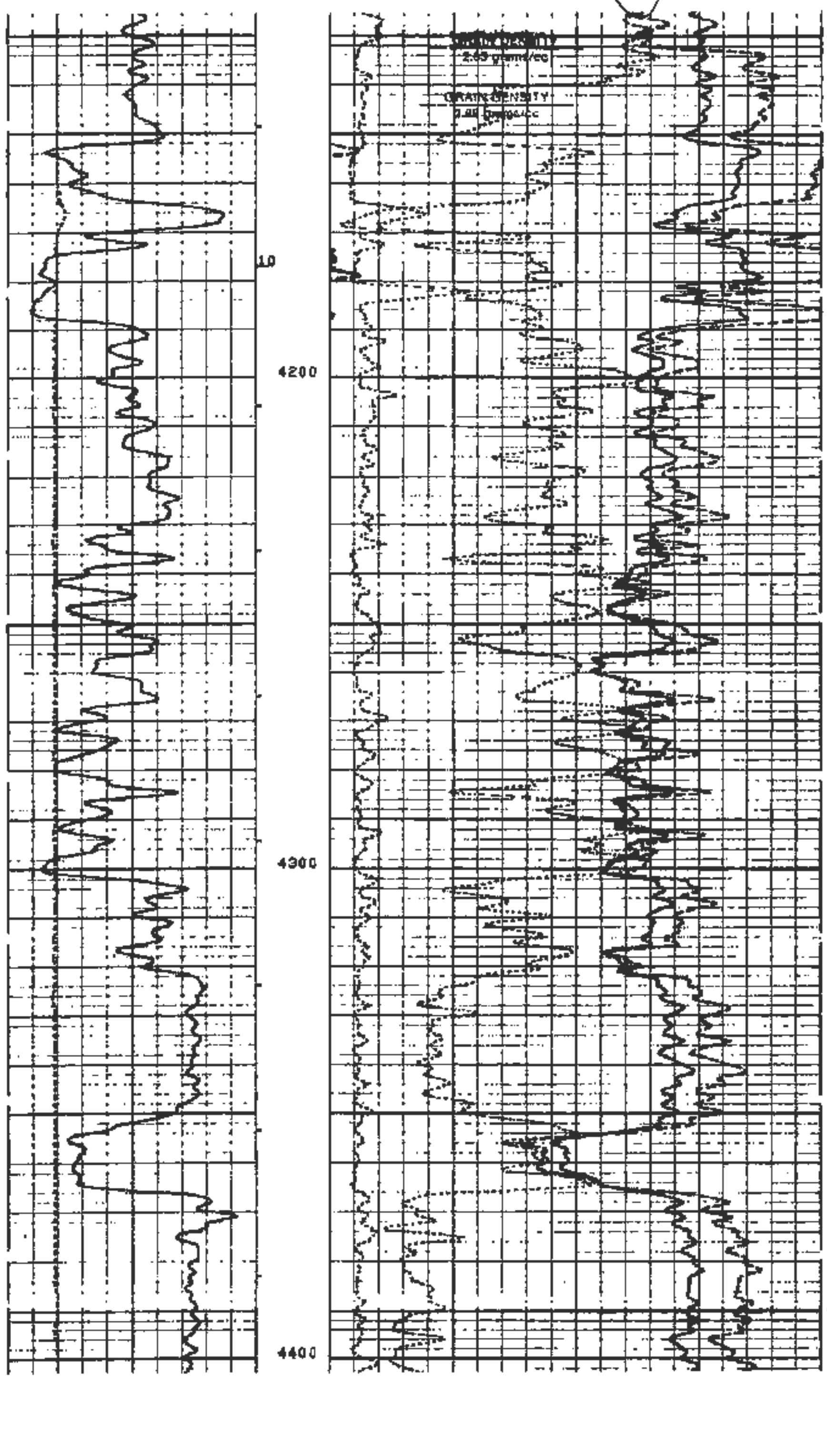
NAME	TOP	BOTTOM	GAS AT	OIL AT	WATER AT (FRESH OR SALT WATER)	SOURCE OF DATA
Unconsolidated Gravel	0'	37'			Fresh @ 25'	Driller's record and geophysical logs
Devonian Shale	37'	2679'				
"Tully" Ls	2679'	2785'				
Hamilton Shales	2785'	2955'				
Onondaga	2955'	3129'				
Unconformity Interval	3129'	3145'				
Akron-Bertie	3145'	3220'			Salt @ 3935'	
Camillus	3220'	3298'				
Syracuse	3298'	3525'				
Vernon	3525'	3784'				
Salt Zone	3504'	3709'	4430'			
Lockport	3784'	4009'				
Rochester	4009'	4113'				
Irondequoit-Reynales	4113'	4150'				
Grimsby	4150'	4265'				
Power Glen	4265'	4316'				
Whirlpool	4316'	4331'				
Queenston	4331'	TD				
TD	4431					

June 21, 1984
DATE

Douglas K. Walch
APPROVED BY Douglas K. Walch

Geophysicist
TITLE

Gamma Ray, Density Neutron Log -- Bittinger #4 (123-39874)



Completion Report (page 1) -- Bittinger #4 (123-39874)

ER-OG-4. Rev. 10/82

RB

970' S 42°00'00"
11240' W 79°30'00"
(C)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF OIL AND GAS REGULATION
PITTSBURGH, PENNSYLVANIA 15222

WELL RECORD

Columbus

REC-I/HLD

Office Use Only

123-39874

71275

PERMIT NO 37-123-39874-00 | PROJECT NO DEEP | TYPE OF WELL Gas

COLUMBUS FIELD, DEWEY CORNERS POOL DEU

WELL OPERATOR U. S. Energy Development Corporation	TELEPHONE NO (716)856-9764
ADDRESS 670 Statler Towers, Buffalo, NY 14202-9990	ZIP
FARM NAME Bittinger	FARM NO 4 / SERIAL NO / ACRES 62
TOWNSHIP Columbus	COUNTY Warren
DRILLING COMMENCED 8/11/87	DRILLING COMPLETED 8/15/87
ELEVATION 1561'	QUADRANGLE Columbus ☒ 7½' ☐ 15'

CASING AND TUBING RECORD

PIPE SIZE	AMOUNT IN WELL	MATERIAL BEHIND PIPE CEMENT (SKS)	GEL (SKS)	PACKER TYPE	SIZE	DEPTH	DATE RUN
13 3/8'	30'	NA					8/11/87
8 5/8'	506'	220	5				8/12/87
4 1/2'	4454.9'	265					11/5/87

T.D.	D.D.	D.P.I.	Class	O/G	Lease
4496		4362	D	O /	/

PERFORATION RECORD DATE	INTERVAL PERFORATED FROM	TO	STIMULATION RECORD DATE	INTERVAL TREATED	AMOUNT FLUID	AMOUNT SAND	INJECTION RATE
8/19	4459'	4362'	8/20/87	Same	840bbls.	67,000#	20.7

NATURAL OPEN FLOW 300 MCF	NATURAL ROCK PRESSURE NA HRS DAYS
AFTER TREATMENT OPEN FLOW 5,600MCFD	AFTER TREATMENT ROCK PRESSURE 1100 72 HRS

REMARKS: MEDINA

RECEIVED SEP 30 1988 PA GEOLOGICAL SURVEY

(FORMATION ON REVERSE SIDE)

A WELL RECORD SHALL BE FILED WITHIN 30 DAYS OF CESSATION OF DRILLING. IF THE WELL IS NOT COMPLETED WITHIN 30 DAYS OF CESSATION OF DRILLING, AN UPDATED WELL RECORD MUST BE SUBMITTED UPON COMPLETION OF THE WELL.

CDM
3-18-88

Completion Report (page 2) -- Bittinger #4 (123-39874)

ER-OG-4: Rev. 10/82
(pg 2)

123-39874

FORMATIONS

NAME	TOP	BOTTOM	GAS AT	OIL AT	WATER AT (FRESH OR SALT WATER)	SOURCE OF DATA
Unconsolidated Gravel	0	18'				Driller's Record & Geophysical Logs
Devonian Shale	18'	2741'				
Tully Limestone	2741'	2848'				
Hamilton Shale	2848'	3018'				
Onondaga Limestone	3018'	3182'				
Bois Blanc	3182'	3211'				
Akron Dol	3211'	3292'				
Camillus	3292'	3366'				
Syracuse	3366'	3547'				
Salt	3547'	3896'				
Lockport Dol	3896'	4067'			Salt water	
Rochester Shale	4067'	4151'				
Packer Shell	4151'	4189'				
Grimsby Sandstone	4189'	4304'	Gas			
Power Glen Shale	4304'	4350'				
Whirlpool Sandstone	4350'	4367'	Gas			
Queenston Shale	4367'	4496' T.D.				

RECEIVED SEP 30 1988 PA GEOLOGICAL SURVEY Oil & Gas Geology Division

August 1[illegible] 19 87
DATE

[signature]
APPROVED BY

[signature]
TITLE

OMB No. 2040-0042 Approval Expires 11/30/2014

EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Bittinger #2
Columbus Township, Warren County, PA

Name and Address of Owner/Operator
Bear Lake Properties, LLC
3000 Village Run Road, Wexford, PA 15090

Locate Well and Outline Unit on Section Plat - 640 Acres

N

W E

S

State	County	Permit Number
PA	Warren	

Surface Location Description
___ 1/4 of ___ 1/4 of ___ 1/4 of ___ 1/4 of Section ___ Township ___ Range ___

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location ___ ft. frm (N/S) ___ Line of quarter section
and ___ ft. from (E/W) ___ Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name Bittinger

WELL ACTIVITY
- [ ] CLASS I
- [x] CLASS II
  - [x] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number #2

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
8.625	24	428	428	12.25
4.5	10.5	4457	1267	7.875
2.375	4.7	4280	0	

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche:	4.5	7.875	7.875				
Depth to Bottom of Tubing or Drill Pipe (ft.	4457	3190	480				
Sacks of Cement To Be Used (each plug)	16	469	16				
Slurry Volume To Be Pumped (cu. ft.)	19	554	19				
Calculated Top of Plug (ft.)	4240	1700	430				
Measured Top of Plug (if tagged ft.)							
Slurry Wt. (Lb./Gal.)	15.6	15.6	15.6				
Type Cement or Other Material (Class III)	Class A	Class A	Class A				

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
See Attached Drawing			

Estimated Cost to Plug Wells
$30,000 See attached Estimate and Plugging Drawing

Certification

I certify under the 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. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
John C. Holko, Vice President	[signature]	03/19/2014

PLUGGING AND ABANDONMENT PLAN
Bittenger #2; Columbus Township, Warren County, Pennsylvania
API/Permit: 37-165-3394

This well will be plugged using the tubing balanced plug placement method. All plugs will be set through tubing at the desired locations with a gel spacer between each plug. The cement to be used will be class A common cement mixed to 15.6 #/gal with a yield of 1.18 cubic feet per sack.

The first and deepest cement plug will be set across the injection interval from a depth of 4,240 to 4,450 feet across the existing injection interval and tagged before proceeding with additional cement plugs.

We will utilize the cement bond log run on 8/13/2013 which located the top of existing cement outside the 4.5" casing at 3,190 feet. At this point, the 4.5" casing will be cut and pulled to allow the next plugs to be placed in the open hole with OD of 7-7/8 inches. The plugs will cover all possible hydrocarbon intervals as well as providing a seal below the surface casing at 428 feet.

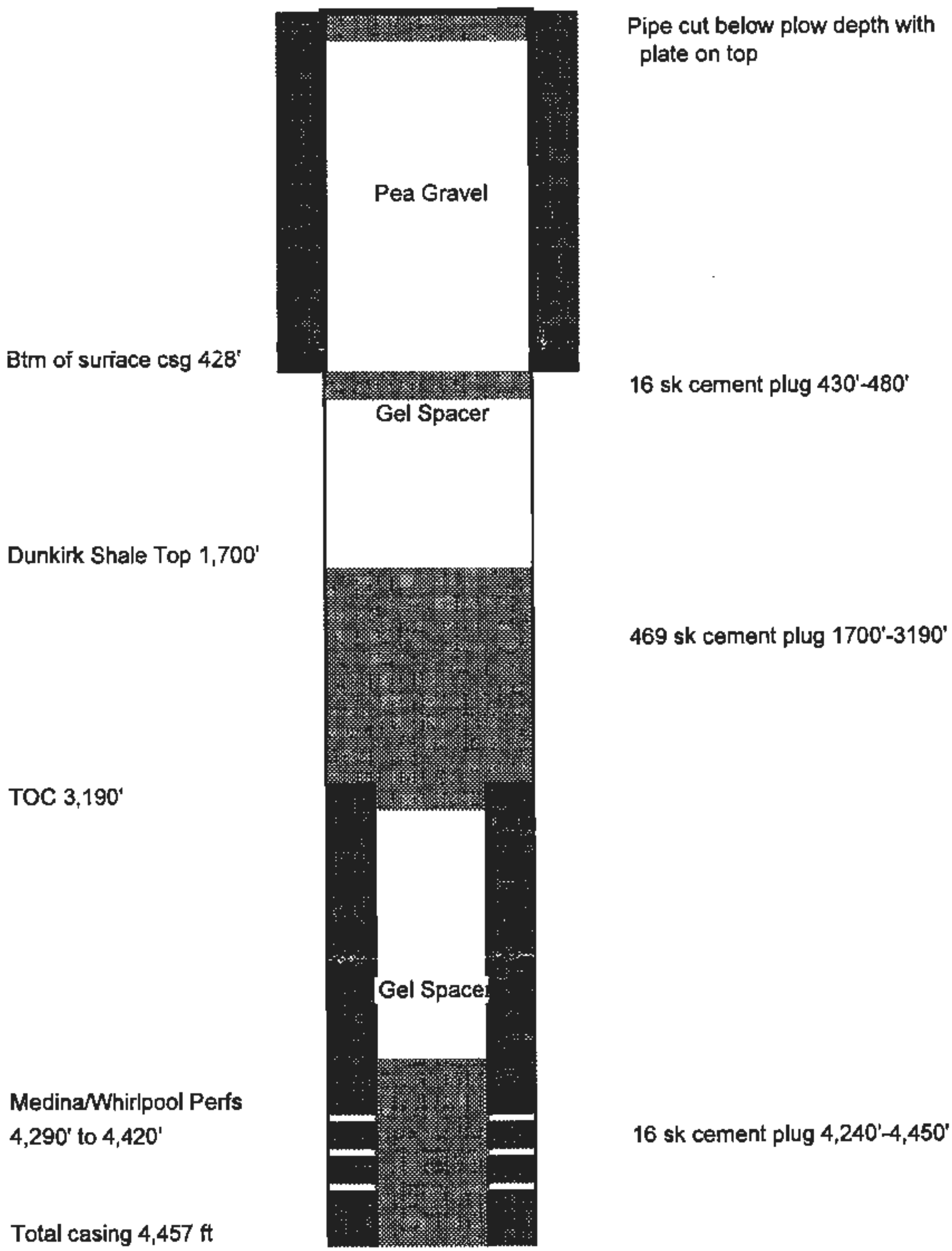
1. Gelled spacer will be placed between the top of the bottom plug and the bottom of the next plug from 4,240' to 3,190'.
2. A 469 sack cement plug will be used to seal from the top of the cut 4.5" casing at approximately 3,190' to above the last possible hydrocarbon zone at 1,700'. Utilizing this plug to cover the Oriskany, Marcellus, Rhinestreet and Dunkirk formations.
3. The next 16 sack plug will be placed just below the bottom of the 8-5/8" surface casing covering 50 feet from 430' to 480'

The 8-5/8" casing from surface to 430 feet will be filled with pea gravel and the top of the casing will be cut at approximately 40 inches below the surface and a plate will be welded on the top of the casing.

Any remaining equipment will be removed and the location will be restored and seeded.

FINAL PLUGGED WELL DRAWING

API/Permit: 37-123-33944
Bittinger #2



TRISTATE CAPITAL

TriState Capital Bank
One Oxford Centre
301 Grant Street, 27th Floor
Pittsburgh, PA 15219

Telephone: 877-304-0304
Fax: 412-304-0391

General Copy

DATE: August 12, 2014

AMENDMENT TO OUR LETTER OF CREDIT NO. 1036
ISSUED ON: December 13, 2010

AMENDMENT NO. 1
DATED: August 12, 2014

APPLICANT: Bear Lake Properties, LLC
3000 Village Run. Suite 103, #223
Wexford, PA 15090

BENEFICIARY: United States Environmental Protection Agency
Region 3, Ground Water & Enforcement Branch (3WP22)
1650 Arch Street
Philadelphia, PA 19103

THE ABOVE MENTIONED LETTER OF CREDIT IS AMENDED AS FOLLOWS:

LETTER OF CREDIT AMOUNT INCREASED BY: USD $30,000.00

NEW AMOUNT TO NOW READ: USD $90,000.00

SPECIFICALLY FOR THE PLUGGING AND ABANDONMENT OF THE FOLLOWING WELLS: BITTINGER #2 (See Amended and Restated Schedule A)

ALL OTHER TERMS AND CONDITIONS REMAIN UNCHANGED.

THIS AMENDMENT IS TO BE CONSIDERED AS PART OF THE ABOVE CREDIT AND MUST BE ATTACHED THERETO.

IF YOU HAVE QUESTIONS OR NEED FURTHER INFORMATION, PLEASE CONTACT TRISTATE CAPITAL BANK AT 1-877-304-0300.

REGARDS,

AUTHORIZED SIGNATURE
TRISTATE CAPITAL BANK

AUTHORIZED SIGNATURE
TRISTATE CAPITAL BANK

Amended and Restated Schedule A

Identification of Facilities and Cost Estimates

Schedule A is referenced in the standby trust agreement dated December 13, 2010 by and

Between Bear Lake Properties, LLC, the "Grantor" and
(Name of owner or operator)

TriState Capital Bank, the "Trustee".
(Name of trustee)

EPA identification number	#1 PAS 2D 216 BWAR #2 PAS 2D 217 BWAR #4 PAS 2D 215 BWAR
Name of Facility	Bittinger #1 & #4 Water Disposal Wells Bittinger #2 Water Disposal Well
Address of facility	
Current plugging and Abandonment cost estimate	$30,000 per well
Date of estimate	October, 2010

 Additional Info

Section 11 – Plan for Well Failures

Section 11: Plans for Well Failure

General system design and monitoring: The system being utilized for monitoring and control will function with the use of pressure switch gauges with adjustable limit switches and motor valves. The gauges provide a sensing device for changes in pressure conditions and if the limit switches are reached, they will send responses to activate motor valves controlling injection flow and pressure relief. In addition to the automated portion of the system, the manual operation of all pumping equipment as well as the continual inspections of the pumping and monitoring equipment provide additional safeguards for appropriate actions necessary in case of well failures.

Injection Pressure Limit Monitoring: The primary safeguard to prevent over pressuring is the automated shutdown on the pumping equipment at which the maximum operating pressure can be set as a limit at which all pumping will cease.

Additional switch gauges and motor valves will be utilized at the wellhead to monitor pressure changes that would be caused by tubing or casing failures and the appropriate valve will be activated to cease injection.

Tubing and Packer Monitoring: With the monitoring switch gauge connected to the tubing, we will have a secondary system to prevent over pressuring of the tubing. When the maximum pressure is sensed, a response is sent to a motor valve which will stop additional injection into the tubing.

Tubing to Casing Annulus Monitoring: This annular space is being monitored for both increase and decreases in pressure. The switch gauge will have both a low and high shutdown tab limit. When either of the limits is reached, the sensor will send a response to a motor valve shutting down flow. The lower limit will be used to monitor damage to the casing which allows fluid to leave the casing, and the high limit will sense a pressure increase in the casing that may be caused by communication with the tubing or flow into the annular space. Both of these limits when reached will send responses shutting down the injection cycle.

8-5/8" Annular Monitoring: The PADEP requires the annular valve on the 8-5/8" casing head to remain open to the atmosphere at all times. We will connect this point to a storage tank capable of collecting any fluid and allowing visual monitoring of any fluid flow. The valve and associated gauge will be monitored and inspected visually for changes or fluid flow. If such is detected, the system will be shut down and the remaining equipment associated with the system will be inspected to evaluate the cause of the changes.

Under the monitoring provided above, well failures will either be identified by the automated equipment and switch gauges or by visual inspection during injection operations or at other times. Should any failure occur, all injections will cease and proper notifications to EPA will be made. Analysis of the failure will take place and the necessary repairs to be implemented along with any equipment replacement will be coordinated with the EPA.

WELL NAME ------------------ Bittinger #1
OPERA ------------------ Bear Lake Properties LLC

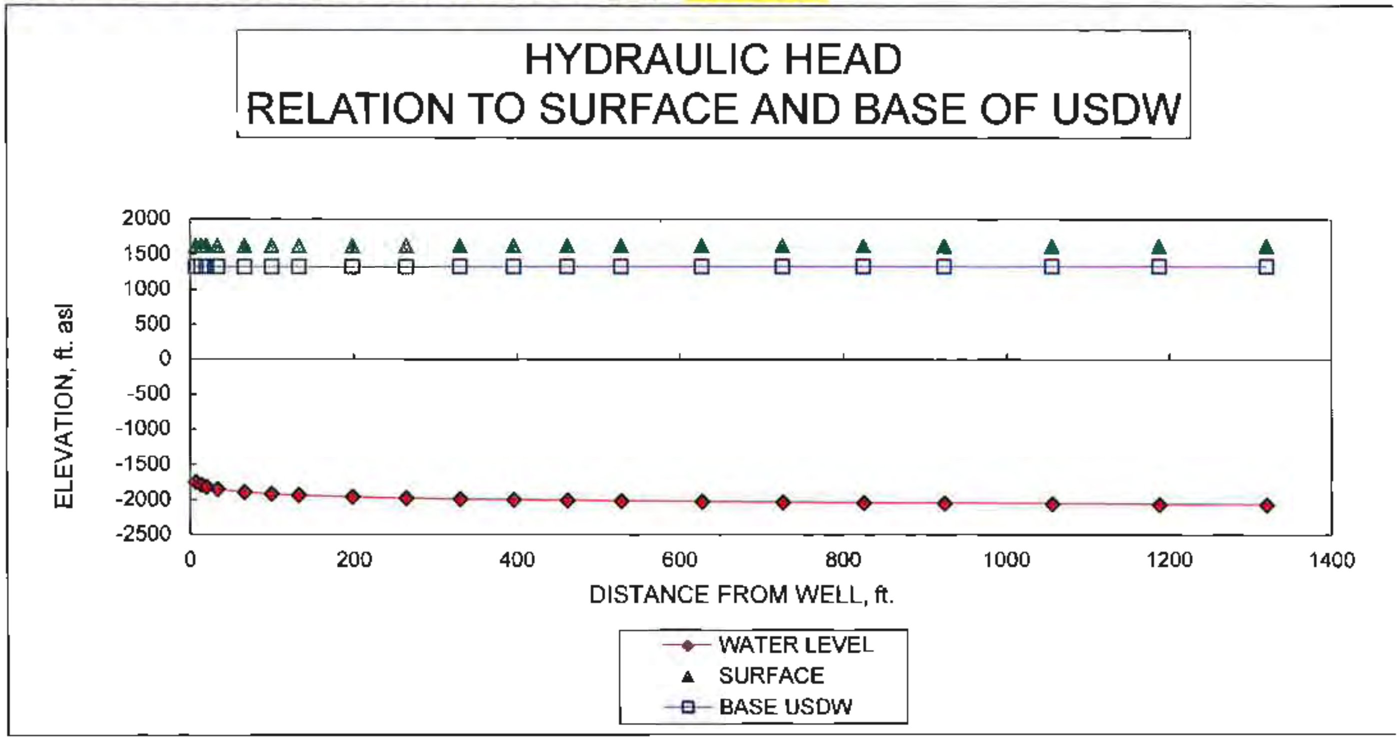
PERMI MBER ------------ PAS2D217BWAR
DATE OF ANALYSIS --------- 9-Sep-14
ANALYST ------------------ Brian Poe

WELL AND FORMATION PARAMETERS

initial pressure at the top of the injection formation, p(i)(psia	142.7	Note:14.7 has been added to psig for psia
injection rate, q (bwpd) ------------------------------	-3000	3000 = #1,#2, & #4
length of injection time, (months) ------------------------------	120	10 years - permited for 5 years
viscosity, mu (cp.) ------------------------------	1	Constant
specific gravity of liquid ------------------------------	1.218	permit app
formation volume factor, beta (1 for aqueous liquids) --------	1	Constant
permeability, k (md.) ------------------------------	100	Area of Review section of Application
reservoir thickness, h (ft.) ------------------------------	133	Actual thickness of reservoir at well
compressibility, c(t) 1/psi) ------------------------------	3.00E-06	Constant
porosity, phi, ratio ------------------------------	0.08	Area of Review section of Application
surface elevation KB, (ft.) ------------------------------	1621	log
depth to injection zone, (ft) ------------------------------	4246	top of formation
end of cross-section, (ft.) ------------------------------	1320	qtr mile. Fixed

CALCULATION OF CRITICAL PRESSURE RISE

depth of concern, feet below KB (ft.) ------------------------------	300	100'USDW;300' is conservative
critical pressure rise to lift liquid to depth of concern, (psi) --	1938.3967	

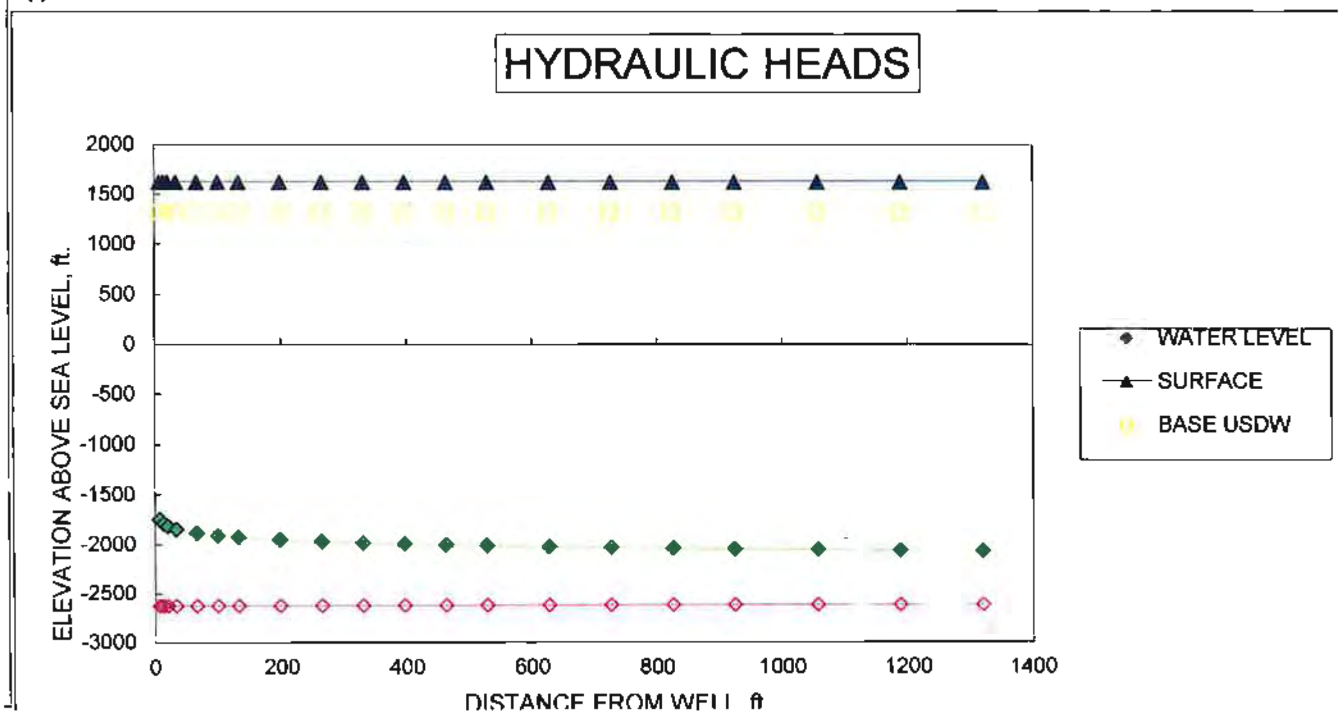


DISTA'	't. pressure	WATER LEVEL	SURFACE	BASE USD'	IECTION ZONE
6	461.3374733	-1750.250812	1621	13.	-2625
13.2	439.2609962	-1792.110365	1621	1321	-2625
19.8	426.3470849	-1816.596634	1621	1321	-2625
33	410.0774808	-1847.445684	1621	1321	-2625
66	388.0010037	-1889.305237	1621	1321	-2625
99	375.0870924	-1913.791506	1621	1321	-2625
132	365.9245266	-1931.16479	1621	1321	-2625
198	353.0106153	-1955.651059	1621	1321	-2625
264	343.8480495	-1973.024343	1621	1321	-2625
330	336.7410112	-1986.50011	1621	1321	-2625
396	330.9341382	-1997.510612	1621	1321	-2625
462	326.024497	-2006.81986	1621	1321	-2625
528	321.7715723	-2014.883896	1621	1321	-2625
627	316.2982063	-2025.262031	1621	1321	-2625
726	311.6289407	-2034.115499	1621	1321	-2625
825	307.5574959	-2041.835429	1621	1321	-2625
924	303.9480199	-2048.679413	1621	1321	-2625
1056	299.6950952	-2056.743449	1621	1321	-2625
1188	295.9437498	-2063.856434	1621	1321	-2625
1320	292.588057	-2070.219216	1621	1321	-2625

RADIAL DISTRIBUTION OF PRESSURE AROUND WELL OF CONCERN

linear term ---------------- -15.92481203

E(i) term ------------------- 2.63334E-11



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ATTACHMENT C
DOCUMENTATION OF ULTRACONE.xls

Ultracone uses simple calculations of the critical pressure based on properties of the lowermost USDW and the injection zone to calculate the pressure increase needed to cause liquid from the injection zone to move upward through an open conduit and into the lowermost USDW. It also calculates the radius within which pressures will exceed that level.

DATA VALUES WITHIN IN THE PRINTABLE AREA OF THE ZEI WORKSHEET

1. Data that must be entered directly into the ZEI worksheet (green cells):

E8 Analyst
C13 Duration of Additional Injection, mos
C28 Feet to Potential Conduit

2. Data that may be either automatically returned or manually entered (yellow cells). If no reference value is entered on the "Transfer" sheet, or a different value than the one calculated is more appropriate, some of these cells may be overwritten.

C11 Injection Rate, gpm (must show up as a negative number)
D11 Minimum Specific Gravity (of injectate)
E13 Cumulative Injected Volume – Should be entered directly into Cell E13. Otherwise, it is (inaccurately but conservatively) calculated based on nominal maximum rate of injection and duration of past injection. [DAYS360(E11,D8)*1440*Transfer!B102]

3. Data automatically returned:

B13 Radius of Injection Well, ft. – Converts standard notation of diameter in inches to radius in feet. [=IF(Transfer!B93>0,Transfer!B93,Transfer!B75)/24]
E11 Date of First Injection - Uses today's date if no date has been entered in the data transfer sheet (not required, used to calculate plume radius) [=IF(Transfer!B99>0,Transfer!B99,TODAY())]

4. Data automatically transferred from the data transfer sheet to protected cells in the worksheet:

<u>For administrative information:</u>
B4 Facility Name
D4 Operator
B6 Well Name
D6 U.S. EPA Permit Number
E6 Well Class
B8 County
C8 State

D8 Date - The date is entered automatically to ensure that printed versions are the most recent and for simple differentiation.

For well and operational information:

B11 Surface Elevation of Well, ft. (not required if information is all from the subject well)
D13 Viscosity of Injectate

For USDW information:

B16 Name of USDW (not required for calculation)
C16 Hydrostatic Pressure in USDW, psi
D16 Specific Gravity of Water in USDW
B18 Depth to Base of USDW, ft.
C18 Depth of Pressure Measurement, ft.

For injection zone information:

B21 Formation at Top of Injection Zone
C21 Porosity of Injection zone
D21 Specific Gravity of Liquid in the Injection zone
B23 Depth to Top of Injection Zone, ft.
C23 Permeability of Injection Zone, ft.
E23 Measured Pressure in Injection Zone, psi
B25 Effective Thickness of Injection Zone, ft.
C25 Compressibility of Injection Zone, $ft^3/ft^3/psi$
E25 Depth of Pressure Measurement, ft.

CALCULATIONS WITHIN IN THE PRINTABLE AREA OF THE ZEI WORKSHEET

Cell formulas are shown with row & column cell references only, then with cell names, if applicable.

Cumulative Injected Volume, gals.

Cell E13 =DAYS360(E11,D8)*1440*Transfer!B103

This is V_{past}, and may be entered directly if known (preferred) or calculated based on the maximum permitted injection rate and the duration of past injection.

Pressure at the base of USDW, psia

Cell D18 =C16+(B18-C18)*0.433*D16+14.7
=psiusdw+(dusdw-usdwpd)*0.433*usdwsg+14.7

The pressure at the base of the USDW is calculated using the equation:

$$p_{USDW} = p_{meas} + (d_{base} - d_{meas}) \times SG_{USDW} \times 0.433 psi/ft \qquad \text{Eq. 1}$$

where:
p_{USDW} = pressure at the base of the lowermost underground source of drinking water, in psia;
p_{meas} = a measured pressure reflecting hydrostatic pressure within the USDW, in psig;
d_{base}= the depth to the base of the lowermost USDW, in feet;
d_{meas} = the depth at which the pressure measurement was made,
SG_{USDW} = the specific gravity of the water in the USDW, and
0.433 psi/ft = the liquid pressure gradient for fresh water.

Translation: The pressure at the base of the USDW is equal to the measured pressure (psig) plus the height of the liquid column separating the depth of the measurement and the base of the USDW multiplied by the liquid pressure gradient of the liquid in the column plus the approximate influence of atmospheric pressure [14.7] in psi. Gauge pressure is used because very often pressure measurements are based on a liquid level at a depth which is affected by atmospheric pressure although it is recorded as zero psi.

Pressure at the top of the injection zone.

Cell E21:
```
=E23-D21*0.433*(E25-B23)
=iipsi-izsg*0.433*(iipsid-izt)
```

The pressure at the top of the injection zone or interval is calculated from a measurement of pressure representing the hydrostatic pressure in the injection zone. It is calculated using an equation similar to Eq. 1, but using data appropriate for the injection zone. Gauges which measure hydrostatic pressure usually include the effects of atmospheric pressure in their readings.

Viscosity of Connate Fluid, md

Cell D23
```
=IF('Transfer'B54>0, 'Transfer'B54,IF(I35>0,SUM(G36:G43),))
=IF(izvis>0,izvis,IF(I35>0,SUM(G36:G43),))
```

Translation: If a value for reservoir fluid viscosity was entered, return it; otherwise, if a reservoir temperature was entered, retrieve the viscosity value calculated from it; otherwise, leave blank.

Compressibility of connate fluid

Cell D25
```
=IF(Transfer!B51>0,1/(7.033*E21+0.05413*Transfer!B51-537*
    IF(E30=D21,Transfer!B59,70)+403.3*10^3),0)
=IF(cl>0,cl,IF(iztds>0,1/(7.033*E21+0.05413*iztds-537*
    IF(effsg=D21,iztemp,70)+403.3*10^3),0))
```

This calculation is based on Equation 2 on Page 24-13 of the Petroleum Engineering Handbook:

$$1/c_w \equiv m_1 \times p + m_2 \times C + m_3 \times T + m_4 \qquad \text{Eq. 2}$$

Where:

- c_w = Compressibility of water,
- p = Hydrostatic pressure,
- C = Salinity, mg/l,
- T = Temperature, degrees Fahrenheit,
- m_1 = 7.033
- m_2 = 0.05413
- m_3 = -537
- m_4 = 403.3×10^3

Translation: If a value has been entered for total dissolved solids divide 1 by the sums of constant m_1 times the average formation pressure, constant m_2 times the total dissolved solids concentration of the connate water, constant m_3 times the average temperature of the injection zone if the specific gravity of water in the injection zone was chosen as appropriate, otherwise 70 °F, and constant m_4, Otherwise (if no value was entered for dissolved solids), leave blank.

Critical pressure

Cell B28 =IF(E30>0,D18+(B23-B18)*0.433*E30-E21,"Choose Viscosity")
=if(effsg>0,D18+(izt-dusdw)*0.433*effsg-E21,"Choose Viscosity")

A critical pressure is computed if all of the cells requiring data are filled. An if-then statement requires that the appropriate specific gravity be specified in cell E30. The pressure is computed using the equation:

$$p_c = p_{USDW} + (d_{iz} - d_{base}) \times SG_{iz} \times 0.433\,psi/ft - p_{iz} \qquad \text{Eq. 3}$$

Where:

- p_c = the critical pressure addition needed to cause flow of liquid from the injection zone, through an open conduit, and into the lowermost USDW, in psi;
- d_{iz} = the depth to the top of the injection zone, in feet;
- SG_{iz} = the specific gravity of the liquid in the injection zone near the distance of the radius of endangering influence; and
- p_{iz} = the hydrostatic pressure at the top of the injection zone, in psi.

Translation: If a value has been entered for specific gravity to use, calculate the critical pressure by adding to pressure at the base of the lowermost USDW the product of the pressure which would be exerted by a column of liquid reaching from the top of the injection zone to the base of the USDW minus the pressure already existing at the top of the injection zone.

The radius of the cone of endangering influence.

Cell D28 =IF($D$30>0,IF(B28>B13,SQRT($C$23*$H$9/($C$21*$D$30*($C$25+$D$25)*10^($B$28*$C$23*$B$25/(162.6*$G$9*$D$30)+3.23))),"INFINITE"),"Fill Blanks")
=IF(effvis>0,IF(cp>B13,SQRT(izhk*t/(izpor*effvis*(cfm+D25)*10^(-cp*izhk*izh/(162.6*q*effvis)+3.23))),"INFINITE"),"Fill blanks")

This is computed using the criteria in 40 CFR 146.6(a)(ii)(2) with the exponential integral method for calculating pressure in horizontal reservoirs. The equation is couched in reservoir engineering terms, more commonly used when dealing with deep reservoirs rather than hydrological terms, more commonly used when dealing with near surface reservoirs. A result will be calculated if the blanks are filled and if the radius of the ZEI is greater than 0.5 feet in diameter:

$$r_{ZEI} = \sqrt{\frac{k \times t}{\phi \times \mu \times (c_f + c_w) \times 10^x}} \qquad \text{Eq. 4}$$

Where:

- k = permeability, md
- t = time, hours
- ϕ = the porosity of the effective injection zone
- μ = viscosity of liquid dominating pressure buildup in the injection zone, cp
- c_f = compressibility of the formation, psi^{-1}
- c_w = compressibility of water psi^{-1}
- x = Equation 5

$$x = \frac{p_c \times k \times h}{162.6 \times q \times \mu} + 3.23 \qquad \text{Eq. 5}$$

Where:

- h = effective thickness of the injection zone/interval, ft
- q = injection rate, gpm

Translation: If a value has been entered for the specific gravity to be used; if the critical pressure is larger than an arbitrarily small number (greater than the radius of the well bore), the square root of: permeability multiplied by time of injection divided by the product of the porosity and viscosity and compressibility of the formation and the contained water times 10 raised to the x^th^ power (x defined as 3.23 plus the quotient of the product of -1, critical pressure, permeability and thickness, divided by the product of 162.6, injection rate and viscosity; if the critical pressure is not greater than an arbitrarily small number, then display "INFINITE". If no value has been entered for the specific gravity to be used, display "Choose SG".

Radius of the waste plume, some dispersion

Cell B30 IF(B25*C21>0,SQRT((E13+C11*C13*1440*30.44)*0.1337*3/(B25*C21*PI())),0)
=IF(izh*izpor>0,SQRT(totvol*0.1337*3/(izh*izpor*PI())),0)

This computed result is only for the purpose of getting a relative idea of the size of the plume. The distance beyond which there is essentially no migration of waste will actually be as though three times the volume of waste had been injected. The radius is a simple calculation of the radius of a cylinder of porous material with the volume determined by the total injected volume multiplied by three using equation 9:

$$r_{wp} = \sqrt{\frac{V_{cum} \times 0.1337 \times 3}{h \times \phi \times \pi}} \qquad \text{Eq. 6}$$

Where:

r_{wp} = the radius of the waste plume, assuming no dispersion
V_{cum} = the cumulative injection at the end of the well's projected life
0.1337 = factor to convert gallons to cubic feet
3 = factor to roughly account for dispersion

Maximum Injection Rate Label

Cell C29 = IF(C28>0,"Max Safe Injection Rate, gpm","")

Translation: If the distance to a conduit was entered in Cell C29, display "Max Safe Injection Rate, gpm; otherwise, display an invisible zero.

Distance beyond which injection pressure is below critical pressure

Cell C30 =IF(C28>0,42/1440*$C$23*$B$25*$B$28/(162.6*$D$30)/(LOG10($C$23*$H$9/($C$21*$D$30*($C$25+$D$25)*$C$28^2))-3.23),"")

Calculation of the radial distance at which injection pressure falls below critical pressure. The log approximation of the Ei method is adequate for the time periods typical of injection well lives. The source equation is from Earlougher, 1977, Equation 3.4.

$$p_{WF} = p_i - 162.6 \times \frac{qB\mu}{kh} \times \left(\log\left(\frac{kt}{\phi\mu c_t r_c^{\ 2}} \right) - 3.23 \right) \qquad \text{Eq. 7}$$

Where:

p_{wf} = flowing pressure, psi
p_i = initial pressure, psi
r_c = radial distance to potential conduit

Setting initial pressure equal to zero ($p_i = 0$), and solving for q, the resulting equation for the pressure change, which will be the critical pressure, p_c, is:

$$q = \frac{khp_c}{162.6\mu \times \left(\log\left(\frac{kt}{\phi\mu c_t r_c^2} \right) - 3.23 \right)} \qquad \text{Eq. 8}$$

Translation: If a distance to a conduit has been entered, return the product of a conversion factor for injection rate, permeability, net thickness of the reservoir, and critical pressure, all divided by the product of 162.6, viscosity, and the difference of $\log_{10}$ of the quotient of permeability times the injection duration divided by the product of porosity, viscosity, total compressibility of the reservoir formation and reservoir liquid, and square of the distance to the suspected conduit, minus 3.23; otherwise, leave blank.

CALCULATIONS MADE IN THE NON-PRINTING AREA OF THE ZEI WORKSHEET

This table converts values in the units used to input data, such as gallons per minute to the units typically found in reservoir engineering equations, such as barrels per day.

	G	H	I
6 7	THESE ARE CONVERSIONS FROM FAMILIAR UNITS TO UNITS FOR EQUATIONS		
8 9	Injection rate, BPD	Duration, hours	Total volume, gals
10 11	Effective years of past i	total years of injection	total hours

Injection Rate, BPD

Cell G9 =C11/42*1440

Translation: Injection rate in BPD divided by 42 gal/bbl multiplied by 1440 min/day.

Duration, hrs

Cell H9 =C13*30.44*24+E13/C11/60

Translation: The product of the number of months of future injection times 30.44 days per month times 24 hours per day, plus the quotient of the current cumulative injected volume in gallons divided by both the absolute value of the injection rate in GPM and 60 minutes per hour.

Cumulative injected volume

Cell I9 =E13+C11*C13*30.44*1440

This is the total volume which is expected to be injected through the life of the well, including previously injected volume and the volume yet to be injected. It is calculated to estimate the radius of the waste plume:

$$V_{cum} = V_{past} + V_{fut} \quad \text{Eq.9}$$

and:

$$V_{past} = t_{past} \times q \quad \text{Eq. 10}$$

and:

$$V_{fut} = t_{fut} \times q \quad \text{Eq. 11}$$

Where:

V_{cum} = the final cumulative volume including all past and projected future injection (may be entered directly or computed based on rate information and length of prior injection period);

V_{past} = volume already injected (E13);

V_{fut} = volume projected to be injected in the future (C11*C13*30.44*1440);

t_{past} = the time in minutes between date of first injection and today, calculated by subtracting the date number of the date of first injection from today's date number.

t_{fut} = the time in minutes for projected future injection, calculated by multiplying the number of months (C13) by the nominal number of days per month (30.44), times the number of minutes in a day (1440);

q = the injection rate in gallons per minute.

Translation: Past injection plus the absolute value of the average or permitted maximum injection rate times the duration of additional injection in months, times the number of days per average month times the number of minutes per day.

Effective years of past injection

Cell G11 =E13/(C11*1440*365.25)

Translation: Current cumulative injected volume divided by the projected rate in gallons per minute times 1440 minutes per day times 356.35 days per year.

Total years of injection

Cell H11 =IF(E11>"01/01/1901",TODAY()-DATEVALUE(E11)/365.25,C13/12)

Translation: If a value has been entered for date of first injection, return the result of dividing the period of future injection by 12 and adding the duration of past injection in years; otherwise, return the number of future months of injection divided by 12.

Total hours

Cell I11 =H11*365.25*24

Translation: Total effective years of injection times 365.25 days per year times 24 hours per day.

Calculation of the Exponential Integral

The calculation of the exponential integral is the most accurate means of calculating pressure increase. This table allows calculation of a complex mathematical function which is normally found through reference to tables. The calculations come from Attachment VI.A.1(a)-1 of the petition for exemption from the land disposal restrictions prepared by The Subsurface Group for submission by Environmental Disposal Systems, Inc.

	G	H	I	J
18 19 20	THESE ARE CALCULATIONS NEEDED TO CALCULATE THE CONE OF INFLUENCE USING THE EXPONENTIAL INTEGRAL METHOD			
21				
22	X	ln(1.781 x X)	ei(-x)	
23				
24	G	A	B	INTERMED
25				

X, the argument for the exponential integral function

Cell G23 =948*C$21*D$30*(C$25+D$25)*D28^2/(C$23*H$9)

Translation: The constant 948 needed to account for unit conversions times porosity times viscosity in centipoise times the sum of the compressibility of the formation and the compressibility of the liquid in the pore spaces times the square of the radius of the distance in feet from the point of injection to the point at which pressure is being calculated divided by the product of permeability in millidarcies and the duration of injection in hours.

Log approximation of the exponential integral

Cell H23 =LN(1.781*G23)

This expression provides results which deviate very slightly from the exponential integral for arguments within the range of 0 to 0.02.

ei(-x)

Cell I23 =IF(G23<=0.02,-H23,IF(G23<=0.1,0-0.37528+0.95243*(-LN(G23)),IF(G23<=0.3,-0.099525+0.83515*(-LN(G23)),IF(G23<=1,0.21888+0.37839*(-LN(G23))+0.159733*(-LN(G23))^2,G25*(J25*EXP(-G23))))))

This formula partitions values of the Ei-function argument to correctly calculate the Ei value as shown in the table below by successively testing to find whether the value of the Ei-function argument is in the next higher range and then calculates the Ei value using the formulas shown in the table below.

Value of Equation 10 for distance r	Formula for exponential integral
<0.02	-H23
0.02 to 0.1	$-0.37528 + 0.95243 \times (-\ln(\text{Cell G23}))$
0.1 to 0.3	$-0.099525 + 0.83515 \times (-\ln(\text{Cell G23}))$
0.3 to 1.0	$0.21888 + 0.37839 \times (-\ln(G23)) + 0.159733 \times (-\ln(G23))^2$
>1.0	Cell G25 x J25 × exp(-Cell G23))

G, a factor in calculating the exponential integral

Cell G25 =1/G23

Translation: The inverse of the argument for the exponential integral function

A, a factor in calculating the exponential integral

Cell H25 =G25*(G25+3.37735)+2.05216

B, a factor in calculating the exponential integral

Cell I25 =G25*(1.072553*G25+5.716943)+6.945239

Intermediate step in the calculation of the exponential integral for very large values of X

Cell J25 =1-G25*(H25*G25+0.2709479)/(G25*(I25*G25+2.59388)+0.2709496)

Calculation of Viscosity

The table at right is based on linear fits to the graphical depiction of the relationship of viscosity to salinity and temperature. The reservoir temperature is provided to equations in column I and each equation is solved for viscosity as though the TDS content of the water were within the range indicated by the number just to the right and the number just below that. Equations in column G select the proper result found by the equations in Column I by testing the salinity value to see within which of the ranges described above the salinity falls.

	G	H	I
34	CALCULATION OF VISCOSITY		
35	Reservoir Temperature, F		0
36	0	260000	4.84
37	0	240000	3.91
38	0	200000	3.73
39	0	160000	2.98
40	0	120000	2.88
41	0	80000	2.41
42	0	40000	2.25
43	2.16	0	2.16

Reservoir Temperature

Cell I35 =Transfer!B59

Reservoir temperature is a factor in the determination of viscosity

Selection of viscosity

Cell G36 =IF(AND(Transfer!B$51<=H36,Transfer!B$51>H37),I36,0)

Salinity

Column H: Contains the upper concentration limits of the ranges in which the viscosities calculated in Column I are adequately accurate. See chart for cell contents.

Calculation of Viscosity

Column I - Rows 36 to 43

Cell I36 =IF(I35<80,1.64+(80-I35)*0.04,IF(I$35<120,1.1+(120-I$35)*0.0135,IF(I$35<160,0.77+(160-I$35)*0.00825,IF(I$35<200,0.6+(200-I$35)*0.00425,"Use chart"))))

Translation: If the temperature is less than 80° F, return 1.64 plus 0.04 times the difference between 80° F and the temperature; if the temperature is less than 120° F, return 1.1 plus 0.0135 times the difference between 120° F and the temperature; if the temperature is less than 160° F, return 0.77 plus 0.00825 times the difference between 160° F and the temperature; if the temperature is less than 200° F, return 0.6 plus 0.00425 to the difference between 200° F and the temperature; if none of these apply, display "Use chart".

Calculations in succeeding rows are similar, translated one row downward.

Check of calculation of ZEI

Purpose: This calculation uses a familiar equation and an alternate route for using base data to provide an indication if some step has become corrupted.

A	B	C	D	E
57	THIS SECTION IS USED TO CHECK THE CALCULATION OF RADIUS OF INFLUENCE BY			
58	CALCULATING THE PRESSURE BUILD UP AT THE EDGE OT THE CALCULATED CONE OF			
59	INFLUENCE. IF THE VALUE IN THE OUTLINED CELL EQUALS CALCULATED CRITICAL			
60	PRESSURE, CALCULATION IS CORRECT			
61				
62	The result of using the exponential integral solution must nearly match the value found in Cell C60			
63				

Cell D60 =-162.6*C11*42/1440*D30/(C23*B25)*(LOG10(C23*(C13*30.44*24+E13/abs(C11)/60)/(C21*D30*(C25+D25)*D28^2))-3.23)

Translation: The product of -162.6, the injection rate in gpm converted to bpd, the viscosity divided by the product of permeability and thickness, and the difference of the log of the permeability times all the hours of past and future injection divided by the product of porosity, viscosity, total compressibility, and the square of the ZEI radius (close log), minus 3.23.

Cell D63 =-70.6*C11*42/1440*D30/(C23*B25)*I23

Purpose: Another cross check using a different method to check the computation of the Exponential integral.

Translation: Product of negative 70.6, injection rate in gpm converted to bpd, and viscosity, divided by the product of effective thickness and permeability, all multiplied by the Exponential integral from I23.

FORMULAS USED ON PLOT WORKSHEET

Calculation of the linear portion of the equation for the exponential integral (Ei) solution of the diffusivity equation.

Cell I23 =70.6*'ZEI'!$G$9*'ZEI'!$D$30/('ZEI'!$C$23*'ZEI'!$B$25)
=70.6*q*effvis/(izhk*izh)

Purpose: This cell contains the solution of that part of the exponential integral method for calculating pressure increase which is outside the brackets.

Translation: The product of 70.6 (a constant accounting for units), the injection rate in barrels per day, and the viscosity of appropriate fluid in centipoise (cp) divided by the product of the permeability (md) and effective thickness (ft) of the injection zone.

Column I - Distance, ft

Purpose: To establish a series of increasing distances from the subject well at which to calculate pressure increase.

Cell I3 =ZEI!B13

Translation: The starting point for the transect will be at the formation face of the well.

Cell I4 = IF(I$3<0.005*I$22*J22,0.005*I$22*J22,I$3)

Translation: In this cell and in each lower row in this column, use the larger of the well radius or the calculated portion of the total ZEI distance. This prevents a graphing problem if the distance to the first point (Cell I3) is larger than the distance to a subsequently calculated point. Each cell in lower rows uses a set increase in the multiplier used to calculate distance relative to the radius of the ZEI. J22 is set at 2, but where another multiplier would result in a "more satisfying" view of the decline curve as a whole, a larger or smaller multiplier may be substituted in Cell J22.

Cell I15 =0.5*I22*J22

This row will contain the critical pressure. The plot continues to show an equivalent amount of decline beyond the limit of the ZEI.

Cell I21 =I22*J22

This is the last of the cells containing distances for the calculation of pressure.

Cell I22 =ZEI!$D28
=zei

The radius of the ZEI is D28 on the worksheet page. This distance is a factor in determining the length of the radial transect along which to show pressure decline.

Column J – Injection zone pressure extrapolated to base of the USDW

Calculations in this column estimate the pressures which would exist at the depth of the base of the lowermost USDW in a series of wells extending away from the center of injection if those wells are open to flow from the injection zone.

Cell J3-J21 ='ZEI'!E$21-I$23*R3-(+'ZEI'!B$23-'ZEI'!B$18)*'ZEI'!E$30*0.433
=ZEI!E$21-I$23*R3-(+ZEI!B$23-dusdw)*effsg*0.433

Purpose: Extrapolates the hydraulic pressure in the injection zone to the base of the USDW at a series of distances from the injection well. To the pre-existing pressure at the top of the injection zone, adds the pressure increase due to injection and decreases that result by the pressure lost between the top of the injection interval and the base of the USDW.

Translation: The pressure at the top of the injection zone minus the product of the solution of the portion of the Ei method outside the brackets and the value of the Ei function minus the product of the difference between the depths of the top of the injection zone (interval) and the depth to the base of the lowermost USDW, the specific gravity of the fluid in the formation at the distance of the limits of the ZEI, and the liquid pressure gradient of fresh water.

Cell J22: The value in Cell J22 is a multiplier which the analyst can adjust to show as much of a "tail" on the depiction of the pressure distribution as he believes is instructional. The default value is two (2).

Column K - Pressure at base of the lowermost USDW

This column calculates the pressure at the bottom of the lowermost USDW, providing the data foro the top plot and the "ZEI" page's plot to display this pressure as a solid, horizontal line.

Cells K3 through K21 =ZEI!D$18

Column L - Water Level, ft

Cell L3 ='ZEI'!B$11-'ZEI'!B$18+J3/(0.433*'ZEI'!E$30)
=gl+kb-dusdw+J3/(0.433*effsg)

This column converts the pressure due to injection at the depth of the base of the lowermost USDW to hydrostatic head measured in feet relative to sea level. Allows display of the piezometric surface on the diagrams.

$$H_{iz} = e_{surf} - d_{base} + \frac{p_{trans}}{0.433 psi/ft \times SG_{iz}} \qquad \text{Eq. 12}$$

where:
H_{iz} =elevation of the piezometric surface along a transect away from the injection well;
e_{surf} = surface elevation of the wellhead,
d_{base}= the depth to the base of the lowermost USDW, in feet;
0.433 *psi/ft* = the liquid pressure gradient for fresh water
p_{trans} = pressure of the injection zone (interval) calculated at base of the USDW
SG_{iz} = the specific gravity of the water in the injection zone.

Translation: Calculate the depth to the base of the lowermost USDW with respect to mean sea level by subtracting the base of the USDW from the surface elevation of the well, then add the quotient of the injection zone (interval) pressure at the base of the USDW divided by the weight per foot of the injection zone fluid.

Column M - Surface Elevation, ft

Allows the display of reference elevation on the plot as a solid line.

Cells M3 through M20 ='ZEI'!B$11
=gl+kb

Translation: Display the reference elevation for the well head.

Column N - USDWS Base

Allows display of the elevation of the base of the lowermost USDW on Diagram #2.

Cells N3 through N20 ='ZEI'!B$11-'ZEI'!B$18
=gl+kb-dusdw

Translation: Reference elevation of the well minus the depth to the base of the lowermost USDW.

Column O - USDW Head, ft

This column calculates the hydrostatic head at the base of the lowermost USDW.

Cells O3 through O20 ='ZEI'!B$11-'ZEI'!B$18+'WorkSheet'!D$18/('ZEI'!D$16*0.433)
=gl+kb-dusdw+ZEI!D$18/(usdwsg*0.433)

Translation: Reference elevation of the wellhead minus the depth to the base of the lowermost USDW plus the quotient of the pressure at the base of the lowermost USDW divided by the weight of the fluid in the USDW per foot.

Column P -Ei-function argument

Calculates the Ei-function argument (value for which the exponential integral is found) of the solution for pressure increase. *(Smith)*

$$\left[-948\times\frac{\phi\times c_t\times\mu\times r^2}{k\times t}\right] \qquad \text{Eq. 13}$$

Where:
948= Constant required to account for units;
N= average porosity of the effective portion of the injection zone;
c_t = total compressibility of the formation and contained fluid;
μ = viscosity of liquid dominating pressure buildup in the injection zone, cp;
r= radius at which the pressure increase is to be calculated;
k= permeability, md;
t= time, hours.

Cell P3 =948*"ZEI'!C$21*'ZEI'!D$30*('ZEI'!C$25+'ZEI'!D$25)*I3^2/('ZEI'!C$23*'ZEI'!H$9)
=948*izpor*effvis*(cl+cfm)*I3^2/(izhk*t)

Translation: The product of -948, porosity of the effective injection zone (interval), viscosity of the reservoir fluid beyond the limits of the ZEI, total compressibility of the injection reservoir rock and its contained fluid and the square of the distance to the point of calculation divided by the product of the permeability of the effective injection reservoir (interval) and the "effective" injection time.

Column Q - ln(1.781 x X)

Calculates the log approximation of the solution to the diffusivity equation for use when the Ei-function argument is less than 0.02. *(Smith, Eq. 2.33)*

Cell Q3 =LN(1.781*P3)

Translation: Calculate the natural log of the product of 1.781 and the Ei-function argument of the Ei equation for pressure increase.

Column R - ei(-x)

Chooses which calculation of the exponential integral to use in column J for the calculation of injection zone pressure translated to the elevation of the base of the lowermost USDW.

Cell R3 =IF(P3<=0.02,-Q3,IF(P3<=0.1,0-0.37528+0.95243*(-LN(P3)),IF(P3<=0.3,-0.099525+0.83515*(-LN(P3)),IF(P3<=1,0.21888+0.37839*(-LN(P3))+0.159733*(-LN(P3))^2,S3*(V3*EXP(-P3))))))

Translation: This formula partitions values of the Ei-function argument to correctly calculate the Ei value as shown in the table below by successively testing to find whether the value of the Ei-function argument is in the next higher range and then calculates the Ei value using the formulas shown in the table below.

Value of Equation 10 for distance r	Formula for exponential integral
<0.02	-ln(1.781 x Cell P3)
0.03 to 0.1	-0.37528 + 0.95243 x (-ln(Cell P3))
0.1 to 0.3	-0.099525 + 0.83515 x (-ln(Cell P3))
0.3 to 1.0	0.21888 + 0.37839 x (-ln(P3)) + 0.159733 x (-ln(P3))^2
>1.0	Cell S3 x V3 x exp(-Cell P3))

Column S – Factor G in Column V

Calculates the inverse of the Ei-function argument needed to calculate the Ei function at very high values of the Ei-function argument.

Cell S3 =1/P3

Column T – Factor A in Column V

Calculates an early value needed to calculate the Ei function at very high values of the Ei-function argument.

Cell T3 =S3*(S3+3.37735)+2.05216

Column U – Factor B in Column V

Calculates an early value needed to calculate the Ei function at very high values of the Ei-function argument.

Cell U3 =S3*(1.072553*S3+5.716943)+6.945239

Column V – Intermediate

Calculates an intermediate value based on the results of calculations in columns S, T, and U. This value is needed to calculate the Ei function at high values of the Ei-function argument

Cell V3 =1-S3*(T3*S3+0.2709479)/(S3*(U3*S3+2.59388)+0.2709496)

Region 3 framework for evaluating seismic potential associated with UIC Class II permits

Scientists have long recognized that human activities, such as construction of dams and water reservoirs, mining and oil and gas production, can trigger seismic events, including those that are felt by humans. Under certain conditions, disposal of fluids through injection wells has the potential to cause human-induced seismicity. However, induced seismicity associated with brine injection is uncommon, as additional conditions necessary to cause seismicity often are not present. Seismic activity induced by Class II wells is likely to occur only where all of the following conditions are present: (1) there is a fault in a near-failure state of stress; (2) the fluid injected has a path of communication to the fault; and (3) the pressure exerted by the fluid is high enough and lasts long enough to cause movement along the fault line. In the United States, EPA Region III is aware of fewer than 10 documented cases of injection well-induced seismicity, in contrast to more than 30,000 wastewater disposal injection wells in operation. Induced Seismicity Potential in Energy Technologies, National Academy Press (prepubliation draft), 2012, at p. 6.

The presence of a fault in a receiving formation potentially creates a more vulnerable condition for a future seismic event. A fault is a fracture or a crack in the rocks that make up the Earth's crust, along which displacement has occurred. During an earthquake, energy is radiated away from the area of the fault in the form of seismic waves. This causes the ground to move as the seismic waves travel away from the fault. However, the location of the fault where the earthquake originated does not extend to the whole area that felt the earthquake. For this reason, history of seismicity that originates in areas other than the location of the injection well is not relevant in considering the potential of injection-induced seismicity at that location, as it does not provide any information about potential faults or formation pressures at the location of the well. The United States Geologic Service (USGS) tracks, records and maps earthquake epicenters and faults in certain areas throughout the United States. For areas where not much seismic activity has occurred, the USGS may not have much information about seismic events originating or faults located in those areas.

Scientists believe that injection can cause seismicity when the pore pressure (pressure of fluid in the pores of the subsurface rocks) in the formation increases to such levels as to overcome the friction force that keeps a fault stable. Pore pressure increases with increases in the volume and rate of injected fluid. Thus, the probability of triggering a significant seismic event during injection, where a fault exists in the receiving formation, increases with the volume and rate of fluid injected. In addition, the larger the volume injected over time (rate of injection), the more likely a fault could be intersected, because the fluid will travel farther within a formation. When injected fluid reaches a fault, frictional forces that have been maintained within that fault can be reduced by the fluid. At high enough pore pressure, the reduction in frictional forces can cause the formation to shift along the fault line, resulting in a seismic event. Therefore, limiting the rate and volume of the fluids injected limits the potential for seismicity.

Because increases in pore pressure due to the rate and the volume of injected fluid can act on existing faults and provide a mechanism for induced seismicity, most examples of injection-induced seismicity are in cases where the receiving formation has low permeability and/or the pressure or volume of fluid injected over time is quite large. Formations such as crystalline basement rock (deeper geological formations of igneous or metamorphic rock that underly layers of sedimentary rock), have very low permeability. Permeability is the ease with which a fluid can flow through the pores in a rock layer. For example, in the case of the Northstar 1 injection well in Youngstown, Ohio, injection occurred into very low permeability, crystalline bedrock. Where permeability is low, injected fluid cannot flow easily through the pores in this rock and therefore flow is oriented mainly through existing fractures or faults in the rock. These kinds of rock formations have high transmissivity and low storability. This means that the formation cannot store a lot of fluid; rather fluid moves farther and faster in these formations than in more porous formations. Because of the high transmissivity and low storativity of these kinds of rocks, the potential exists to induce pore pressure increases at considerable distances away from the injection well. Injection into a more permeable sedimentary formation is much less likely to induce seismicity.

Because of the likelihood of greater permeability and the reduction in pore pressure, injecting into formations with a significant history of oil and gas production is unlikely to cause seismicity. The production of oil and gas, with the accompanying brine produced during such operations, results in the removal of large amounts of fluid from the formation. That means there has been a corresponding decrease in pore pressure in the formation. If injection occurs into these depleted reservoirs, pore pressure may not reach the original levels, or in some cases, may not increase at all due to the relative volumes of injection versus extraction. For this same reason, injection for the purpose of enhanced recovery has very low potential to induce seismicity. In such cases there is little total change in formation pressure as the injection fluid replaces the volume of oil and gas extracted. Also, in formations with a long-term history of oil and gas production, more information is generally available about the geology of the formation, such as well drilling records that can provide information about injection and extraction rates and displacement of geologic formations (which could be indicative of faults).

Further, history of past, as well as currently active, injection for disposal and enhanced recovery wells (as opposed to production wells) into a formation without induced seismicity is also supporting evidence that seismicity is unlikely, either because no faults are present or because increases in formation pore pressure due to injection have not caused sufficient pressure changes for movement to occur along the fault. For example, that active injection has been occurring for decades into a formation without triggering a seismic event indicates that the formation has high permeability and that formation pore pressure is not very responsive to injection at the existing rates.

Finally, to minimize conduits for fluid to potentially contaminate underground source of drinking water (USDWs), operating conditions in an injection well permit can expressly limit the injection pressure to prevent fracturing (or cracking of the rock) of the injection zone. Limiting injection pressure provides the secondary benefit of preventing fractures that also could act as conduits through which fluid could flow and act upon an existing fault. In order to induce seismicity, pressure from the fluid injection first would have to be great enough to create or reopen fractures that would act as conduits for the fluid to reach the fault and second would have to exert enough pressure and flow to overcome the frictional forces in, and thereby destabilize, the fault. During the construction of a well, a completion process will take place whereby the operator obtains data on the amount of pressure necessary to fracture the formation and determine the instantaneous

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shut-in pressure. Instantaneous shut-in pressure is the minimum pressure necessary to begin to re-open fractures created during the hydraulic fracturing process. This pressure is significantly lower than the fracture pressure. The Region uses instantaneous shut-in pressure as a basis to establish the injection pressure, thereby preventing the fracturing of the receiving formation, in UIC permits.

For a more extensive discussion on injection-induced seismicity, see the report by the Academy of National Sciences, Induced Seismicity Potential in Energy Technologies, National Academy Press (prepubliation draft), 2012 , in particular Chapters 2 and 3. See also *Preliminary Report on the Northstar1 Class II Injection Well and the Seismic Events in Youngstown, Ohio Area*, Ohio Department of Natural Resources, March 2012; *Final Report and Recommendations*, Workshop on induced Seismicity Due to Fluid Injection/Production From Energy-Related Applications, Lawrence Berkeley National Laboratory, February 4, 2012; "*Managing the Seismic risk posed by wastewater disposal,*" Earth, April 17, 2012.

USGS
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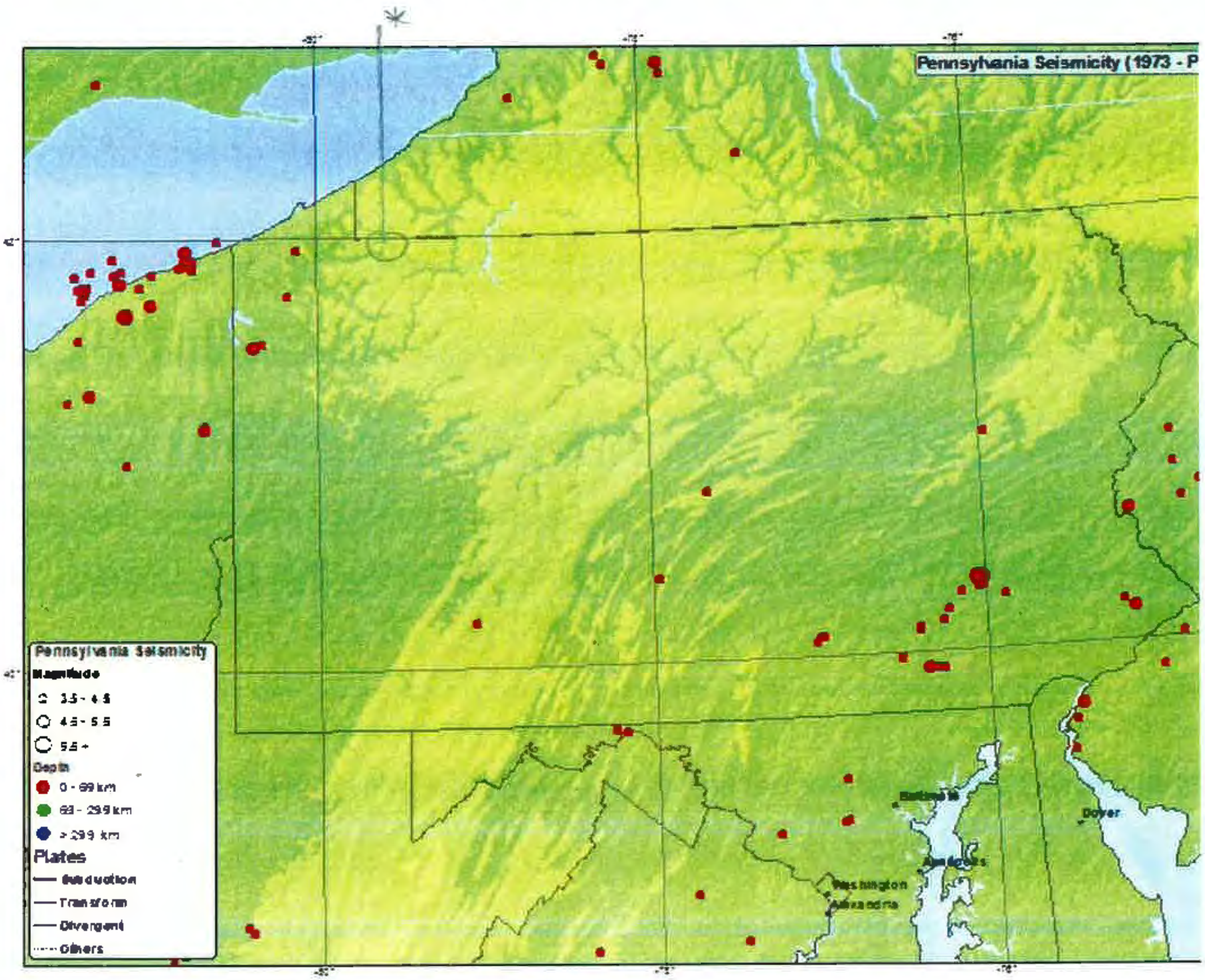
Earthquake Hazards Program

Pennsylvania

Seismicity Map - 1973 to March 2012



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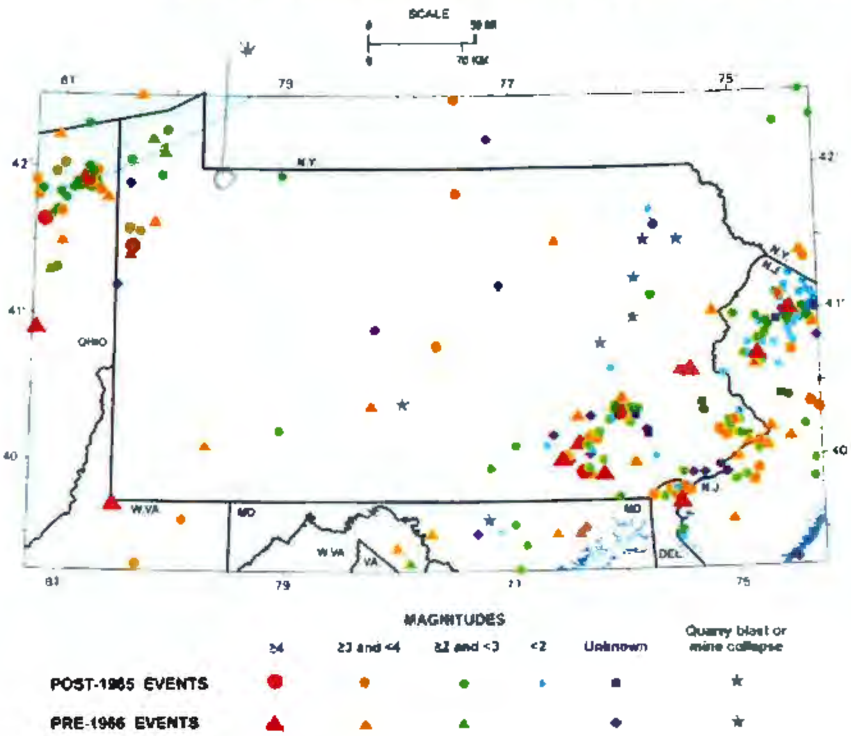

Simplified map of earthquake epicenters in and near Pennsylvania.

This earthquake epicenter map shows the location of historical quakes for Pennsylvania. The epicenter is the point on the earth's surface above the center point (called the focus) of the earthquake's origin in the subsurface.

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Permit # PAS2D217BWAR

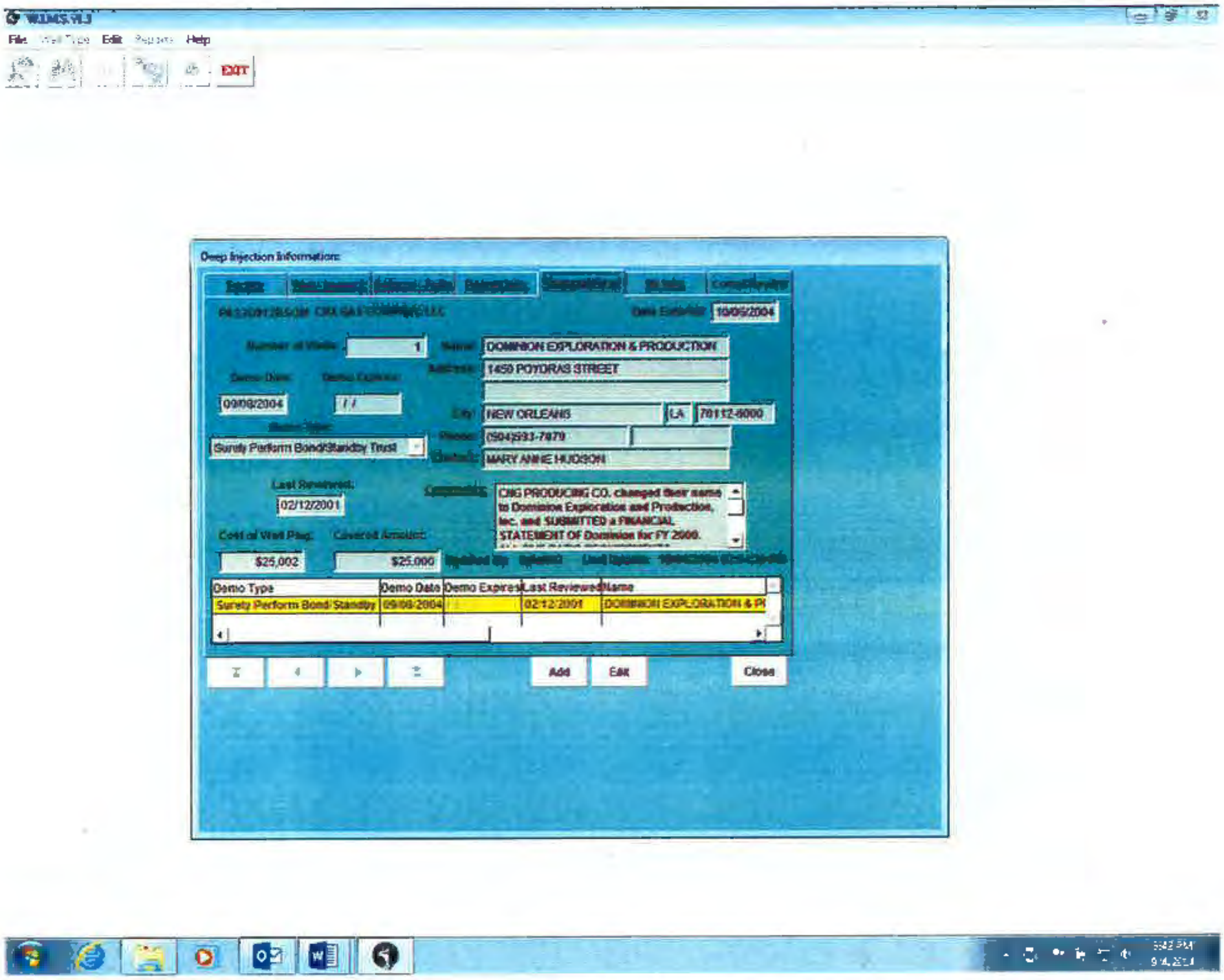
Calculate Fracture Gradient					
FG = [(ISIP + (.433 X SG x D)]/D	ISIP	SG Water	SG	D	FG
	2200	0.433	1	4588	0.912512
				TD	

Calculate MIP (Surface)					
MIP=[FG-(.433XSG)]XD	FG	SG Water	SG	D	MIP
	0.912512	0.433	1.218	4286	1650.615
				top of perf	

Calculate Bottom Hole Pressure						
BHP=(.433 X SG x D) + MIP	SG Water	SG	D	MIP	HP	BHP
	0.433	1.218	4286	1650.61476	2260.411	3911.025

FG	(B5+(0.433*D5*E5))/E5
MIP	(B10-(C10*D10))*E10
BHP	PRODUCT(B15,C15,D15)

For assistance in accessing this document, contact R3_UIC_Mailbox@epa.gov



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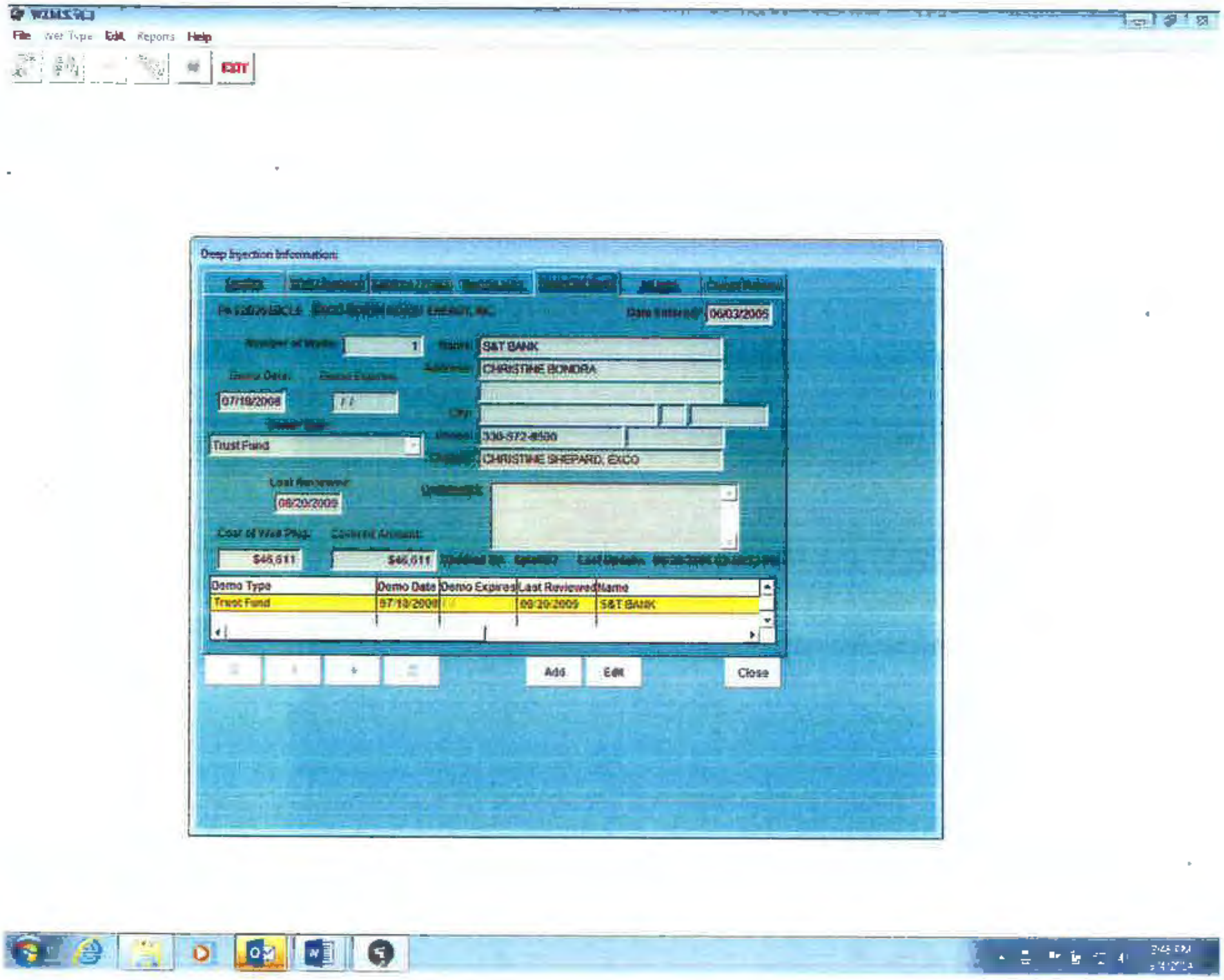


Facility ID	Facility Name	County	Injection Formation	Surface Injection Pressure	Injection Volume	Vol. Bbls/ M	API	Latitude	Longitude (-)	Plugging Estimate
PAS2D041BBEA	Columbia Gas	Beaver	Huntersville/Oriskany	1300	21,000		37-017-20027	40° 45' 22.20"	80° 26' 36.80"	75,000
PAS2D205BCLE	EXCO Resources PA	Clearfield	Oriskany	3240	27,000		37-033-00053	40° 58' 24.40"	78° 46' 18.30"	46,611
PAS2D010BVEN	Stonehaven Energy	Venango	Speechley	1358	4,500		37-121-44484	41° 23' 16.4"	79° 37' 43.5"	10,000
PAS2D251BERI	Range Resources*	Erie	Gatesburg	1570	45,000		37-049-24388	41° 58' 54.40"	80° 00' 33.20"	
PAS2D322BIND	XTO Energy*	Indiana	Balltown	1930	3600		37-063-20246			
PAS2D561BSOM	Cottonwood	Somerset	Oriskany	3250	27,000		37-111-20059	40° 02' 42.90"	78° 56' 9.20"	18,300
PAS2D902BCLE	EXCO Resources PA	Clearfield	Oriskany	1450	4200		37-033-22059	40° 54' 38.90"	78° 35' 54.70"	10,000
PAS2D912BSOM	CNX Gas Company	Somerset	Huntersville/Oriskany	3218	30,000		37-111-20006	40° 06' 33.80"	79° 03' 26.80"	25,000
PAS2D215BWAR	Bear Lake Properties	Warren	Medina	1726	30,000		37-123-39874	41° 59' 50.50"	79° 32' 27.50"	30,000
PAS2D216BWAR	Bear Lake Properties	Warren	Medina	1696	30,000		37-123-33914	41° 59' 37.50"	79° 32' 27.20"	30,000
PAS2D020BCLE	Windfall Oil & Gas	Clearfield	Huntersville/Oriskany	2443	30,000		To be drilled	41° 04' 55.0"	78° 44' 48.95"	30,000
PAS2D025BELK	Seneca Resources	Elk	Elk 3 Sand	1416	45,000		37-047-23835	41° 37' 08.1"	78° 49' 17.5"	24,650
PAS2D013BIND	PA General Energy	Indiana	Huntersville Chert	2933	30,000		37-063-31807	40° 44' 43.00"	78° 55' 34.00"	60,000

Note: Bear Lake and Windfall are commercial facilities
* Plugged and Abandoned

U.S. Fish and Wildlife Service

Natural Resources of Concern

FWS Migratory Birds (USFWS Migratory Bird Program).

Most species of birds, including eagles and other raptors, are protected under the Migratory Bird Treaty Act (16 U.S.C. 703). Bald eagles and golden eagles receive additional protection under tbe Bald and Golden Eagle Protection Act (16 U.S.C. 668). The Service's Birds of Conservation Concern (2008) report identifies species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become listed under the Endangered Species Act as amended (16 U.S.C 1531 et seq.).

Migratory bird information is not available for your project location.

NWI Wetlands (USFWS National Wetlands Inventory).

The U.S. Fish and Wildlife Service is the principal Federal agency that provides information on the extent and status of wetlands in the U.S., via the National Wetlands Inventory Program (NWI). In addition to impacts to wetlands within your immediate project area, wetlands outside of your project area may need to be considered in any evaluation of project impacts, due to the hydrologic nature of wetlands (for example, project activities may affect local hydrology within, and outside of, your immediate project area). It may be helpful to refer to the USFWS National Wetland Inventory website. The designated FWS office can also assist you. Impacts to wetlands and other aquatic habitats from your project may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal Statutes. Project Proponents should discuss the relationship of these requirements to their project with the Regulatory Program of the appropriate U.S. Army Corps of Engineers District.

IPaC is unable to display wetland information at this time.

U.S. Fish and Wildlife Service

Natural Resources of Concern

Endangered Species Act Species List (USFWS Endangered Species Program).

There are a total of 5 threatened, endangered, or candidate species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fishes may appear on the species list because a project could cause downstream effects on the species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section below for critical habitat that lies within your project area. Please contact the designated FWS office if you have questions.

Species that should be considered in an effects analysis for your project:

Clams	Status		Has Critical Habitat	Contact
clubshell (*Pleurobema clava*) Population: Entire Range; Except where listed as Experimental Populations	Endangered	species info		New York Ecological Services Field Office
rabbitsfoot (*Quadrula cylindrica cylindrica*)	Threatened	species info		Pennsylvania Ecological Services Field Office
Rayed Bean (*Villosa fabalis*)	Endangered	species info		New York Ecological Services Field Office
Mammals				
Indiana bat (*Myotis sodalis*) Population: Entire	Endangered	species info		Pennsylvania Ecological Services Field Office
northern long-eared Bat (*Myotis septentrionalis*) Population:	Proposed Endangered	species info		New York Ecological Services Field Office

Critical habitats within your project area:

There are no critical habitats within your project area.

FWS National Wildlife Refuges (USFWS National Wildlife Refuges Program).

There are no refuges found within the vicinity of your project.

U.S. Fish and Wildlife Service

Natural Resources of Concern

Project Location Map:

Project Counties:

Chautauqua, NY | Warren, PA

Geographic coordinates (Open Geospatial Consortium Well-Known Text, NAD83):

MULTIPOLYGON (((-79.5440007 41.9914387, -79.5438762 41.9981143, -79.5435543 42.004617, -79.5322118 42.004617, -79.5201311 42.0044958, -79.5201483 41.9982865, -79.5199723 41.9915599, -79.5318084 41.9916588, -79.5440007 41.9914387)))

Project Type:

Oil Or Gas

U.S. Fish and Wildlife Service

Natural Resources of Concern

This resource list is to be used for planning purposes only — it is not an official species list.

Endangered Species Act species list information for your project is available online and listed below for the following FWS Field Offices:

New York Ecological Services Field Office
3817 LUKER ROAD
CORTLAND, NY 13045
(607) 753-9334
http://www.fws.gov/northeast/nyfo/es/section7.htm

Pennsylvania Ecological Services Field Office
315 SOUTH ALLEN STREET, SUITE 322
STATE COLLEGE, PA 16801
(814) 234-4090
http://www.fws.gov/northeast/pafo/

Project Name:

UIC PAS2D217BWAR

AP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Subject: Fish and Wildlife Endangered Species – Bear Lake Properties, Bittinger 2 Permit. PAS2D217BWAR

From: Brian Poe
Ground Water & Enforcement Branch (3WP22)

To: File

Bear Lake Properties, LLC Bittinger #2 Class II-D commercial well located at:

Columbus Township
Warren County, Pennsylvania
Latitude 41° 59' 50.2" and Longitude -79° 32' 7.5"

EPA searched Fish and Wildlife's website, http://ecos.fws.gov/ipac/, for endangered species located in Warren County, Pennsylvania and received an official species list. The list identified five (5) threatened, endangered, or candidate species, and/or designated critical habitat. There are no critical habitats within the project area. A copy of the list provided by the Fish and Wildlife is attached to this memo.

EPA does not believe the project will have any effect on this species for the following reasons:

1. Injection will take place approximately 4,426 feet underground. The only way for injected fluid to impact species at the surface would be through a surface spill. Since this is an active gas production facility, the Pennsylvania Department of Environmental Protection has jurisdiction over spill prevention associated with tanks, surface containment, etc. at the injection well.
2. The injection well is currently in operation, so surface disruption at the site will be minimal.

EPA is sending a copy of the permit, statement of basis, and public notice to the U.S. Fish and Wildlife Service Pennsylvania Ecological Services Field Office for comment during the public notice of the draft permit.

Brian Poe
Ground Water and Enforcement Branch, 3WP22

Enclosure: Pennsylvania Ecological Services Field Office
315 South Allen Street, Suite 322
State College, Pennsylvania 16801-4850

EPA United States Environmental Protection Agency

EJScreen Version 1 Report for Block Group 421239703004, Pennsylvania Population: 1179

03/25/14

Selected Variables	Raw Data	State Avg.	State %ile	EPA Region Avg.	EPA Region %ile	USA Avg.	USA %ile
Environmental Factors							
Particulate Matter (PM 2.5 in µg/m³)	10.7	12.6	9	11.8	26	10.7	50
Ozone (ppb)	46.4	48.8	8	49.9	3	46	51
NATA Diesel PM (µg/m³)	0.0268	0.5180	1	0.6390	1	0.8250	3
NATA Air Toxics Cancer Risk (risk per MM)	26	54	1	59	1	61	3
NATA Respiratory Hazard Index	0.59	2.3	1	2.6	1	3.1	3
NATA Neurological Hazard Index	0.026	0.0660	5	0.0630	7	0.0630	10
Traffic Proximity (daily traffic count/distance to road)	10	75	24	110	21	110	23
Lead Paint Indicator (% Pre-1960s Housing)	0.46	0.50	49	0.38	65	0.31	72
Proximity to NPL sites (facility count/km distance)	0.015	0.13	2	0.11	6	0.0960	17
Proximity to RMP sites (facility count/km distance)	0.17	0.31	51	0.26	63	0.31	57
Proximity to TSDFs (facility count/km distance)	0.0064	0.0550	5	0.0370	7	0.0660	8
Proximity to Major Direct Dischargers (count/km)	0.19	0.35	52	0.28	62	0.25	67
Primary Demographic Index	21%	25%	60	28%	48	34%	37
Minority Population	8%	20%	48	29%	32	35%	23
Low Income Population	34%	29%	66	27%	68	32%	59
Linguistically Isolated Population	0%	2%	60	3%	57	5%	46
Population With Less Than High School Education	11%	13%	51	13%	50	15%	47
Population Under 5 years of age	7%	6%	73	6%	69	7%	62
Population over 64 years of age	13%	15%	45	14%	55	13%	62

For additional information, see: www.epa.gov/environmentaljustice

EJSCREEN is a screening tool for pre-decisional use only. It can help identify areas that may warrant additional consideration, analysis, or outreach. It does not provide a basis for decision-making, but it may help identify potential areas of EJ concern. Users should keep in mind that screening tools are subject to substantial uncertainty in their demographic and environmental data, particularly when looking at small geographic areas. This screening tool does not provide data on every environmental impact and demographic factor that may be relevant to a particular location. EJSCREEN outputs should be supplemented with additional information and local knowledge before taking any action to address potential EJ concerns.

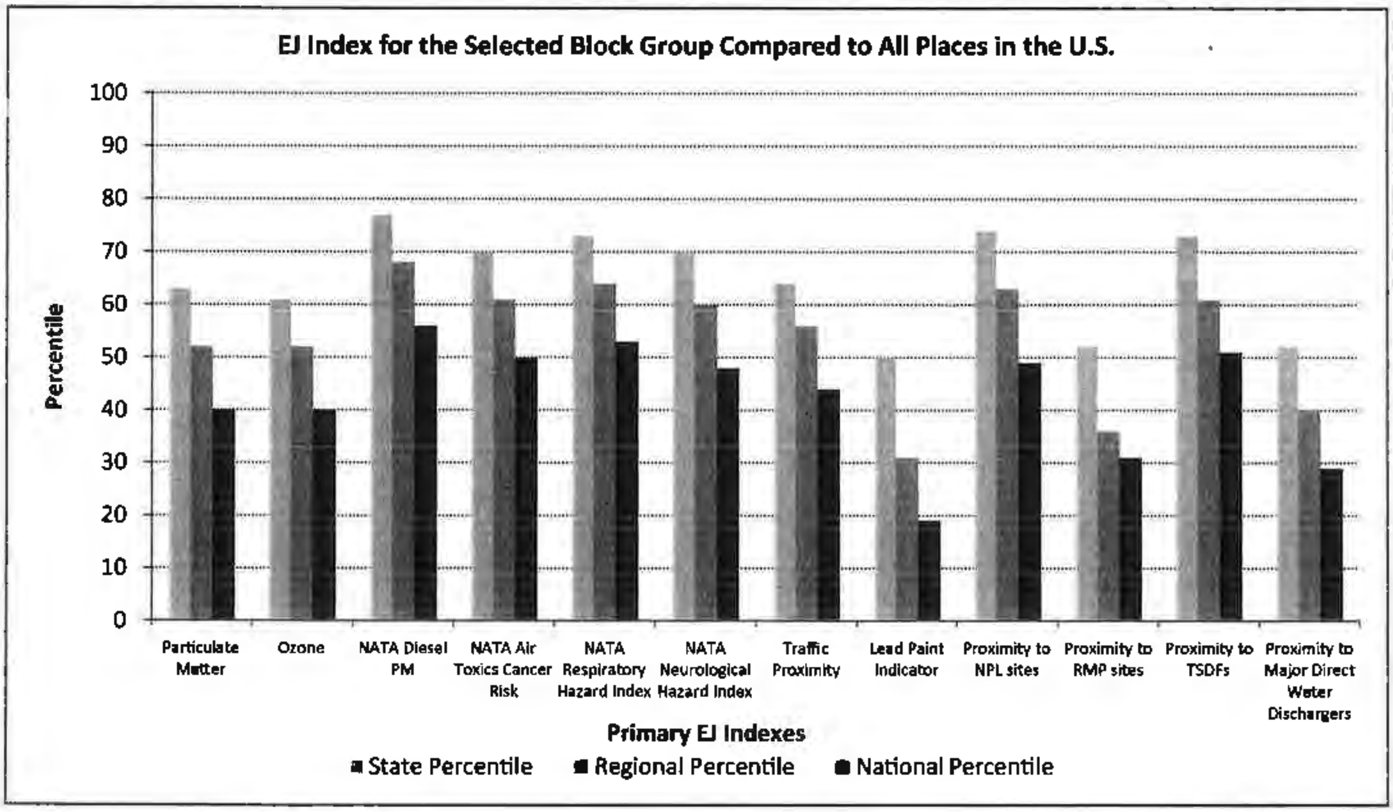
PP

EPA United States Environmental Protection Agency

EJScreen Version 1 Report for Block Group 421239703004, Pennsylvania Population: 1179

03/25/14

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
Primary EJ Indexes			
Particulate Matter	63	52	40
Ozone	61	52	40
NATA Diesel PM	77	68	56
NATA Air Toxics Cancer Risk	70	61	50
NATA Respiratory Hazard Index	73	64	53
NATA Neurological Hazard Index	70	60	48
Traffic Proximity	64	56	44
Lead Paint Indicator	50	31	19
Proximity to NPL sites	74	63	49
Proximity to RMP sites	52	36	31
Proximity to TSDFs	73	61	51
Proximity to Major Direct Water Dischargers	52	40	29



This report shows environmental, demographic, and EJ indicator values. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators.