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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Office of Oil and Gas Management

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TITLE: Guidelines for Implementing Area of Review Regulatory Requirement

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AUTHORITY: The Oil and Gas Act of 2012 (58 Pa. C.S. § 3201 *et seq.*)
The Clean Streams Law (35 P.S. § 691.1 *et seq.*)
25 Pa. Code §§78.52a., 78a.52a., 78.73, and 78a.73

POLICY: Conventional and unconventional well operators conducting hydraulic fracturing activities should follow this policy to reduce the likelihood of communication incidents and to ensure protection of people and the environment.

PURPOSE: The purpose of this guidance is to inform those engaged in hydraulic fracturing activities how to comply with the requirements of The Clean Streams Law, the 2012 Oil and Gas Act, Chapters 78 and 78a, and other applicable laws. This policy is developed to facilitate appropriate risk mitigation for conventional and unconventional well operators and includes a risk-based classification scheme for offset well locations and commensurate levels of monitoring; sections addressing communication incident management, reporting, and resolution; and operational alternatives and technical considerations for different anticipated scenarios. This policy also provides an outline of DEP's well adoption permitting process.

APPLICABILITY: This Policy applies to operators conducting hydraulic fracturing activities at both conventional and unconventional wells in the Commonwealth of Pennsylvania.

DISCLAIMER: The policies and procedures outlined in this document are intended to supplement existing requirements. Nothing in these policies and procedures shall affect regulatory requirements. The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give this document that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy if circumstances warrant.

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I. INTRODUCTION

Hydraulic fracturing is a technical procedure utilized by the oil and gas industry to break down rock and extend and prop open fractures in hydrocarbon reservoirs in order to increase oil and gas recovery. It involves the application of surface and hydrostatic pressures that combine to generate bottom hole pressures in excess of rock strength and, thus, fracture the rock. Subsequent to this, emplacement of materials known as proppants occurs to prevent fracture closure after treatment pressure is reduced. Due to the character of the oil and gas reservoirs in Pennsylvania, *hydraulic fracturing* is necessary at most wells to produce commercial quantities of hydrocarbons.

When reservoirs are completely sealed from shallower aquifers serving as sources of drinking water, *hydraulic fracturing* can be utilized with negligible risk to waters of the commonwealth. However, when other wells penetrate the area of influence of the *hydraulic fracturing* activity, they increase risk by serving as potential conduits to the surface and shallow subsurface. Properly plugged or equipped operating wells notably lessen this risk.

The AOR regulations of Chapters 78 and 78a, found in §§78.52a./78a.52a. and 78.73/78a.73, summarize the assessment, reporting, monitoring and incident resolution requirements established to appropriately address risks associated with *hydraulic fracturing* communications. This document provides further clarification related to those sections of the regulations. Wherever possible, materials are sequenced chronologically from an operational perspective.

II. DEFINITIONS

This section of the document provides DEP's interpretations of terms referenced in 25 Pa. Code §§78.52a./78a.52a. and 78.73/78a.73 and utilized throughout the document. Many of these terms have context-specific meanings and the definitions are, therefore, provided for clarity related to specific regulatory requirements. This section also includes definitions from the 2012 Oil and Gas Act and 25 Pa. Code Chapters 78 and 78a provided for reference. Note that the terms defined in this section are italicized throughout the document.

Abandoned well – As defined in Oil and Gas Act of 2012 (58 Pa. C.S. §3201 *et seq.*).

Active well – For the purposes of this policy, a well that is designed to be capable of flowing or producing hydrocarbons into a metered gathering system, for commercial purposes; or one which is designed to provide natural gas for the purposes of supplying a domestic or commercial property. Both uses defined may apply at a single well. More specifically, any well that has been assigned a permit or registration number by the state of Pennsylvania and has not been designated as having "Inactive Status." In certain cases, for the purposes of monitoring and/or coordination with adjacent operators, wells being drilled will meet this definition if it is determined that they penetrate or are likely to penetrate the zone of influence of the *hydraulic fracturing* activity.

Bottom hole location – GPS coordinates of the deepest penetration of the well (decimal degrees) for a vertical well, i.e., *GPS coordinates* of surface hole location; and depth below the last measured *GPS coordinate* pair equivalent surface location for an intentionally deviated or horizontal well.

Closest Approach – the point or points along the length of a lateral (horizontal) well bore that potentially fall within the AOR radius (1,000 feet) of an offset well.

Conventional well – As defined in 25 Pa. Code §78.1.

Conventional gas well – Any *conventional well* that is capable of producing marketable quantities of gas or of gas and oil with a gas-to-oil ratio of more than 100 Mcf per bbl of oil as defined in 25 Pa. Code §78.52a.(g).

Communication incident – Any transfer of measurable pressure or fluid flow from a well undergoing *hydraulic fracturing* to an offset well.

Deep conventional well – Any *conventional well* bore that is completed with a *true vertical depth* of greater than 5,000 feet. The significance of this definition is related to the monitoring requirements established in Table 2 of §78.73(c).

GPS (global positioning system) coordinates – A satellite-based positioning system that provides detailed coordinate data, i.e., latitude and longitude. It is composed of user, control, and satellite segments, and allows precise position location quickly and with high accuracy (adapted from Bolstad, 2008). GPS utilizes a worldwide common grid that is easily converted to any local grid, is passive in all-weather operations, gives continuous real-time information, and is capable of supporting an unlimited number of users and areas (adapted from U.S. Air Force, 2016). The accuracy of coordinates provided by any GPS must be compliant with the current DEP Policy 550-2100-009 (+/- 10m) for wells that require visual monitoring at the offset well location as part of the AOR regulation. It is acceptable to collect locational information using standard surveying techniques. For wells in the area of review depicted on the submitted plat, *GPS coordinates* may be derived from a separate source such as on-file permits or available databases and do not need to be field-verified or compliant with DEP Policy 550-2100-009. All coordinate data must reference NAD 83.

Hydraulic fracturing/hydraulically fractured – Injecting fracturing fluids into the target formation at a force exceeding the parting pressure of the rock, thus inducing fractures through which oil or gas can flow to the well bore (adapted from API Guidance Document HF3, 2011).

Inactive well – A well granted Inactive Status by the DEP pursuant to the Oil and Gas Act of 2012 (58 Pa. C.S. §3214).

Landowner – Any owner that minimally has the rights and interests in a surface estate. In certain cases, this owner may also have rights or interests in the mineral estate or oil and gas rights.

Natural production/naturally produced – Hydrocarbons capable of flowing out of a reservoir into a well bore without artificial stimulation; specifically, *hydraulic fracturing*.

Orphan well – As defined in Oil and Gas Act of 2012 (58 Pa. C.S. §3201 *et seq.*).

Owner (of a well) – An *owner* per Pennsylvania's Oil and Gas Act, 2012 (58 Pa. C.S. §3203) is defined to be person who owns, manages, leases, controls or possesses an oil or gas well. *Owner* does not include owners or possessors of surface real estate property on which an *abandoned well* is located who did not participate or incur costs in the drilling/extraction operation of the *abandoned well* and has no right of control over the drilling/extraction operation of the *abandoned well*. An *owner* is not necessarily the same individual as the *Responsible Party/Operator* (see definition that follows), but is understood to be the person who has legal access to the well, and legal rights to any economic benefit, i.e. production, from the well.

Responsible Party/Operator – The person designated as the well *operator* or *operator* on the permit application or well registration per Pennsylvania's Oil and Gas Act (58 Pa. C.S. §3203), i.e., the permit holder. Where a permit or registration was not issued, the term shall mean any person who locates, drills, operates, alters or plugs any well or reconditions any well with the purpose of production therefrom. In cases where a well is used in connection with the underground storage of gas, the term also means a "storage operator." Simply "locating" a well without the purpose of producing it does not assign *responsible party* status to an *operator* developing an area. The *responsible party* for the condition and maintenance of a well is assumed to be equivalent to the *operator*, but could also be the *owner* in the case where the two are not the same.

Shallow conventional well – Any *conventional well* bore that is completed with a *true vertical depth* of less than or equal to 5,000 feet. The significance of this definition is related to the monitoring requirements established in Table 2 of §78.73(c). Note that treatment pressure monitoring serves as *visual monitoring* for a subset of *shallow conventional wells*, i.e., those with *true vertical depths* less than or equal to 2,000 feet.

True vertical depth/True bottom hole depth – For the purposes of the AOR regulations, these terms should be considered to be equivalent. *True bottom hole depth* is defined to be the best available estimate of the depth in feet below the surface hole location for the deepest penetration point of the well. This shall be either as reported in available records, or represent a best technical estimate provided by the operator in consideration of development history in the state in the area of activity. For an intentionally deviated well, this is the depth below the x-y equivalent surface location of the deepest penetration point.

Unconventional formation – As defined in Oil and Gas Act of 2012 (58 Pa. C.S. § 3201 *et seq.*).

Unconventional well – A bore hole drilled or being drilled for the purpose of or to be used for the production of natural gas from an *unconventional formation* (as defined in the Oil and Gas Act of 2012 (58 Pa. C.S. § 3201 *et seq.*).

Visual monitoring – Verification at the location on the ground that is the identified site of a well bore requiring monitoring or some other feature that would require such monitoring. Eye contact or instrumentation are both suitable mechanisms for completing *visual monitoring* and "visual" inspections may be completed at a time interval that is respective of how well the site requiring monitoring is secured and the risk the monitored site poses. For *shallow conventional wells* with *true vertical depths* of 2,000 feet or less, continuous observation of treatment pressures may be implemented as a means of continuous *visual monitoring* assessing whether or not communication has occurred at surrounding wells within the AOR.

Well control incident/loss of well control – A scenario where the treatment pressure, producing pressure, and/or annular pressure of the well being treated or any offset well deviates from anticipated pressures in a manner that indicates mechanical integrity has been compromised and continued operations pose a risk to personnel safety, equipment integrity, or the environment (adapted from API RP 100-1, 9.4.5, 2015). This definition also includes any situations where a communication incident requires mobilization of specialized equipment to a well to enter an offset well under pressure in order to circulate out a kick.

Zone of hydraulic fracturing influence – A vertical buffer distance referencing upward or downward offsets from notch or perforation elevations in order to define what offset wells falling in the AOR have the highest potential to be communicated with during *hydraulic fracturing* activities. The *zone of hydraulic fracturing influence* is defined as a function of notch or perforation elevation for *conventional wells* in Table 2 of §78.73(c) and is set at +/- 1,500 feet for all *unconventional wells*.

III. AOR GEOMETRY

The AOR regulations of Chapters 78 and 78a., found in §§78.52a./78a.52a. and 78.73/78a.73, require an operator of oil and gas wells which will be stimulated using *hydraulic fracturing* to identify wells within a specific area, execute monitoring at a subset of those wells having certain penetration depths, and submit a report to DEP containing the information required by §§ 78.52a(d) and 78a.52a(c) prior to drilling the well. These areas and penetration depths are a function of the well attributes that is subject of the area of review, i.e., the well that will be stimulated using *hydraulic fracturing*.

For horizontal *conventional* oil wells, *conventional gas wells*, and *unconventional wells*; survey distances reference the well bore path and are set at 1,000 feet in all directions

surrounding it. *See* §§ 78.52a(a), 78a.52a(a). For vertical oil wells, survey distances also reference the well bore path and are set at 500 feet. *See* 78.52a(b).

True vertical depths of offset wells determine whether or not wells contained within the AOR must be visually monitored during *hydraulic fracturing* activities. Vertical buffer distances, referencing perforation elevations for cased hole completions and notch elevations for open hole completions, are established at +/- 1,500 feet for all *unconventional wells* (§78a.73(c)) and *deep conventional wells* (Table 2 in §78.73(c)). Vertical buffer distances, referencing perforation elevations for cased hole completions and notch elevations for open hole completions, are established at +/- 500 feet for all *shallow conventional wells* (Table 2 in §78.73(c)).

Schematics depicting AOR geometries are included in Appendix A.

A. AOR Geometry Selection Table

Select the characteristics that describe the well that is the subject of the AOR:

Well Type	Orientation	Gas-to-Oil Ratio	AOR Distance (ft)	Wells Requiring Monitoring
Shallow Conventional	Vertical	≤100 Mcf/bbl of Oil	500	all that penetrate within +/- 500 feet of uppermost and lowermost perforations/notches
Deep Conventional	Vertical	≤100 Mcf/bbl of Oil	500	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations/notches
Shallow Conventional	Vertical	>100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 500 feet of uppermost and lowermost perforations/notches
Deep Conventional	Vertical	>100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations/notches
Shallow Conventional	Horizontal	≤100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 500 feet of uppermost and lowermost perforations
Deep Conventional	Horizontal	≤100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations
Shallow Conventional	Horizontal	>100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 500 feet of uppermost and lowermost perforations
Deep Conventional	Horizontal	>100 Mcf/bbl of Oil	1,000	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations
Unconventional	Vertical	NA	1,000	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations
Unconventional	Horizontal	NA	1,000	all that penetrate within +/- 1,500 feet of uppermost and lowermost perforations

Table 1. AOR Geometry table.

IV. REFERENCE MATERIAL REVIEW

Sections 78.52a(c) and 78a.52(b) provide that operators must identify offset wells by (1) conducting a review of DEP's well databases and other available well databases and (2) conducting a review of historical sources of information, such as applicable farmline maps, where accessible. Numerous sources of information are available for determining the best-known locations of *active*, *inactive*, *abandoned*, *orphan*, and plugged and *abandoned* offset wells falling within the AOR.

DEP has identified several well databases and historical sources of information to ensure compliance with the identification requirements in Chapters 78 and 78a. In addition to these well databases and historical sources of information, DEP will make sources submitted by operators as part of the AOR report deliverables package publically available. These additional reference materials will only be inclusive of identified wells sites that are not known to be part of the standard reference materials described in this section. Finally, a thorough field survey may in many cases be superior to a desktop review of databases and historical sources.

Table 2 lists potentially useful sources for completing the AOR survey. Discretion may be applied by the *operator* to arrive at a final conclusion regarding which reference sources may be most useful for assessing their site.

Table 3 provides additional pay-for-service sources that may be useful when completing the AOR survey. Note that accessing these additional reference materials is not a regulatory requirement and that the compilation is provided for informational purposes only.

A. Reference Material Requirements Checklist

- ☐ Review list of reference materials in Table 1 and the associated Map Indices in Appendix B. Apply professional discretion to determine which reference materials should be used to locate offset wells at your site, keeping in mind that the DEP Oil and Gas Map (or associated databases) and the EDWIN Viewer must always be consulted for any portions of the AOR not surveyed on foot.
- ☐ Construct a table of well locations by status and list the reference material source used to identify each well.
- ☐ Determine which wells will require monitoring, i.e., which wells penetrate the *zone of hydraulic fracturing influence*?
- ☐ Indicate which wells in the AOR will require notification of adjacent operators.

Source	Geographic Area of Applicability	Location	Comments	Instructions for Use
County/Local Historical Societies	Statewide	Establish local contacts through various mechanisms	These organizations often archive historical maps which may be inclusive of oil and gas well locations	Find contact information and call organization to determine if any sources are available for review.
DCNR BTGS Reports and Publications	Limited Geographic Extent	http://www.gis.dcnr.state.pa.us/geology/index.html Also see Map Index in Appendix B	Reports and other publications with maps depicting oil and gas well locations associated with different fields throughout the commonwealth	Navigate to PaGEODE website and search for reports by quadrangle. Compare to Appendix B to determine which reports cover oil and gas topics and download applicable reports for review or visit BTGS in Pittsburgh to review report.
DCNR BTGS Historic Farmline Maps	Limited Geographic Extent	See Map Index in Appendix B	Farmline map collection represents working field maps willed to Bureau of Topographic and Geologic Survey by Equitable	Reference Appendix B to determine if maps are available that cover drilling site and visit BTGS in Pittsburgh to review maps.
DEP Oil and Gas Map[1]	Statewide	http://www.depgis.state.pa.us/PaOilAndGasMapping/	Web-based GIS for mapping wells throughout the state	Navigate to area of operation and select well by status to view locations. Note that this information can also be downloaded in tabular format from DEP's website: http://www.dep.pa.gov/Business/Energy/OilandGasPrograms/OilandGasMgmt/Oil-and-Gas-Reports/Pages

Source	Geographic Area of Applicability	Location	Comments	Instructions for Use
DEP Production Reporting	Statewide	https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Welcome/Agreement.aspx	Most useful in situations where adjacent operator cannot be successfully contacted using available DEP address, as sometimes other companies report production on behalf of operator and may be able to provide updated contact information	Search for well using API #. Contact DEP (717.772.2199) to determine who reported production for the well in question.
DEP Spud Report[1]	Statewide	http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Spud_External_Data	For wells in process of being drilled that have not yet been input in eFACTS or EDWIN	Use option for querying by location, i.e., municipality to determine what wells may be in process of being drilled.
PASDA Historic Wells and Mine Map Atlas	Limited Geographic Extent	http://www.pasda.psu.edu/	This currently includes wells that were digitized from analog source maps (WPA and K-sheet/H-sheet mine map series) by DEP and wells located in the footprint of historic coal mines (Mine Map Atlas); this is not a comprehensive compilation and is subject to updates	In the "Data Search" box in the upper right corner of the main website, search for "historic wells." Click on the title and then click preview data to see locations in map form or to download a scanned map. The mine Map Atlas link is on main PASDA Page.
Penn Pilot	Statewide	http://www.pennpilot.psu.edu/	Archive of historical aerial imagery	Input address or coordinates to download associated aerial images. Options include filtering on location and image era. Images from the 1930s to 1970s are available.

Source	Geographic Area of Applicability	Location	Comments	Instructions for Use
The National Map	Statewide	http://viewer.nationalmap.gov/viewer/	Archive of current USGS topographic maps	Input address or coordinates and select "Other Featured Data" to view available topographic maps.
USGS Historical Topographic Map Explorer	Statewide	http://historicalmaps.arcgis.com/usgs/	Archive of current and historic USGS topographic maps	Input address or coordinates to review available historical topographic maps for the site. Maps from late 1800s to 1980s are available.
Google Earth Pro	Statewide	https://www.google.com/earth/	Aerial imagery dating back 1990s	After downloading free software, input address or coordinates to review available historical aerial imagery for the site.
USGS Reports and Publications	Limited Geographic Extent	http://energy.usgs.gov/RegionalStudies/AppalachianBasin.aspx	Archive of open-file reports discussing development histories in various portions of Appalachian basin	Compare to Appendix B to determine which reports cover oil and gas topics and visit BTGS in Pittsburgh to review report.
Industry Historic Map Inventory	Limited Geographic Extent	Various	Any maps in the possession of the operator completing *hydraulic fracturing*	Review available maps.

Source	Geographic Area of Applicability	Location	Comments	Instructions for Use
EDWIN Viewer [1]	Statewide	Tool anticipated to be available when regulation is final	Web-based GIS tool depicting historic oil and gas fields/pools along with production depth intervals and oil and gas well locations; links to well record scans also available	Instructions TBD

Table 2. List of potential reference materials for completing AOR survey. Note that not all sources provide statewide coverage and professional judgment should be applied to determine which sources are appropriate for the site being assessed. A thorough field survey is considered superior to a review of reference materials.

[1]Indicates mandatory reference source

Source	Location	Comments
Core Lab Consortia	http://corelab.com/	None
DrillingInfo	http://drillinginfo.com/	None
ENERDEQ	https://www.ihs.com/products/oil-gas-tools-enerdeq-browser.html	An IHS service
IHS	https://www.ihs.com/products/us-well-data.html	None
ITG	www.ITG.com	Analysis of data
Natural Gas Intelligence	http://www.naturalgasintel.com.newsletters/2-shaledaily	Analysis of data
PA Logs	http://www/pairis.state.pa.us/ftp/	Source of records related to individual wells
TGS Well Log Data	https://llp.tgsnopec.com/llp/index.aspx	None
Woodmac	http://www/woodmac.com	Analysis of data

Table 3. List of pay-for-service reference materials that may have additional information useful for completing the AOR survey.

V. LANDOWNER COORDINATION/SURFACE ACCESS

As part of regulations established in §§78.52a(b)(3) and 78a.52a(b)(3), the *operator* is required to provide evidence to DEP that a due-diligence effort was made to identify potential offset wells of concern through submittal of questionnaires to *landowners* by certified mail delivery, or equivalent. Along with a review of well databases and historical sources of information, conducting surveys of landowners represents the third process for securing information related to identifying well locations during the AOR analysis. This process is also critical for coordinating surface access to locate any wells in the field that the *operator* is responsible for monitoring.

All information gathered as part of landowner surveys conducted under this section of the document may be cataloged for reuse by the *operator* for up to three (3) years from the date surveying of the parcel was completed. With approval from DEP, information may gathered using the development plan option described below may be referenced for an additional two (2) years for a total of five (5) years from the date of collection. Information collected is not transferrable to other *operators*.

A. Use of Standard DEP Forms

Two standard forms have been developed for completing the required landowner surveys: one for the *operators* of vertical oil wells (AAA-AAA-AAAA) and one that applies for all other types of wells (BBB-BBB-BBBB). If used, these forms must be sent via certified mail to all landowners occupying parcels within the established AOR. It is recommended that a reference map be included with the form to best assist the landowner in determining whether or not wells they are aware of fall within the AOR. The form must be mailed to the person identified in courthouse records of the county who is designated to receive tax notices for the surface tax parcel. If more than one tax parcel within the prescribed AOR radius is registered to the same individual, multiple tax parcels can be included on a single form. Multiple well locations may also be referenced on a single form. This is most relevant in situations where a landowner owns are large parcel or when a single parcel contains a multi-well pad.

Instructions specify that a landowner or their designee should complete and return the form to the operator within ten (10) business days of receipt. Although it is not required that certified mail receipts or completed forms be sent to DEP along with the AOR deliverables package, it is recommended that this information be retained by the operator for five (5) years following the completion of *hydraulic fracturing* activities as documentation that the regulatory requirements were satisfied.

As part of the survey, landowners are asked to provide documentation of any wells they are aware of on their property. Documentation may be in the form of pictures (physical evidence) or records (historic maps, well records, etc.). Landowners are also asked if they would be willing to share documentation concerning any wells with operators and allow the operator access to their property to evaluate any identified

wells, including those known by the landowner and any wells the *operator* may have become aware of through analysis of available reference materials.

There is no expectation that *operators* access wells under any of the following scenarios:

(1) The landowner does not complete the questionnaire within the requested timeframe or at all.
(2) The landowner does not acknowledge that any physical evidence of a well's presence exists nor do they indicate that they have any official records documenting the presence of a well.
(3) The landowner claims they have physical evidence or official records documenting the presence of wells on their property but is unwilling to share such information with the *operator*.
(4) The landowner will not grant access to the *operator*.
(5) Research completed by the *operator* and documented along with the AOR report deliverables indicates that any wells that may be present on the landowner's property are not likely to penetrate within the zone of *hydraulic fracturing* influence and the landowner has not provided any information that would call into question the validity of this determination.

B. Development Plan Option

Many operators have lease agreements with state agencies or coordinate with land management agencies when oil and gas rights are severed from surface rights. Private landowners may also own significant acreage in rural areas. It is more common in these situations for development to take place on large tracts of land and submitting landowner questionnaires may not be efficient. Additionally, operators may wish to evaluate many smaller tracts of land at one time to prepare for well pad development. An alternative process for coordinating with landowners to identify offset wells is presented in this section of the document.

The development plan option, which is designed to enable efficiency measures, may be appropriate in the following scenarios:

(1) An operator has a lease agreement with a state or federal agency or a working access agreement with the agency in cases where oil and gas rights are severed from surface rights , e.g., DCNR, USFS, PGC, NPS, etc.).
(2) An operator is dealing with one or several large landowners.
(3) An operator is looking to evaluate large tracts of land (possibly with numerous surface landowners) in preparation for significant exploration efforts and to complete due-diligence assessments prior to finalizing site construction, drilling, and *hydraulic fracturing* .

Form CCC-CCC-CCCC may be utilized as an alternative process for identifying offset wells under the development plan option. The form allows the *operator* to

maintain an electronic tabular summary of parcels associated with multiple well locations. Because this process potentially covers much larger areas of development, it necessarily requires more lead time/earlier coordination with landowners and it should not be used in situations where information must be gathered within ten (10) business days, although the forms associated with the 10-day process may be used to facilitate the collection of information needed under the development plan option. *Operators* choosing the development plan option should allow for up to 30 business days for receipt of responses and may request approval from DEP to extend the reference period up to a maximum of five (5) years for any single well location.

C. Landowner Coordination Requirements Checklist

- ☐ Have all parcels in the AOR been identified and have addresses been determined for each landowner?
- ☐ Have landowner questionnaires been submitted to each property owner in the AOR or has the alternative development plan process been followed?
- ☐ Were landowner questionnaires submitted via certified mail or equivalent?
- ☐ Is it necessary to schedule site visits to inspect any alleged wells or wells identified by the operator through the database or historic source review?
    - The landowner has completed the questionnaire within the allotted timeframe.
    - The landowner has acknowledged that physical evidence of a well's presence exists or indicated that they have official records documenting the presence of a well and is willing to share this information.
    - The landowner has agreed to grant access to the operator.
    - Research completed by the operator and documented along with the AOR report deliverables indicates that at least one well present on the landowner's property is likely to penetrate within the zone of *hydraulic fracturing* influence or the landowner has provided information that at least one well on their property is likely to penetrate the zone of *hydraulic fracturing* influence

D. Other Considerations

- ☐ Were site maps included with each landowner questionnaire?
- ☐ Have returned questionnaires and certified mailing receipts been placed in a file that has a retention schedule of five (5)) years following the completion of *hydraulic fracturing* activities?
- ☐ Has the *operator* determined that it will be important to document conditions at wells on a landowner's property prior to *hydraulic fracturing* activities even in a situation where communication risks are low?
- ☐ Is a plan in place for attempting to re-contact unresponsive landowners in areas where communication risks are elevated?

VI. ADJACENT OPERATOR COORDINATION

The AOR regulations in §§78.73(c) and 78a.73(c) require operators completing *hydraulic fracturing* activities to notify adjacent *operators* with offset wells that penetrate the *zone of hydraulic fracturing influence*. The intent of these sections is to facilitate the necessary level of coordination between *operators* in order to mitigate risk and ensure the integrity, safety, and continued viability of assets.

A. Wells Within the AOR

After defining the AOR and prior to drilling, the *operator* shall contact all adjacent *operators* who are in the process of drilling or completing new wells, manage wells in production, or maintain wells on inactive status in situations when the intended zone of completion (vertical separation between perforations or notches) for the planned well is within +/-500 feet (*shallow conventional*) or +/-1500 feet (*deep conventional* and *unconventional*) of any portion of any offset well bore path intersecting the AOR.

For recently plugged wells identified within the AOR that intercept the zone of *hydraulic fracturing* influence, i.e., those plugged within the preceding 12 months, the *operator* who plugged the well is considered the *responsible party* and during coordination this should be clearly established. Such wells include those where the final site restoration has not yet been completed/approved and/or the bond has not yet been released. The *operator* intending to complete *hydraulic fracturing* activities may request that DEP complete an inspection of the well prior to stimulation. Such inspections will be completed at the agency's discretion.

Adjacent *operators* whose wells fall within the AOR shall be notified of intended operations 30 days in advance of the anticipated spud date, or at the time the well drilling permit is submitted if it is expected that the well will be spud within 30 days of permit issuance. For *conventional wells* where hydrocarbon extraction is anticipated via *natural production*, this notice may be deferred until within 30 days of *hydraulic fracturing* activities, if such operations ultimately take place at the well to enhance production. Wells in the process of being drilled or stimulated are characterized as *active* and must be considered during the analysis. *Operators* are also expected to coordinate notification and monitoring activities within different business units of their own companies.

DEP's Well Inventory Report serves as the resource identifying the most up-to-date contact information for *operators* in the state and can be accessed from the agency's reporting page. *Operators* intending to complete *hydraulic fracturing* activities should maintain documentation of attempts to contact adjacent *operators* for up to five (5) years following well completion.

B. Adjacent Operator Coordination Requirements Checklist

- ☐ Has notification been provided to *operators* with offset wells, including recently plugged wells (within the last 12 months), within the AOR at least 30 days prior to anticipated well spud?
- ☐ Has notification to different business units, e.g., drilling, completions, operations been provided within the company intending to conduct *hydraulic fracturing* activities?
- ☐ Has the *hydraulic fracturing* operations team been briefed about actions that must be taken when notified by an adjacent *operator* about a confirmed communication incident?

C. Other Considerations

- ☐ Are coordinated monitoring efforts with the adjacent *operator* needed in consideration of the communication risk at the location?
- ☐ Have communication protocols for implementation during *hydraulic fracturing* activities, including timely notification in the event of an unintended communication, been established with the adjacent *operator*?
- ☐ Has the subject of workover procedures been discussed with the adjacent *operator*, including scenarios where well work may be necessary to ensure mechanical integrity and/or environmental protection standards? Has it been determined who may assume financial responsibility for such work and the legal mechanisms for moving forward with adequate liability protection?
- ☐ Have risk mitigation strategies been fully evaluated in situations where an adjacent operator has not been cooperative? Such strategies may include revising/eliminating *hydraulic fracturing* stages or redirecting the targeted well bore path for horizontal *conventional* or *unconventional well*, moving the well location an appropriate distance from the offset well, and/or completing visual observations from a distance.
- ☐ Have all correspondence or attempts to communicate with the adjacent *operator* been adequately documented and archived in a file with a retention schedule of five (5) years?

VII. WELL MONITORING AND ALTERNATIVES

A. Hydraulic Fracturing Communication Risks and Monitoring Levels

Monitoring requirements associated with the AOR regulations of Chapters 78 and 78a are found in §§78.73(c)/78a.73(c). Not all offset wells penetrating the *zone of hydraulic fracturing influence* pose the same level of risk. An assessment of historical data and communication incidents supports the concept that communication risks are a function of several different variables including offset well location, depth,

construction details, age, and status. Several of these variables are interrelated, making it possible to further simplify the risk-characterization model.

Key risk-classification criteria are:

(1) Character of the *hydraulic fracturing* activity
(2) Character and location of wells in the AOR

A generalized risk-classification scheme is presented in the figures that follow. Figure 1 categorizes the potential for impact as a function of reservoir thickness and offset distance between the stimulated wells and surrounding wells falling within the AOR. Figure 2 considers the character of the wells within the AOR.

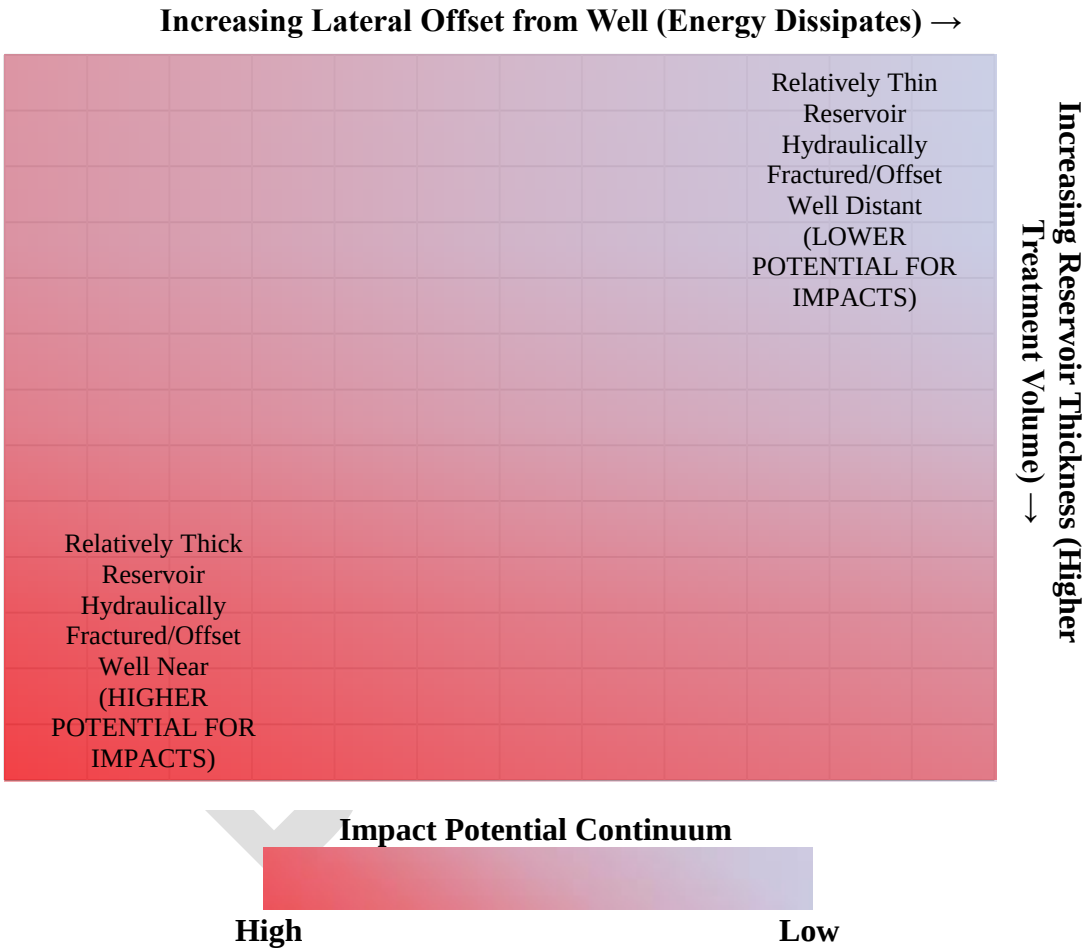


Figure 1. Conceptual model characterizing impact potential based on treatment volume (reservoir thickness) and offset distance for wells within the AOR.

Description	Risk Level
Wells within AOR which do not penetrate the *zone of hydraulic fracturing influence*	NEGLIGIBLE
Wells inside AOR which penetrate the *zone of hydraulic fracturing influence*	
Active wells being drilled	LOWER
Active wells in production/inactive wells	
Zone of hydraulic fracturing influence/pressure isolation is verified	LOWER
Lack of *zone of hydraulic fracturing influence*/pressure isolation	HIGHER
Plugged and/or abandoned wells	
Well plugged in accordance with current regulations and laws	LOWER
Well plugged prior to passage of Act 223 (1984 Oil and Gas Act)	MODERATE
Well plugged prior to well permitting era (1956)	HIGHER
Well on DEP's orphan and abandoned list	HIGHER
Abandoned well for which plugging status is unknown	HIGHER

Figure 2. Characterization of risk associated with offset wells within the AOR that penetrate the *zone of hydraulic fracturing influence* and offset wells within the AOR which do not penetrate the *zone of hydraulic fracturing influence*. Note that site-specific well plugging methodologies may have significant influence on the portion of the classification scheme related to abandoned wells.

Appropriate, risk-based levels of monitoring are established in Figure 3. Adjacent *operator* notification requirements specified in Chapters 78 and 78a, §§78.73(c)/78a.73(c) are also summarized for reference. Finally, general monitoring/risk mitigation alternatives are described.

Description	Monitoring Level	Monitoring/Risk Mitigation Alternatives
Wells within AOR which do not penetrate the *zone of hydraulic fracturing influence*	NONE	NONE
Wells inside AOR which penetrate the *zone of hydraulic fracturing influence*		
Active wells being drilled	LOW	CHECK POST-COMPLETION
Active wells in production/inactive wells		
Zone of hydraulic fracturing influence/pressure isolation is verified	LOW	CHECK POST-COMPLETION
Lack of *zone of hydraulic fracturing influence*/pressure isolation	HIGH	CONTINUOUS MONITORING OR ENSURE CONTAINMENT
Active wells in production or being drilled/inactive wells (adjacent operator)	NOTIFICATION ONLY	
Plugged and/or abandoned wells		
Abandoned well or well plugged within preceding 12 months (adjacent operator)	NOTIFICATION ONLY	
Well plugged in accordance with current regulations and laws	LOW	CHECK POST-COMPLETION
Well plugged prior to passage of Act 223 (1984 Oil and Gas Act)	MEDIUM	CHECK PRE- AND POST-COMPLETION
Well plugged prior to well permitting era (1956)	HIGH	CONTINUOUS MONITORING OR ENSURE CONTAINMENT
Well on DEP's orphan and abandoned list	HIGH	CONTINUOUS MONITORING OR ENSURE CONTAINMENT
Abandoned well for which plugging status is unknown	HIGH	CONTINUOUS MONITORING OR ENSURE CONTAINMENT

Figure 3. Summary table of offset well characteristics, monitoring level, notification responsibilities, and monitoring/risk mitigation alternatives. Note that time intervals over which continuous monitoring is required is dependent upon the character of the *hydraulic fracturing* operation and is further refined in the figures that follow.

B. Standard Risk-Based Monitoring Plans

After locating all wells potentially falling within the AOR per Chapters 78 and 78a, §§78.52a.(a) and (b)/78a.52a.(a), the *operator* must identify the subset of those wells that require monitoring in accordance with §§78.73(c) /78a.73(c): intended zone of completion (vertical separation between perforations or notches) for the planned well is within +/-500 feet (*shallow conventional*) or +/-1500 feet (*deep conventional* and *unconventional*) of any portion of any offset well bore path intersecting the AOR.

Suggested alternatives for both *visual monitoring* and ensuring containment are provided below. In all cases, it is essential that the *operator* coordinate with DEP prior to connecting any containment equipment to an offset well with no *responsible party*, as repercussions related to ownership responsibilities are at stake:

(1) Employ RTU/continuous monitoring/automatic shut-in devices at producing wells (monitoring/containment)
(2) Empty tanks at producing wells for optimum capacity (containment)
(3) Equip *abandoned wells* with pressure gauges (monitoring)
(4) Equip *abandoned wells* with tanks (containment)
(5) Plug or re-plug *abandoned wells* (containment)
(6) Install continuous gas meters/flow meters or employ hand-held gas meters at *abandoned wells* (monitoring)
(7) Appoint field personnel with radio contact to observe adjacent wells (monitoring)
(8) Install chart gauge(s) at producing wells for a permanent pressure record (monitoring)
(9) Use flagging tape and maintain clear observation pathways for *abandoned wells* that can be viewed from the rig operations area (monitoring)
(10) Continuously observe treatment pressures for *conventional* wells less than or equal to 5,000 feet *true vertical depth* (monitoring)

Standard monitoring plans are provided for different types of *conventional* and *unconventional wells* in the tables that follow (Figures 4 through 8). Monitoring protocols are based on risk levels. *Operators* have the option of developing other site-specific monitoring protocols that are considerate of communication risks identified in the AOR.

Well Type	Orientation	Depth (ft)	AOR Survey Criteria	Pre-Hydraulic Fracturing/During Hydraulic Fracturing		
			0 to 500 feet (1,000 feet for gas wells)	Low	Medium	High
Oil Well Type Gas	Vertical	≤ 2,000	Use databases and other applicable reference sources to ID and classify offset wells or survey on foot (any portions of AOR not surveyed on foot must be assessed using applicable reference sources)	Continuously monitor treatment pressure		

Well Type	Orientation	Depth (ft)	Communication Response			Post-Hydraulic Fracturing		
			Low	Medium	High	Low	Medium	High
Oil	Vertical	≤ 2,000	If sudden, unexplained drop in treatment pressure, discontinue hydraulic fracturing, notify DEP, and survey all well sites in AOR starting closest to stimulated well			At conclusion of job, check all identified offset well sites within 200 feet of stimulated well		
Well Type						Low	Medium	High
Gas						At conclusion of job, check all identified offset well sites within 500 feet of stimulated well		

Figure 4. Standard monitoring plans for vertical oil and gas wells less than or equal to 2,000 feet *true vertical depth* (Tier 1 Monitoring Plan: See Appendix C).

Well Type	Orientation	Depth (ft)	AOR Survey Criteria	Pre-Hydraulic Fracturing/During Hydraulic Fracturing		
			0 to 500 feet (1,000 feet for horizontal oil wells)	Low	Medium	High
Oil	Vertical/ Horizontal	> 2,000 and ≤ 5,000	Use databases and other applicable reference sources to ID and classify offset wells or survey on foot (any portions of AOR not surveyed on foot must be assessed using applicable reference sources)	No pre-hydraulic fracturing requirements	Visually observe pre-hydraulic fracturing	Ensure containment Visually observe offset well continuously during highest-risk interval/closest approach and continuously monitor treatment pressure during hydraulic fracturing of other treatment intervals/stages

Well Type	Orientation	Depth (ft)	Communication Response			Post-Hydraulic Fracturing		
			Low	Medium	High	Low	Medium	High
Oil	Vertical/ Horizontal	> 2,000 and ≤ 5,000	No action needed during hydraulic fracturing at offset wells with containment If sudden, unexplained drop in treatment pressure or evidence of release/well control incident, discontinue hydraulic fracturing, notify DEP, and survey all well sites in AOR starting closest to stimulated well			Visually observe post-hydraulic fracturing		

Figure 5. Standard monitoring plans for vertical and horizontal oil wells between 2,000 feet and 5,000 feet *true vertical depth* (Tier 2 Monitoring Plan: See Appendix C).

Well Type	Orientation	Depth (ft)	AOR Survey Criteria	Pre-Hydraulic Fracturing/During Hydraulic Fracturing		
			0 to 1,000 feet	Low	Medium	High
Gas	Vertical	> 2,000 and ≤ 5,000	Use databases and other applicable reference sources to ID and classify offset wells or survey on foot (any portions of AOR not surveyed on foot must be assessed using applicable reference sources)	No pre-hydraulic fracturing requirements	Visually observe pre-hydraulic fracturing	Ensure containment Visually observe offset well continuously during highest-risk interval and continuously monitor treatment pressure during stimulation of other treatment intervals

Well Type	Orientation	Depth (ft)	Communication Response			Post-Hydraulic Fracturing		
			Low	Medium	High	Low	Medium	High
Gas	Vertical	> 2,000 and ≤ 5,000	No action needed during hydraulic fracturing at offset wells with containment If sudden, unexplained drop in treatment pressure or evidence of release/well control incident, discontinue hydraulic fracturing, notify DEP, and survey all well sites in AOR starting closest to stimulated well			Visually observe post-hydraulic fracturing		

Figure 6. Standard monitoring plans for vertical gas wells between 2,000 feet and 5,000 feet *true vertical depth* (Tier 2 Monitoring Plan: See Appendix C).

<table>
<tr><td rowspan="2">Well Type</td><td rowspan="2">Orientation</td><td rowspan="2">Depth (ft)</td><td>AOR Survey Criteria</td><td colspan="3">Pre-Hydraulic Fracturing/During Hydraulic Fracturing</td></tr>
<tr><td>0 to 500 feet (1,000 feet for gas wells)</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td>Oil/Gas</td><td>Vertical</td><td>> 5,000</td><td>Use databases and other applicable reference sources to ID and classify offset wells or survey on foot (any portions of AOR not surveyed on foot must be assessed using applicable reference sources)</td><td>No pre-hydraulic fracturing requirements</td><td>Visually observe pre-hydraulic fracturing</td><td>Ensure containment

Visually observe offset well continuously</td></tr>
</table>

<table>
<tr><td rowspan="2">Well Type</td><td rowspan="2">Orientation</td><td rowspan="2">Depth (ft)</td><td colspan="3">Communication Response</td><td colspan="3">Post-Hydraulic Fracturing</td></tr>
<tr><td>Low</td><td>Medium</td><td>High</td><td>Low</td><td>Medium</td><td>High</td></tr>
<tr><td rowspan="2">Oil/Gas</td><td rowspan="2">Vertical</td><td rowspan="2">> 5,000</td><td colspan="3">No action needed during hydraulic fracturing at offset wells with containment</td><td colspan="3" rowspan="2">Visually observe post-hydraulic fracturing</td></tr>
<tr><td colspan="2">No action needed during hydraulic fracturing</td><td>If evidence of release/well control incident, discontinue hydraulic fracturing and notify DEP</td></tr>
</table>

Figure 7. Standard monitoring plans for vertical oil and gas wells greater than 5,000 feet *true vertical depth* (Tier 3 Monitoring Plan: See Appendix C).

Well Type	Orientation	Depth (ft)	AOR Survey Criteria	Pre-Hydraulic Fracturing/During Hydraulic Fracturing		
			0 to 1,000 feet	Low	Medium	High
Unconventional	Any	Any	Use databases and other applicable reference sources to ID and classify offset wells or survey on foot (any portions of AOR not surveyed on foot must be assessed using applicable reference sources)	No pre-hydraulic fracturing requirements	Visually observe pre-hydraulic fracturing	Ensure containment Visually observe offset well continuously during closest approach

Well Type	Orientation	Depth (ft)	Action			Post-Hydraulic Fracturing		
			Low	Medium	High	Low	Medium	High
Unconventional	Any	Any	No action needed during hydraulic fracturing at offset wells with containment			Visually observe post-hydraulic fracturing		
			No action needed during hydraulic fracturing		If evidence of release/well control incident, discontinue hydraulic fracturing and notify DEP			

Figure 8. Standard monitoring plans for *unconventional wells.*

D. Well Monitoring and Alternatives Requirements Checklist

- ☐ Have the construction characteristics, age, and status of the offset wells in the AOR been determined and used to assign the appropriate monitoring level (Figure 3)?
- ☐ For *active*, *inactive*, *orphan*, *abandoned*, and plugged wells in the AOR requiring monitoring, has well integrity been assessed based on surface observations and a review of available records?
- ☐ Has a risk-based monitoring plan been developed for offset wells within the AOR?

E. Other Considerations

- ☐ Has the character of the *hydraulic fracturing* activity been defined in terms of anticipated treatment pressures, volumes, and pump durations and compared to the information in Appendix C?
- ☐ Has the expected type of fracture plane orientation, e.g, vertical or horizontal, been determined for the interval(s) being targeted for production?
- ☐ Does the risk change as a function of what activity is being completed at the well undergoing *hydraulic fracturing*, i.e., multi-zone or multi-stage completions?
- ☐ Have the standard monitoring protocols been considered (Figures 4 through 8)?
- ☐ Has a plan for securing high-risk offset wells in the AOR been executed to minimize the potential for environmental impacts?

VIII. AOR REPORT DELIVERABLES

The AOR report and monitoring plan required per Chapters 78 and 78a, §§78.52a.(d)/78a.52a.(c) consists of both standard components that will be useful for creating a database detailing *operator* activities associated with the regulation and site-specific analyses and plans that are not easily transferable to a tracking system, but nonetheless important for recognizing and addressing variability throughout the different oil and gas producing areas of the state. This section of the guidance provides a tabular summary of the standard AOR deliverables as well as a discussion of considerations related to the composition of the accompanying site-specific report. The AOR report and monitoring plan must be submitted electronically to DEP at least 30 days in advance of well spud, or in cases where a well will be *naturally produced* initially and *hydraulically fractured* at some later date, at least 30 days in advance of *hydraulic fracturing*.

A. Standard AOR Report Electronic Summary Table

Each AOR report must be submitted electronically. Figure 9 is a tabular summary of the standard components that must accompany each submittal. Note that not all

parameters listed apply for each report developed. Those that are not relevant should be left blank. Each tabular report shall cross-reference a plat using the designated well ID.

Additional information concerning the well that is the subject of the AOR must also be provided. This information shall be inclusive of anticipated surface and *bottom hole GPS coordinates* for the well that will be stimulated by way of *hydraulic fracturing* and the API number, or the farm name and number for a well that has not yet been permitted. Finally, operators must indicate if all *landowners* within the AOR have been notified and whether or not proof of notification is on file.

B. Site-specific AOR Report

In certain cases the *operator* completing the AOR survey may develop a site-specific narrative report to accompany the electronic summary table. Information in the report may consist of the following:

(1) The specifics of the risk assessment completed to determine appropriate levels of monitoring at applicable wells and details related to the type of monitoring activities that will be implemented
(2) Any historical well drilling analysis completed to estimate well *true vertical depths*
(3) Any geologic evaluation used to modify the AOR geometry beyond the dimensions prescribed in the regulations
(4) Coordination/monitoring agreements between adjacent operators
(5) Documentation of identified well ownership and access issues
(6) Bibliography of reference materials used to compile information on wells falling within the AOR

Whenever a written accompanying report is deemed necessary, it shall be submitted to DEP electronically in pdf format. Written reports are recommended by DEP in cases where significant supplemental analyses were used to arrive at conclusions related to assigning risk and implementing monitoring activities, as they will be critical in determining what may have gone wrong when unanticipated communication incidents occur and also useful for resolving compliance matters in such cases.

C. AOR Report Deliverables Requirements Checklist

- ☐ Has the Standard AOR Report Electronic Summary Table been downloaded and completed for the well that is the subject of the AOR?
- ☐ Has an accompanying AOR well plat that references all wells in the AOR Report Electronic Summary Table been prepared and submitted along with the AOR Report Electronic Summary Table?

- ☐ Do submitted *GPS coordinates* for all field-verified wells within the AOR meet DEP accuracy requirements, i.e., +/-10 m?

D. Other Considerations

- ☐ Has the need for an accompanying narrative report been evaluated in consideration of information that is most likely to be included in such a report (see items (1)-(6) in subsection B above)?

Field Heading	Description of Report Parameter
API #/Alternate Well ID	The API # assigned to the well using the following format: CCC-XXXXX. CCC represents the three-digit county code and XXXXX represents the unique, 5-digit county ID. The sections of the API number must be separated by a dash (-). If not a registered well, use the following numbering system: U1, U2, U3, etc. These same numbers must be used on the plat in order to cross-reference the table to the well plat.
Reference Material/Source	The source that was used to identify the offset well from the list of available options: "DEP Database", "Other Database", "Historical Source", "Operator Map", "Landowner Survey", "Aerial Image", or "Field Inspection."
DEP Well Status	The regulatory status used to classify the offset well from the list of available options: "Active", "Inactive", "Orphan", "Abandoned", "Plugged & Abandoned", or "Undetermined."
Adjacent Operator Information	If the offset well included in the summary report is the responsibility of an adjacent operator, please provide the OGO number for operator responsible for the offset well. Leave this field blank for orphan/abandoned wells or wells with no known operator.
Adjacent Operator Notification	"Y" if the adjacent operator was notified or "N" if the delivery service failed.
Latitude DD (surface location)	The true latitude and longitude of the surface location of the wellbore in decimal degrees. This must reference NAD 83 datum. Please note that all coordinate data submitted must conform to DEP's current policy on accuracy standards (+/- 10 meters).
Longitude DD (surface location)	
Latitude DD (bottom hole location)	These fields only apply for horizontal wells. The true latitude and longitude of the bottom hole location of the wellbore in decimal degrees as determined through a review of available records. This must reference NAD 83 datum.
Longitude DD (bottom hole location)	
Survey Accuracy	For any well coordinates referenced in DEP/DCNR databases, or anything digitized from a historical map or a map from a published report, leave this column blank. If well locations are field verified or located in the field with a hand-held GPS or other surveying equipment, accuracy must be reported in accordance with current DEP accuracy policy: +/- 10 meters or better. Enter the numerical value for the accuracy of all field surveyed offset well locations.
Access Granted	"Y" if landowner consent for access has been granted or "N" if landowner consent for access has not been granted.
Surface Property Tax ID #	The tax parcel ID for the tract of land on which the offset well is located.
Well Integrity Assessment	For wells in the monitoring plan that are observed in the field, the operator must assess the well's ability to contain fluids based on a surface visual inspection. Please choose from the following codes for each offset well inspected in the field: "1" if the well appears to have integrity based on field observation and any well construction details gleaned from a file review; "2" if the well appears to have compromised integrity or may have experienced compromised integrity during hydraulic fracturing based on any well construction details gleaned from a file review; and "3" if the integrity status cannot be determined with reasonable confidence. For wells not observed in the field, this parameter should be left blank.
TVD	The true vertical depth (TVD) in feet for the offset well. This shall be either as reported in available records, or represent a best technical estimate provided by the operator in consideration of development history in the state in the area of activity. For an intentionally deviated well, this is the depth below the x-y equivalent surface location of the deepest penetration point.

Field Heading	Description of Report Parameter
Information Source for TVD	Information regarding how the offset well depth was determined from a list of available options: "DEP Well Record", "Publication Well Depth", "Private Source Well Record", "Study of Regional Drilling History", and "Unknown". A separate written report may be necessary to explain steps an operator took to investigate drilling history in an area.
Monitored Site	If the offset well is included in monitoring plan, indicate "Y", otherwise indicate "N."
Monitoring Level	Indicate the monitoring level from the list of available options: "High", "Medium", and "Low."
Monitoring Plan Notes	This field is optional and is designed to contain specific notes explaining monitoring or mitigation plans for each well. Entries are limited to 255 characters or less.
Controlled Communication Anticipated	This field is for unconventional operations only and is intended to archive if an operator expects a controlled communication event or has planned such an event in association with well efficiency testing. If such an event is anticipated or planned, indicate "Y", otherwise indicate "N."
Text Comment	This field is optional and intended for explaining any responses that may need clarification. Entries are limited to 255 characters or less.

Figure 9. Standard report parameters for tabular component of AOR Report and accompanying Monitoring Plan.

Landowner Notification Documentation	An entry of "Y" to certify that all landowners with parcels in the area of review were notified per the regulatory requirements, otherwise enter or "N."
API #/Well Farm Name and Number for Well that is Subject of Area of Review	If the well has been permitted, the API # assigned to the well should be provided using the following format: CCC-XXXXX. CCC represents the three-digit county code and XXXXX represents the unique, 5-digit county ID. The sections of the API number must be separated by a dash (-). If the well has not been permitted, the farm name and number as it will appear on the permit application should be provided.
Surface Hole Latitude for Well that is Subject of Area of Review	The anticipated surface location latitude in decimal degrees for the well that is the subject of the area of review. This must reference NAD 83 datum.
Surface Hole Longitude for Well that is Subject of Area of Review	The anticipated surface location longitude in decimal degrees for the well that is the subject of the area of review. This must reference NAD 83 datum.
Bottom Hole Latitude for Well that is Subject of Area of Review	For horizontal wells, the anticipated bottom hole location latitude in decimal degrees for the well that is the subject of the area of review. This must reference NAD 83 datum.
Bottom Hole Longitude for Well that is Subject of Area of Review	For horizontal wells, the anticipated bottom hole location longitude in decimal degrees for the well that is the subject of the area of review. This must reference NAD 83 datum.

Figure 9 (continued). Supplemental information for AOR Report.

IX. WELL ADOPTION

In §§78.73(d)/78a.73(d), the AOR regulation has provisions for adopting offset wells that have been communicated with. Although a discussion of the details of the well adoption permit is beyond the scope of this document, several recommendations and general guidelines are provided for reference.

If an *operator* identifies an *abandoned* or *orphan well* within the AOR that they are interested in adopting, it is recommended that this activity be pursued prior to commencement of *hydraulic fracturing*, as it may be one way to effectively mitigate risk ahead of stimulation. Establishing well ownership and identifying whether or not there is some operating interest in an *abandoned well* is essential to manage liability in such situations. For wells already on DEP's *orphan* and *abandoned* list, due diligence has been completed in this regard and an interested party need only perform additional measures if they believe it is legally advisable to do so. For wells that are not listed on DEP's *orphan* and *abandoned* list, conducting due diligence related to well ownership and operating interests is a critical step.

In all cases, it is essential to establish an updated lease agreement addressing operating/royalty-disbursement conditions, and to secure ongoing access to rehabilitate and operate the well. DEP does not regulate the details of lease agreements and does not intend to evaluate any processes that were undertaken by the *operator* to bring the well back in to legal production aside from those aimed at assuring that necessary environmental protection standards are in place.

For any wells that were communicated with during *hydraulic fracturing* activities, a site-specific integrity assessment protocol or workover plan, potentially involving downhole analysis procedures, must be submitted to DEP along with the adoption permit.

A. Other Considerations

- ☐ Have the well adoption permit and accompanying instructions been reviewed?
- ☐ Have *abandoned* and *orphan wells* in the AOR been considered for adoption prior to *hydraulic fracturing* activities?
- ☐ For any wells on the adoption permit, have all potential *responsible parties* been considered and has a thorough assessment of potential operating interests been completed?
- ☐ Has a lease agreement been established that provides ongoing access and the ability to operate the well that is being considered for adoption?

X. INCIDENT REPORTING AND RESOLUTION

The AOR regulations generally address incident resolution in the sections detailing well adoption, plugging of altered wells, and DEP authorization prior to recommencement of

hydraulic fracturing activities: §§78.73(d)/78a.73(d) and §§78.73(c)/78a.73(c). To clearly define a protocol for incident resolution, it is first essential to indicate what constitutes a reportable communication incident, as prior sections of this document indicate that intra-well communication may be executed by the *operator* with intent and the fundamental basis for the regulation is the Clean Streams Law and the environmental protections afforded by that statute. *Operators* are also legally obligated to maintain a safe operating environment.

Please note that the notification and reporting requirements included in this regulation do not necessarily satisfy other regulatory obligations under §78.73 pertaining to the over-pressuring of the surface casing seat, §78.86 pertaining to defective casing and cement, §78.88 pertaining the mechanical integrity of operating wells, or §78.89 pertaining to the investigation of stray gas migration incidents; or any other statutory or regulatory investigative and reporting requirements. Further, all environmental releases of regulated substances must be reported and remediated in accordance with §§78.66/78a.66.

A. Incidents Requiring 2-Hour Notification and 3-Day Follow-up Incident Report

In cases where certain reportable incidents are identified, the *operator* must immediately cease *hydraulic fracturing* and notify DEP via the electronic reporting notification service on the DEP website or by telephone. This notice must be filed within two (2) hours of when the *operator* first becomes aware of the incident. *Hydraulic fracturing* may not commence again until DEP is satisfied that the situation is under control and measures have been developed to prevent any further anticipated risk. Part of this process includes submission of the standard follow-up incident reports in Figures 10 and 11.

Immediate activity cessation and notification is essential to begin the process of risk mitigation and reduce the potential for compounding environmental impacts as soon as possible, and is also critical so that the agency may begin conversations with the *operator* and coordinate with the public as necessary. A communication incident report must be filed with the agency within three (3) days of when the *operator* first becomes aware of the incident.

Incidents that must be reported to DEP within two (2) hours and followed up with a standard incident report within three (3) days include:

(1) Any communication incident with an *abandoned*, *orphan* or plugged well; as the ability for containment and pressure control at such wells is significantly limited. Immediate reporting applies even in the case where an *operator* has established temporary containment measures at the surface that appear to have been implemented with success. A plan for permanently plugging the affected well must be developed and executed by the *operator* as soon as practicable. The plan may be implemented without filing a notice of intent to plug the well, provided DEP approval is received.

(2) Any communication incident with any other well that the *operator* completing the stimulation has been made aware of and that threatens or jeopardizes the integrity of the surface or near surface environment as a result of a breach/loss of containment, a release of pollution-causing substances to the environment, or some other occurrence that has the potential to impact the waters of the commonwealth.
(3) Any communication incident that results in a *well control incident/loss of well control* as defined in this guidance.
(4) Any communication incident that results in site safety risks as a result of equipment malfunction or other events within the AOR.

B. Incidents Requiring 24-Hour Notification and 30-Day Follow-up Incident Report

A subset of incidents may occur that were anticipated and coupled with measures introduced by the *operator* to maintain control of the situation, but were not intentionally implemented or engineered. These must be reported to DEP within 24 hours of when the *operator* first became aware of the incident via the electronic reporting notification service on the DEP website or telephone. However, the follow-up standard incident report need only be filed with the agency within 30 days of first becoming aware of the incident. *Hydraulic fracturing* may continue in these circumstances.

Information associated with these incidents will help determine what risk-mitigation measures are appropriate in the future, e.g., size of tank that should be installed, allow DEP to complete follow-up work as needed with regard to any potential well integrity problem(s), and allow DEP and the industry to continue to evaluate the geometry of the AOR in a more comprehensive sense and update this guidance from a risk-mitigation standpoint as needed.

Incidents that must be reported to DEP within 24 hours and followed up with a standard incident report within 30 days include:

(1) Any communication incident with any *active* or *inactive well* that the *operator* completing the stimulation has become aware of that does not result in an environmental or *well control incident*, but does result in a breach/loss of containment that is not coupled to a release, e.g., release to a tank. A breach/loss of containment includes the observation of any flowing fluids in sections of the well where they were previously not noted or any significant increase in the volume of such fluids or annular pressures from baseline conditions as judged by the *operator* completing the monitoring.
(2) Any communication incident that results in production pressure deviations at an offset *active* or *inactive well* that are significantly more than expected. For wells that produce gas inside of surface or coal casing strings, reportable conditions include any surface-measured production pressures in excess of 80% of the hydrostatic pressure (assume 0.433 psi/ft gradient) at the casing seat depth. For

all wells, any pressure increases that are within 10% of the containment rating for the lowest rated barrier element subjected to production pressure must be reported. For example, if a well head valve is rated for 5,000 psi and production pressures increase to 4,500 psi as a result of a communication incident, this constitutes a reportable incident.

C. Incidents Not Requiring Reporting

As discussed previously in this guidance, certain communication incidents are executed by design/engineered by the *operator*. There is no expectation that these incidents either interfere with completing *hydraulic fracturing* activities or be reported to DEP, provided none of the threshold criteria for reporting referenced in subsections A and B are observed.

D. Incident Resolution

For reportable incidents under subsection A of this section, *hydraulic fracturing* incidents may only recommence after DEP has provided authorization. In instances where communication alters a nearby *abandoned* or *orphan well* that is on DEP's list, or any previously plugged well for which no further regulatory obligations exist for another *operator/responsible party*, plugging/re-plugging is required. Provided the *operator* is able to stabilize conditions at the affected well, plugging does not necessarily need to be completed prior to recommencement of *hydraulic fracturing*. The *operator* may choose to plug the well as part of a Good Samaritan Law proposal or may proceed with the project outside of the liability protection afforded under that law. It is not necessary to adopt the well first in these cases.

When plugging is necessary to resolve an issue at a well that is not covered under the previous paragraph, i.e., a well for which some other *operator/responsible party* exists, environmental and safety issues must be mitigated as soon as possible, even if under an Order from DEP. After resolution of these matters, it is up to both *operators/responsible parties* involved to make the necessary arrangements for plugging of the well in accordance with all applicable laws and regulations. Some of these matters are discussed in more detail under Section V of the guidance addressing coordination between adjacent *operators*.

Plugging may not always be necessary to resolve communication incidents, and in certain cases there may be disputes between adjacent *operators* that must be resolved. Resolution of such matters is beyond the scope of this document or regulatory program. In all cases, the *operators/responsible parties* must demonstrate that all environmental and safety matters are mitigated with diligence and that the plan to move forward with *hydraulic fracturing* activities can be implemented in a manner that appropriately mitigates previously revealed or reasonably anticipated risks.

E. Other Considerations

- ☐ Prior to commencement of *hydraulic fracturing* activities, have the subsections of this section detailing incidents requiring suspension of hydraulic fracturing activity and 2-hour reporting (subsection A above), 24-hour reporting (subsection B above) and no reporting (subsection C above) been reviewed and are they understood by operations staff?
- ☐ Has the necessary coordination with adjacent *operators* and landowners been implemented to ensure that environmental and safety risks can be addressed expeditiously in the event of an unforeseen communication incident?
- ☐ Are company personnel responsible for interfacing between operations staff and DEP familiar with the immediate notification and follow-up incident reporting deadlines and where appropriate forms and instructions for notification can be accessed?
- ☐ Have operations staff been in communication with DEP field inspection staff to discuss the timeline for commencement of the *hydraulic fracturing* activities and any aspects of the monitoring plan that may require close coordination with the agency?
- ☐ Has the Good Samaritan Law and project proposal template been reviewed and evaluated for future consideration?

Field Heading	Description of Report Parameter
API # of Hydraulically Fractured Well	The API # assigned to the well that was undergoing hydraulic fracturing at the time of the communication incident. Use the following format: CCC-XXXXX. CCC represents the three-digit county code and XXXXX represents the unique, 5-digit county ID. The sections of the API number must be separated by a dash (-).
API #/ID of Well that Experienced Communication	The API #, if known, or ID from Area of Review Report Summary Table of well that was communicated with. If the well was not identified as part of AOR survey and does not have API#, use the following nomenclature: ("C1", "C2", "C3", etc.). If multiple wells were communicated with, use as many lines as are necessary.
Adjacent Operator	If an adjacent operator's well was involved in the communication incident, this is the OGO Number for that operator. Leave blank if same as the operator that was conducting hydraulic fracturing activities. Indicate "No RP" if well does not have an operator associated with it.
Start Date	The date that the communication incident was first observed in "MM/DD/YYYY" format.
End Date	The date incident control was established at well that experienced the communication incident, i.e., environmental or safety concerns mitigated. Leave blank if incident is ongoing when the report is submitted. Use "MM/DD/YYYY" format.
Environmental/Safety Incident	Indicate "Y" if a surface release, water supply impact, other environmental impacts, or a well control or other safety incident has occurred, otherwise indicate "N."
Communication Type	The type of hydraulic fracturing communication incident from the list of available options: "Stimulation to Operating Well", "Stimulation to Well Being Drilled", Stimulation to Abandoned/Orphan Well", "Stimulation to Inactive Well", "Stimulation to Plugged Well", or "Other."
Latitude DD of Receiving Well	The latitude in decimal degrees representing the surface hole location of the well that experienced the communication incident. This applies for vertical wells or when the vertical section of an intentionally deviated well experiences the communication incident. This must reference NAD 83 datum.
Longitude DD of Receiving Well	The longitude in decimal degrees representing the surface hole location of the well that experienced the communication incident. This applies for vertical wells or when the vertical section of an intentionally deviated well experiences the communication incident. This must reference NAD 83 datum.

Field Heading	Description of Report Parameter
Kick Volume	The volume of the kick circulated out in barrels of the well that experienced the communication incident. This field only applies for offset drilling scenarios.
Frac Stage Fluid Volume.	The volume of the frac stage in barrels that was being hydraulically fractured at the time of the communication incident.
Maximum Treatment Pressure	The maximum treatment pressure in pounds per square inch (psi) of the frac stage that was being hydraulically fractured at the time of the communication incident.
Average Treatment Pressure.	The average treatment pressure in psi of the frac stage that was being hydraulically fractured at the time of the communication incident.
Abnormal Treatment Volumes Noted	Indicate "Y" if the treatment volume of the stage being hydraulically fractured at the time of the communication incident was significantly higher compared to adjacent stages; otherwise indicate "N."
Abnormal Treatment Pressures Noted	Indicate "Y" if the treatment pressure of the stage being hydraulically fractured at the time of the communication incident was significantly higher compared to adjacent stages; otherwise indicate "N."
Any Faults Present or Geologic Anomalies Noted	Indicate "Y" if the presence of faults or other geologic anomalies were observed, otherwise indicate "N."
Orientation of Fault in Horizontal Plane	If any faults are present, provide azimuth in 0 to 360 degrees.
Brief Description	Additional notable details related to incident. Limit description to 255 characters or less.

Figure 10. Standard follow-up report for *conventional* well *hydraulic fracturing* communication incident.

Field Heading	Description of Report Parameter
API # of Hydraulically Fractured Well	The API # assigned to the well that was undergoing hydraulic fracturing at the time of the communication incident. Use the following format: CCC-XXXXX. CCC represents the three-digit county code and XXXXX represents the unique, 5-digit county ID. The sections of the API number must be separated by a dash (-).
API #/ID of Well that Experienced Communication	The API #, if known, or ID from Area of Review Report Summary Table of well that was communicated with. If the well was not identified as part of AOR survey and does not have API#, use the following nomenclature: ("C1", "C2", "C3", etc.). If multiple wells were communicated with, use as many lines as are necessary.
Adjacent Operator	If an adjacent operator's well was involved in the communication incident, this is the OGO Number for that operator. Leave blank if same as the operator that was conducting hydraulic fracturing activities. Indicate "No RP" if well does not have an operator associated with it.
Start Date	The date that the communication incident was first observed in "MM/DD/YYYY" format.
End Date	The date incident control was established at well that experienced the communication incident, i.e., environmental or safety concerns mitigated. Leave blank if incident is ongoing when the report is submitted. Use "MM/DD/YYYY" format.
Environmental/Safety Incident	Indicate "Y" if a surface release, water supply impact, other environmental impacts, or a well control or other safety incident has occurred, otherwise indicate "N."
Communication Type	The type of hydraulic fracturing communication incident from the list of available options: "Stimulation to Operating Well", "Stimulation to Well Being Drilled", Stimulation to Abandoned/Orphan Well", "Stimulation to Inactive Well", "Stimulation to Plugged Well", or "Other."
Communication Cross-over Any Other Laterals Without Noted Affect	Indicate "Y" if communication originated at horizontal well and intervening horizontal wells fall between the source of the communication and the receiving well, otherwise indicate "N."
Latitude DD of Stage Midpoint for Well Undergoing Hydraulic Fracturing	The stage midpoint latitude in decimal degrees of the stage being hydraulically fractured when the communication incident occurred. If a vertical well was being hydraulically fractured, indicate the top hole location. This must reference NAD 83 datum.
Longitude DD of Stage Midpoint for Well Undergoing Hydraulic Fracturing	The stage midpoint longitude in decimal degrees of the stage being hydraulically fractured when the communication incident occurred. If a vertical well was being hydraulically fractured, indicate the top hole location. This must reference NAD 83 datum.

Field Heading	Description of Report Parameter
Latitude DD of Receiving Well	The latitude in decimal degrees representing the surface hole location of the well that experienced the communication incident. This applies for vertical wells or when the vertical section of an intentionally deviated well experiences the communication incident. This must reference NAD 83 datum.
Longitude DD of Receiving Well	The longitude in decimal degrees representing the surface hole location of the well that experienced the communication incident. This applies for vertical wells or when the vertical section of an intentionally deviated well experiences the communication incident. This must reference NAD 83 datum.
Bottom Hole/Bit Location Latitude DD of Receiving Well	The latitude in decimal degrees of the well that experienced the communication incident. If being drilled, indicate the bit location, otherwise indicate bottom hole location. This field applies for intentionally deviated wells only. This must reference NAD 83 datum.
Bottom Hole/Bit Location Longitude DD of Receiving Well	The longitude in decimal degrees of the well that experienced the communication incident. If being drilled, indicate the bit location, otherwise indicate bottom hole location. This field applies for intentionally deviated wells only. This must reference NAD 83 datum.
Landing Point Latitude DD of Receiving Well	The landing point latitude in decimal degrees of the well that experienced the communication incident. This field applies for intentionally deviated wells only. This must reference NAD 83 datum.
Landing Point Longitude DD of Receiving Well	The landing point longitude in decimal degrees of the well that experienced the communication incident. This field applies for intentionally deviated wells only. This must reference NAD 83 datum.
Kick Volume	The volume of the kick circulated out in barrels of the well that experienced the communication incident. This field only applies for offset drilling scenarios.

Field Heading	Description of Report Parameter
Frac Stage Fluid Volume.	The volume of the frac stage in barrels that was being hydraulically fractured at the time of the communication incident.

Figure 11. Standard follow-up report for *unconventional well hydraulic fracturing* communication incident. Note that this report may be necessary for certain *conventional* well communication incidents involving intentionally deviated wells.

XI. PROCESS SUMMARY FOR CONVENTIONAL OPERATORS

As a means of compliance assistance, this section for *conventional* operators summarizes all the relevant information contained within the AOR guidance document in a checklist format. For clarification or further guidance, it may be necessary to refer to individual sections of this guidance document.

The following activities must be completed at least 30 days prior to spud or in advance of submitting the permit application if the well will be spud within 30 days of permit issuance. The only exception is when *natural production* will take place at the well, in which case the AOR requirements are deferred until 30 days in advance of *hydraulic fracturing*:

- ☐ Determine AOR geometry by referencing the AOR Geometry Table (page 8) and examples 3, 4, and 5 in Appendix A (pages 46-48)
- ☐ For any portions of the AOR that will not be surveyed on foot, review the list of reference sources compiled in Table 1 (pages 10-12) and apply discretion regarding which ones are most relevant for the location – at a minimum DEP databases, the DEP spud report, and the EDWIN Viewer must be consulted prior to drilling the well
- ☐ Identify all tax parcels in the AOR and mail certified letters containing Form AAA-AAAA-AAA or Form BBB-BBBB-BBB to all landowners to determine if there are other wells in the AOR and also to secure access, or use development plan option (Form CCC-CCCC-CCC); any individual parcel information remains valid for three (3) years from the date the survey is completed for that parcel unless the development plan option is chosen and DEP approves a five (5) year renewal period
- ☐ From the wells identified in the AOR, determine which require *visual monitoring* based on known *true vertical depths*
- ☐ Visit all well sites that require *visual monitoring* at the offset well location (as opposed to treatment pressure monitoring) and record *GPS coordinates*; if surveying any portion of the AOR on foot, complete field investigation and record *GPS coordinates* for all wells observed (locational data must be reported with an accuracy of +/- 10 m)
- ☐ Notify adjacent *operators* with wells in the AOR, as needed
- ☐ Choose appropriate pre-approved monitoring plan from Figures 4 through 7 (pages 24-27) or develop site-specific, risk-based monitoring plan that is compliant with the applicable regulations
- ☐ Download the AOR report form and complete AOR Summary Table using risk-based classification system in Figure 3 (page 22) and instructions in Figure 9 (pages 32-33)
- ☐ Submit AOR Summary Table to DEP 30 days prior to spud or with the permit application if the well will be spud within 30 days of permit issuance

The following activities must be executed upon commencement of hydraulic fracturing activities:

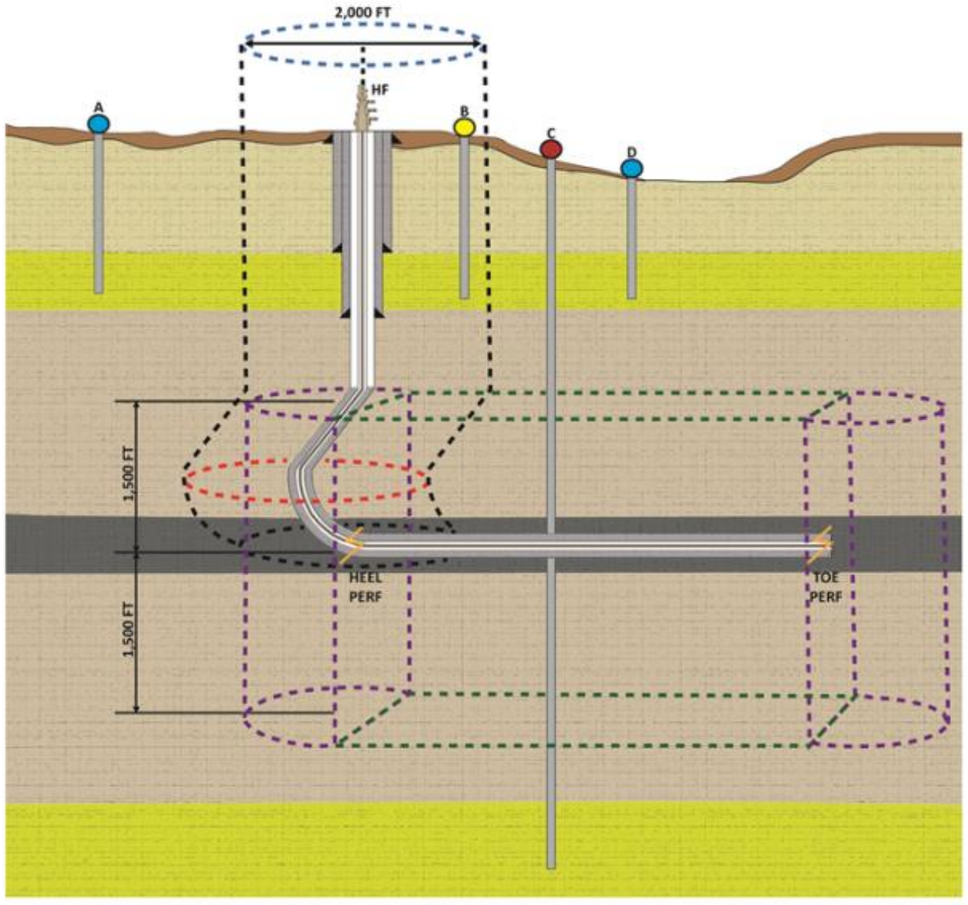
- ☐ Implement appropriate pre-approved monitoring plan from Figures 4 through 7 (pages 24-27) or site-specific, risk-based monitoring plan that was developed and submitted as part of AOR report

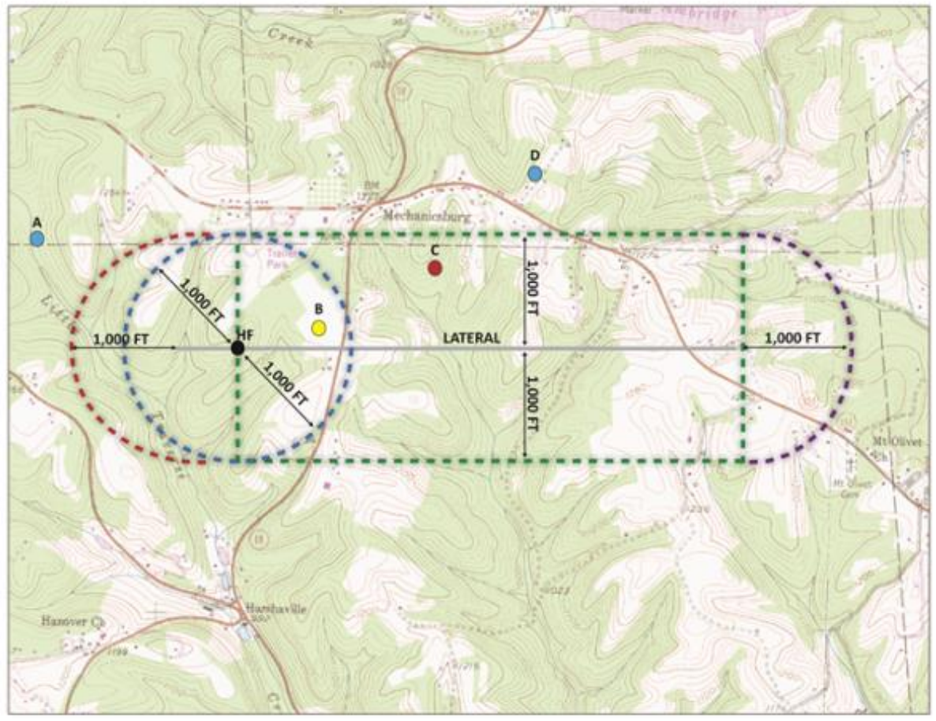
The following activities must be executed if a communication incident is observed by the *operator* or reported to the *operator* and confirmed:

- ☐ Follow notification requirements detailed on pages 36-37
  - Two (2)-hour notification for any communications with *orphan*, *abandoned*, or plugged wells (these wells must be plugged/re-plugged); any communications with *active* or *inactive* wells that result in a breach/loss of containment, i.e., fluid flow, and environmental release; any communications that result in a *well control incident*; or any communications that jeopardize safety within the AOR – stimulation may not continue until authorized by DEP in these cases;
  - 24-hour notification for any communications that result in a breach/loss of containment at *active* or *inactive* wells with no associated environmental release (this includes annular fluid flow or significant increases in annular pressure), or any communications that result in over-pressuring of surface or coal casing used as production casing or increase production pressures to within 10% of the rated pressure for the weakest well component of those designed to isolate production fluids
- ☐ Download incident report form, complete necessary fields using instructions in Figure 10 (page 39), and submit report to DEP within allotted timeframe (pages 36-37)
  - Incident report due in three (3) days for any communications with *orphan*, *abandoned*, or plugged wells (these wells must be plugged/re-plugged); any communications with *active* or *inactive* wells that result in a breach/loss of containment, i.e., fluid flow, and environmental release; any communications that result in a *well control incident;* or any communications that jeopardize safety within the AOR
  - Incident report due in 30 days for any communications that result in a breach/loss of containment at *active* or *inactive* wells with no associated environmental release (this includes annular fluid flow or significant increases in annular pressure) or any communications that result in over-pressuring of surface or coal casing used as production casing or increase production pressures to within 10% of the rated pressure for the weakest component of those designed to isolate production fluids
- ☐ Address any other regulatory or statutory compliance matters that resulted from the communication incident

APPENDIX A AOR GEOMETRY

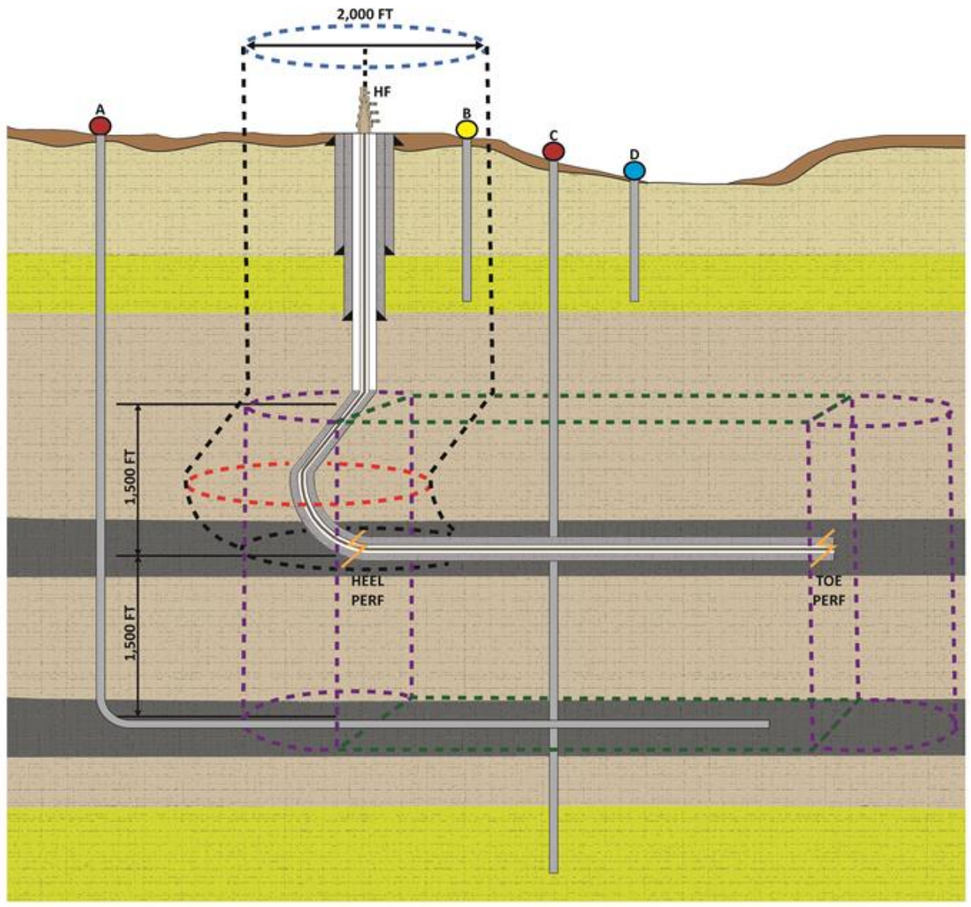
EXAMPLE 1 UNCONVENTIONAL GAS WELL WITH NO NEARBY PROSPECTIVE SHALE GAS UNITS

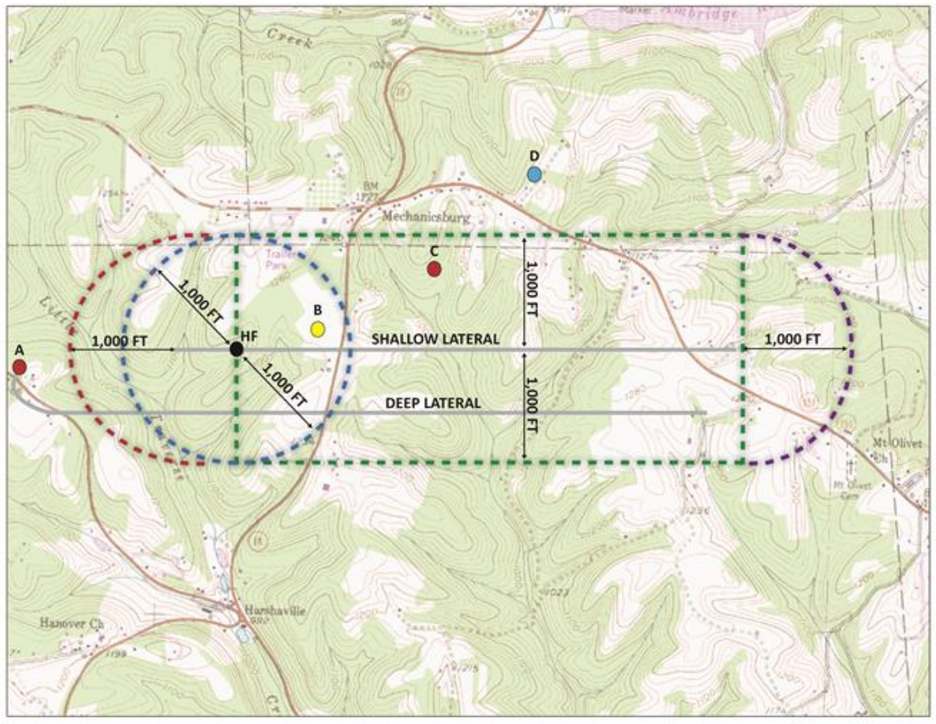




Notes: Yellow (identify); Red (identify and visually monitor); and Blue (no requirements); HF (well that is subject of area of review that will be hydraulically fractured); geometry depicted is similar to that for a *deep conventional well* (oil or gas) that has been intentionally deviated

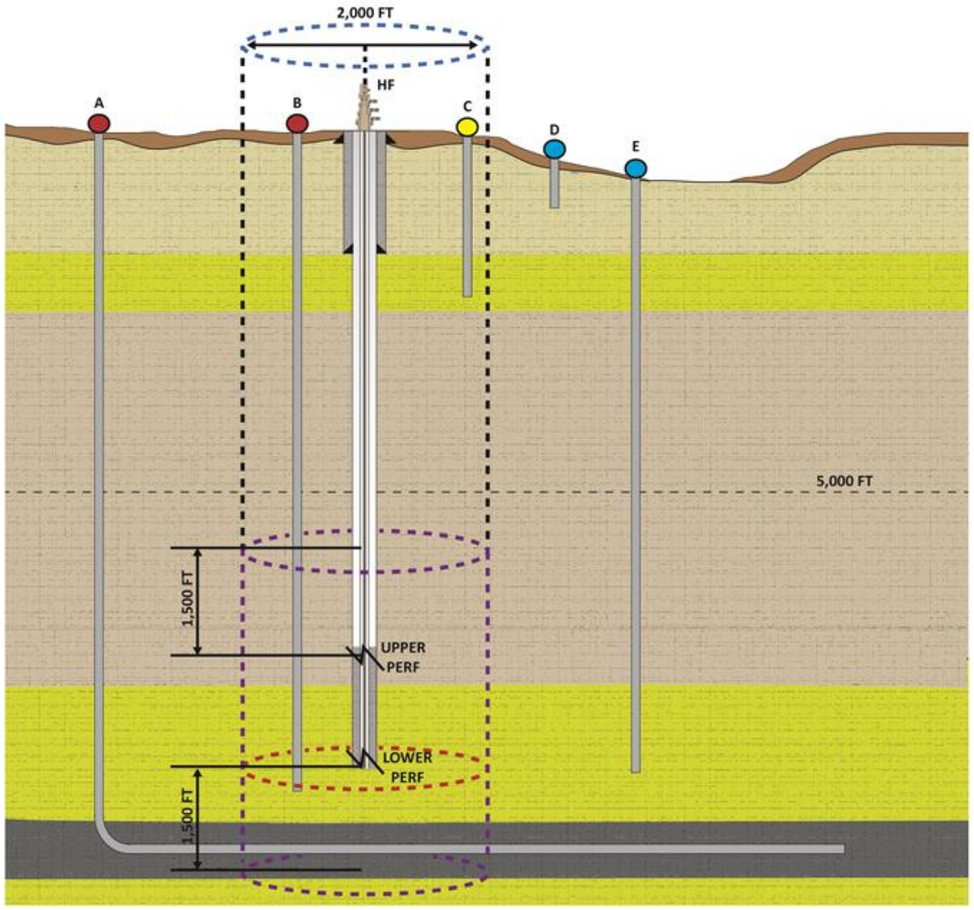
EXAMPLE 2 UNCONVENTIONAL GAS WELL WITH UNDERLYING PROSPECTIVE SHALE GAS UNIT

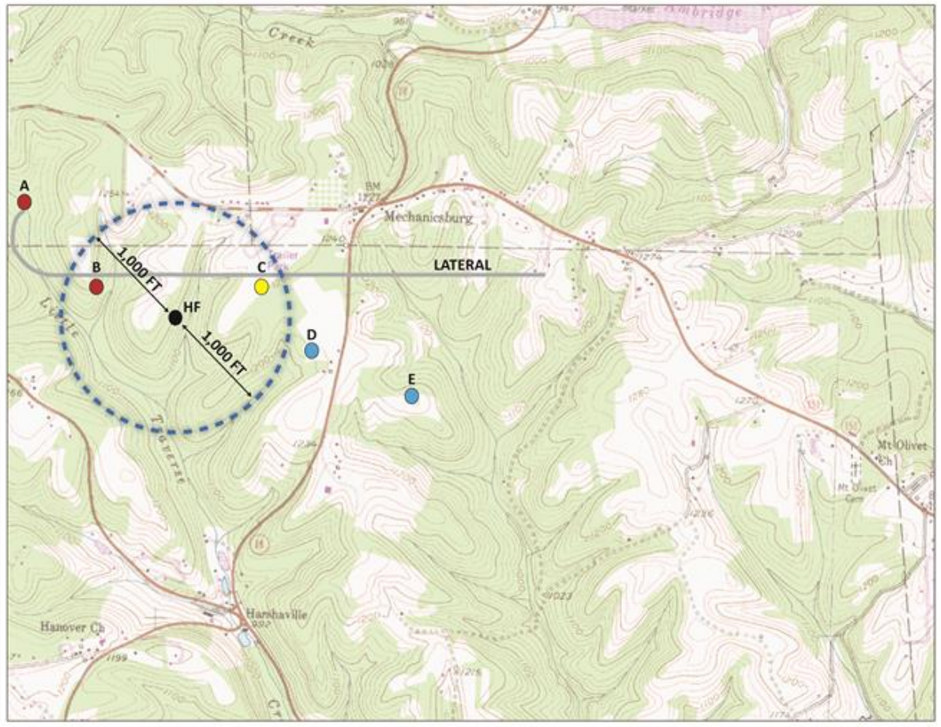




Notes: Yellow (identify); Red (identify and visually monitor); and Blue (no requirements); HF (well that is subject of area of review that will be hydraulically fractured); geometry depicted is similar to that for a *deep conventional well* (oil or gas) that has been intentionally deviated

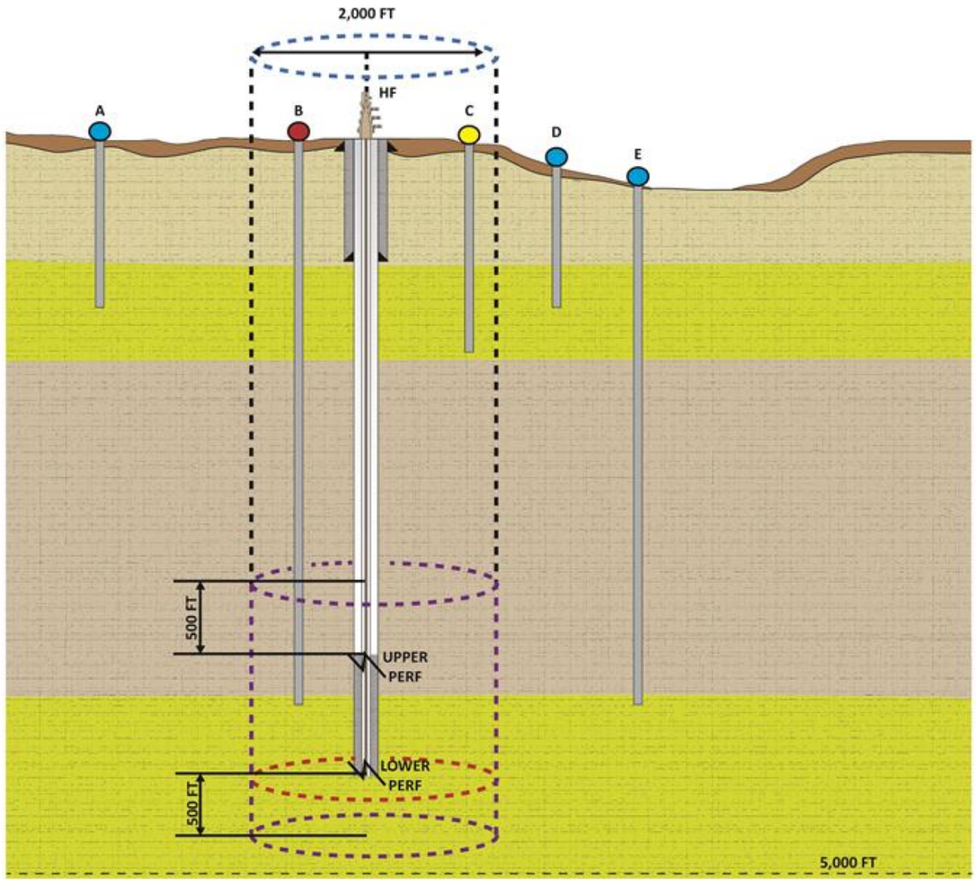
EXAMPLE 3 DEEP CONVENTIONAL GAS WELL

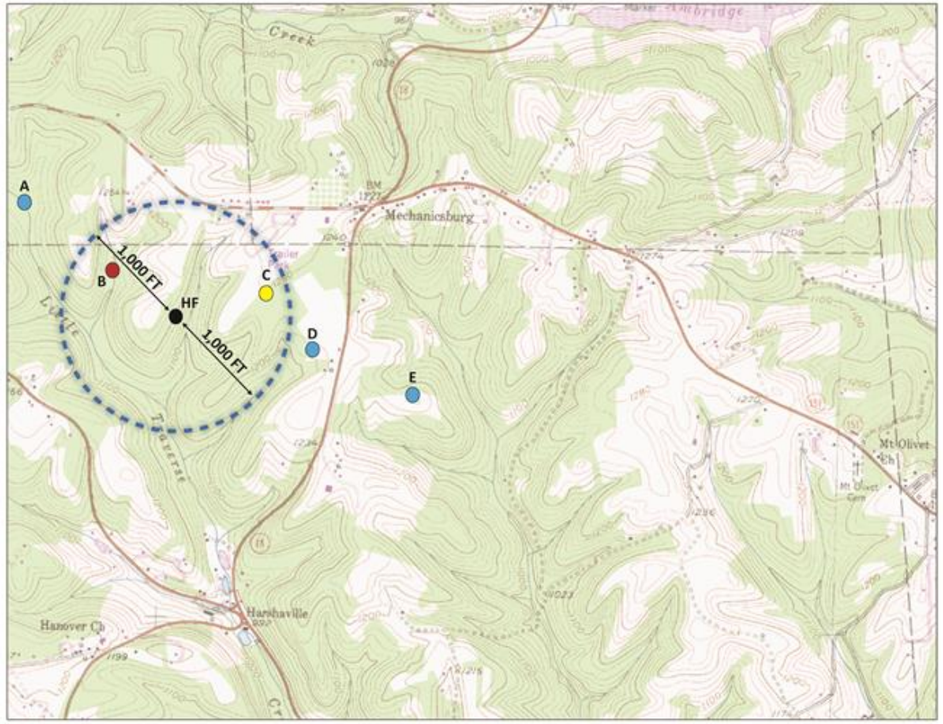




Notes: Yellow (identify); Red (identify and visually monitor); and Blue (no requirements); HF (well that is subject of area of review that will be hydraulically fractured)

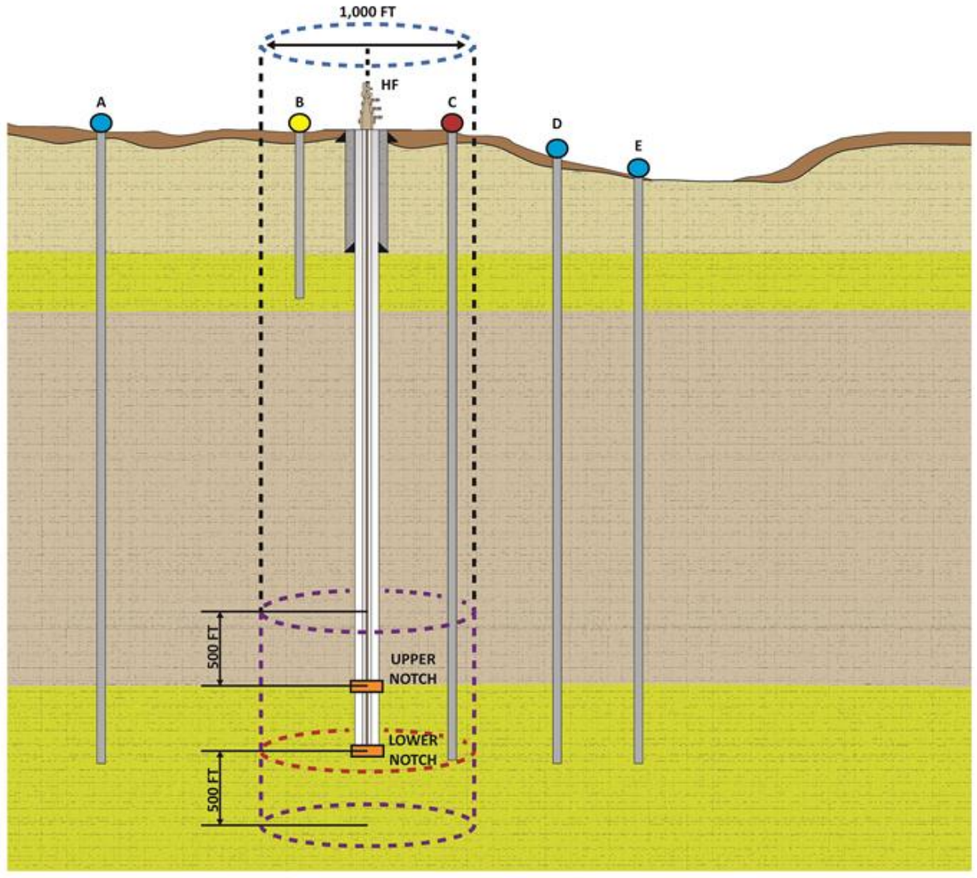
EXAMPLE 4 SHALLOW CONVENTIONAL GAS WELL

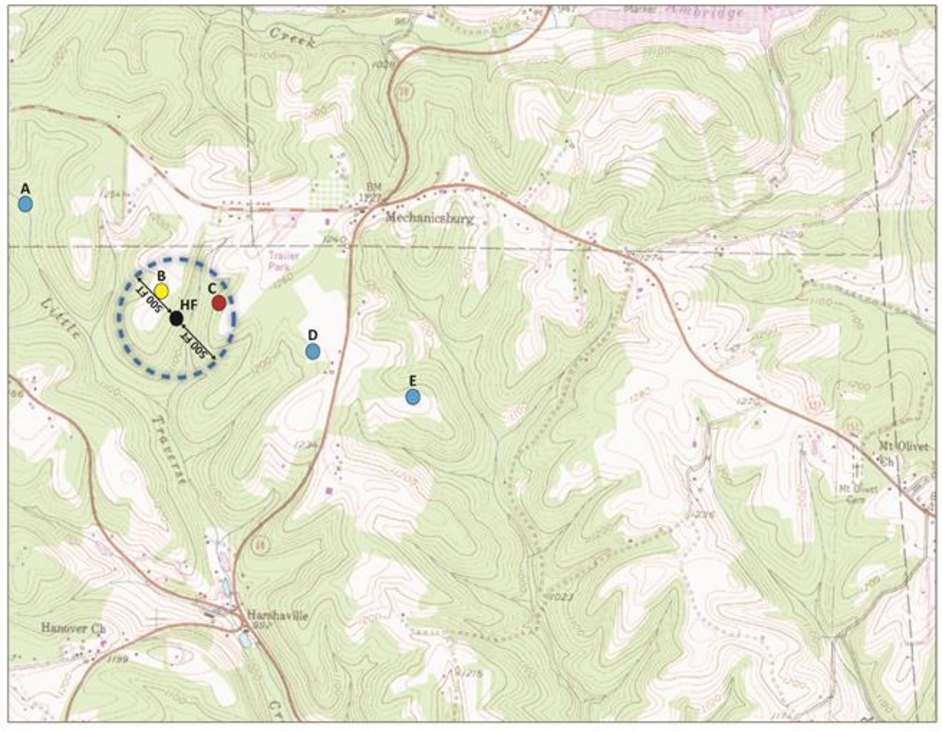




Notes: Yellow (identify); Red (identify and visually monitor); and Blue (no requirements); HF (well that is subject of area of review that will be hydraulically fractured)

EXAMPLE 5 VERTICAL SHALLOW CONVENTIONAL OIL WELL (OPEN HOLE COMPLETION)



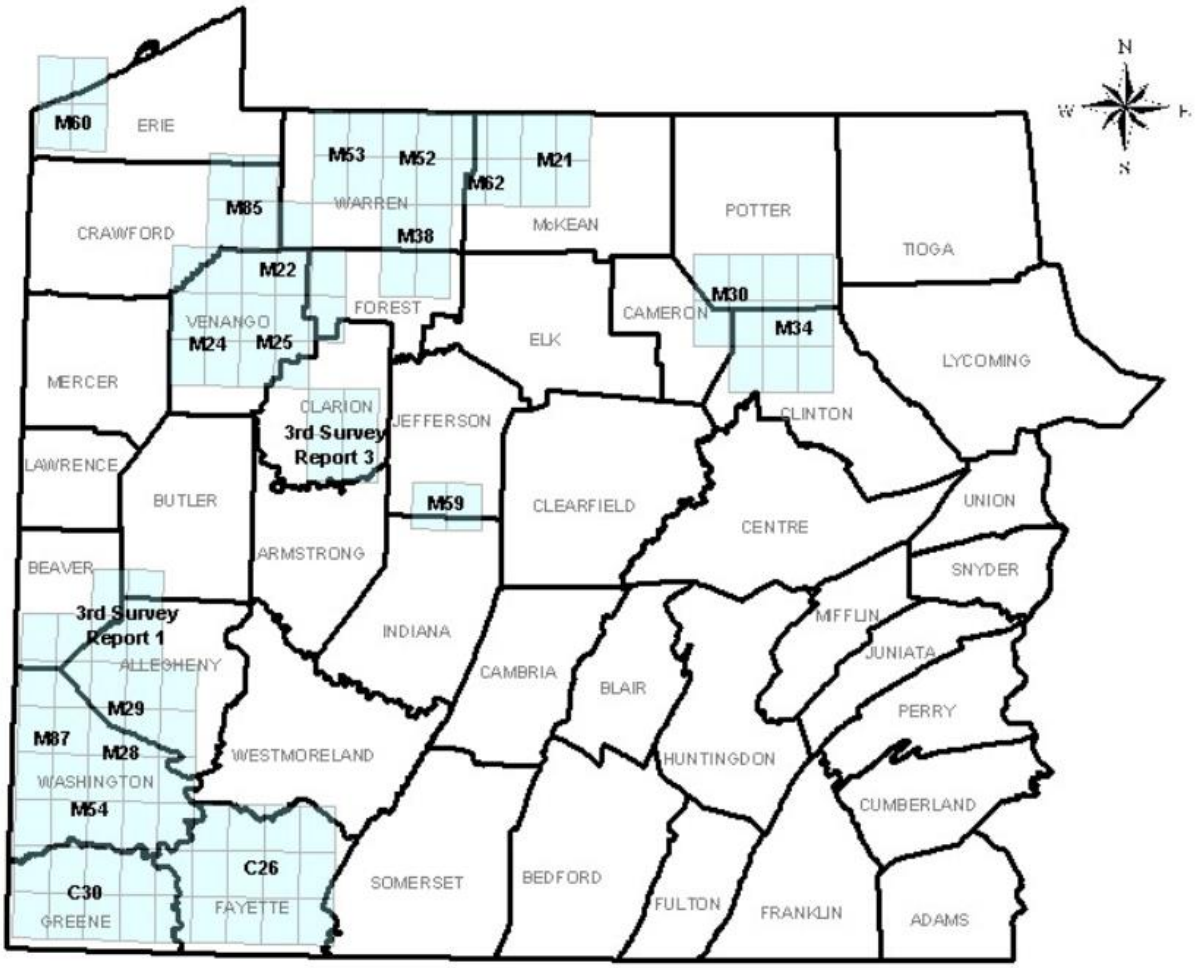


Notes: Yellow (identify); Red (identify and visually monitor); and Blue (no requirements); HF (well that is subject of area of review that will be hydraulically fractured)

APPENDIX B MAP INDICES OF GEOGRAPHIC AREAS COVERED BY VARIOUS STANDARD REFERENCE MATERIALS

Historical Oil and Gas Reports by Series

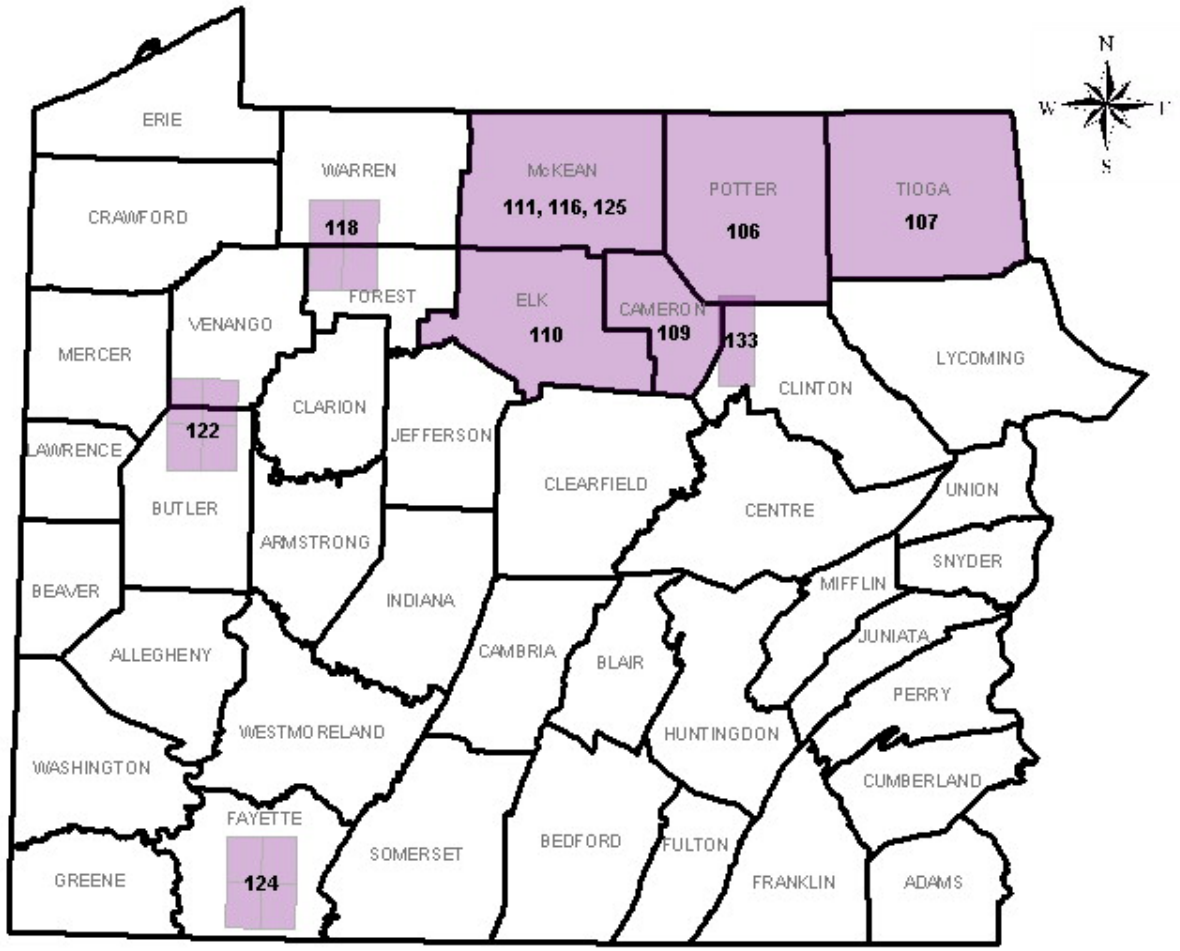
Coverage for Bureau of Topographic and Geologic Survey Reports



Source: DCNR, accessed December 2015

http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/farmline_maps/survey_reports/index.htm

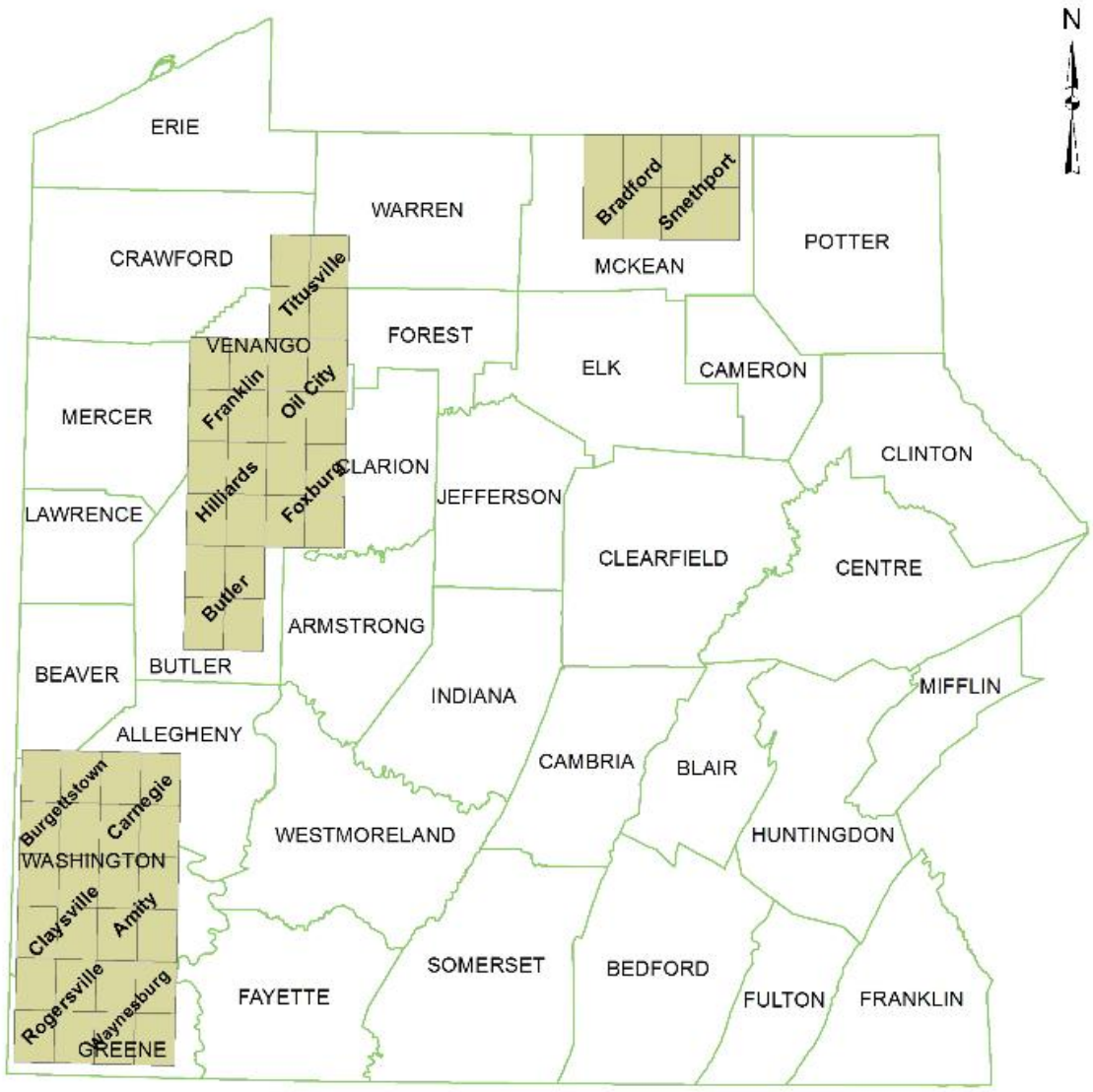
Coverage for Bureau of Topographic and Geologic Survey Progress Reports



Source: DCNR, accessed December 2015

http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/farmline_maps/survey_reports/index.htm

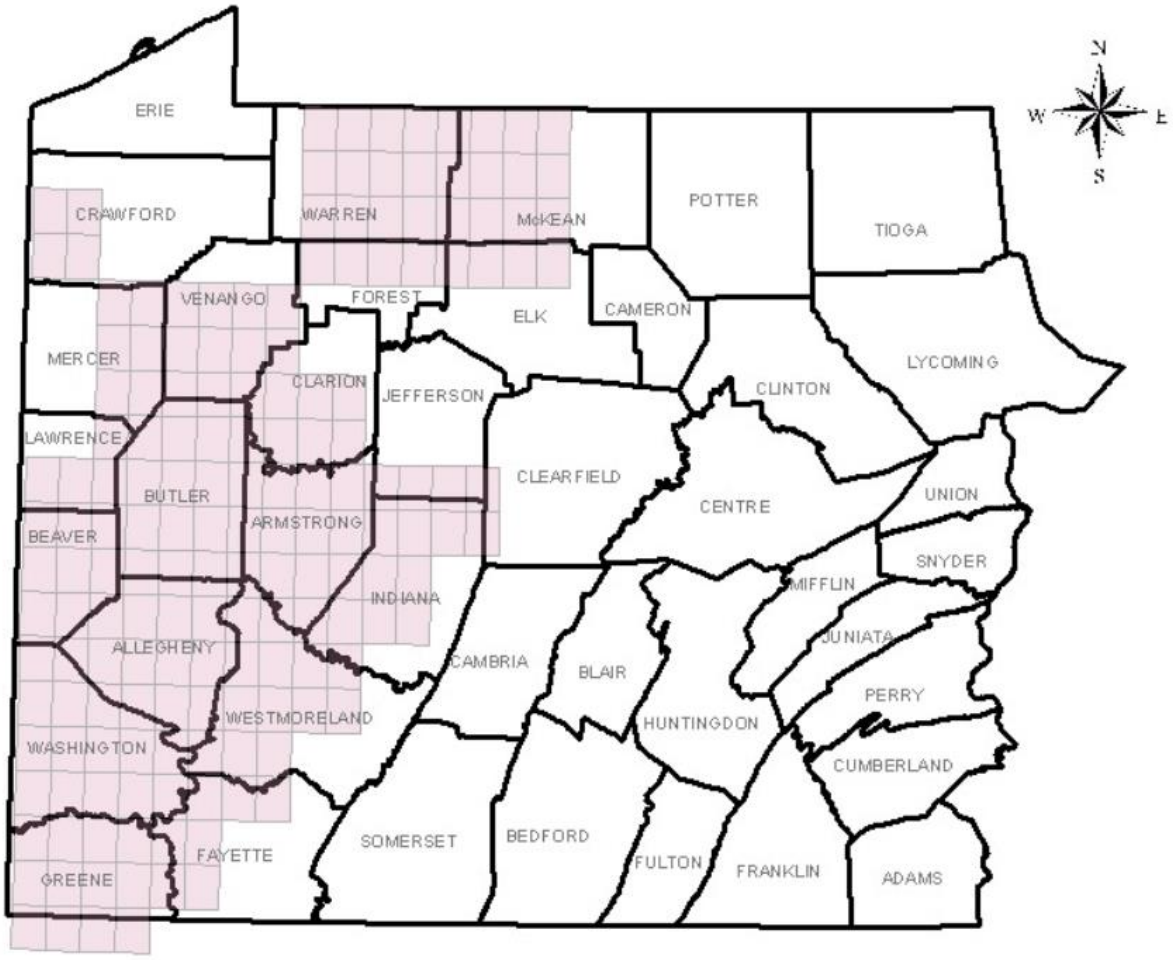
Coverage for Bureau of Topographic and Geologic Survey Special Bulletin Reports



Source: DCNR, accessed December 2015

http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/farmline_maps/special_bulletins/index.htm

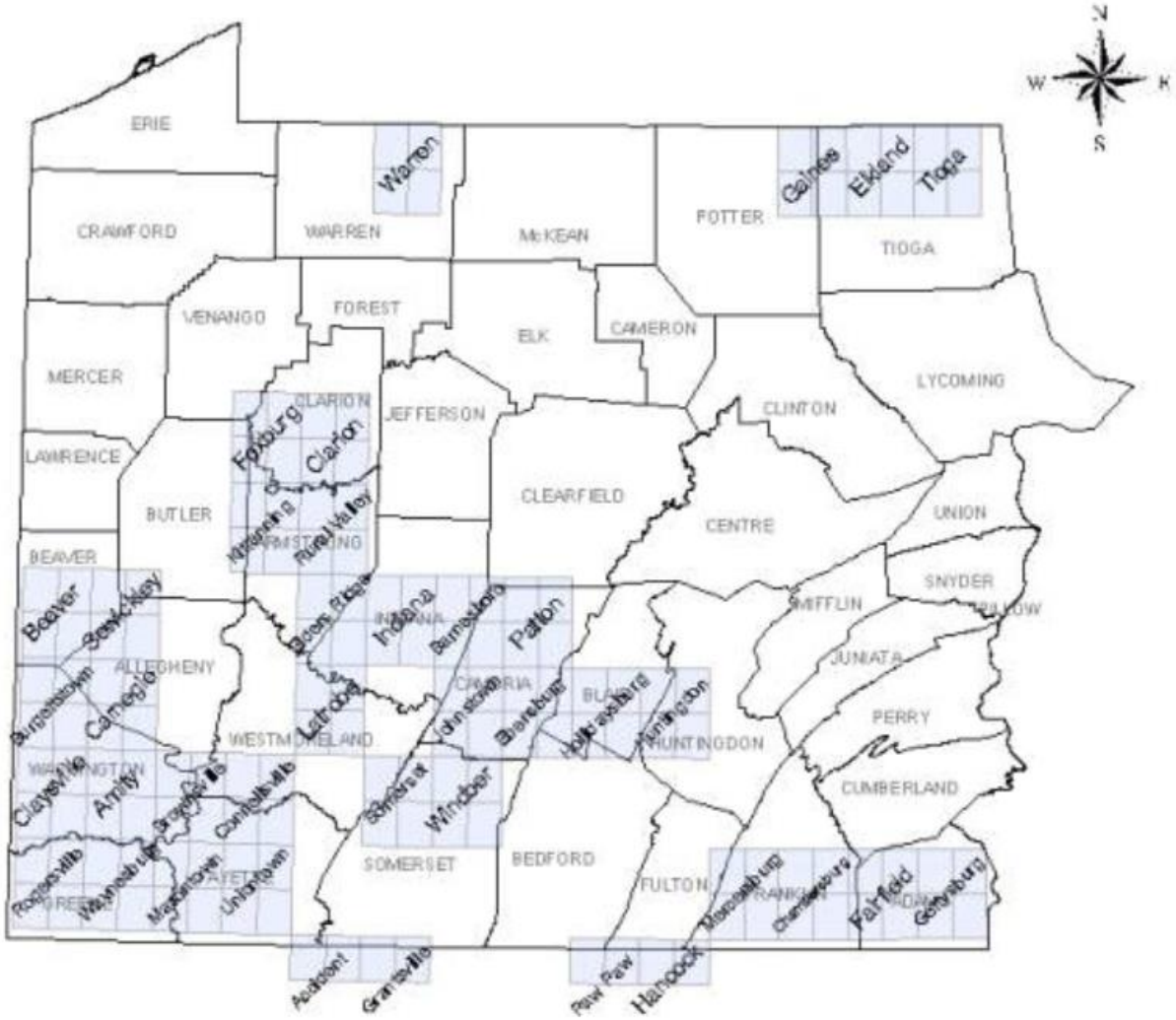
Coverage for Bureau of Topographic and Geologic Survey Farmline Maps



Source: DCNR, accessed December 2015

http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/farmline_maps/index.htm

Coverage for United States Geological Survey Folio Reports



Source: DCNR, accessed December 2015

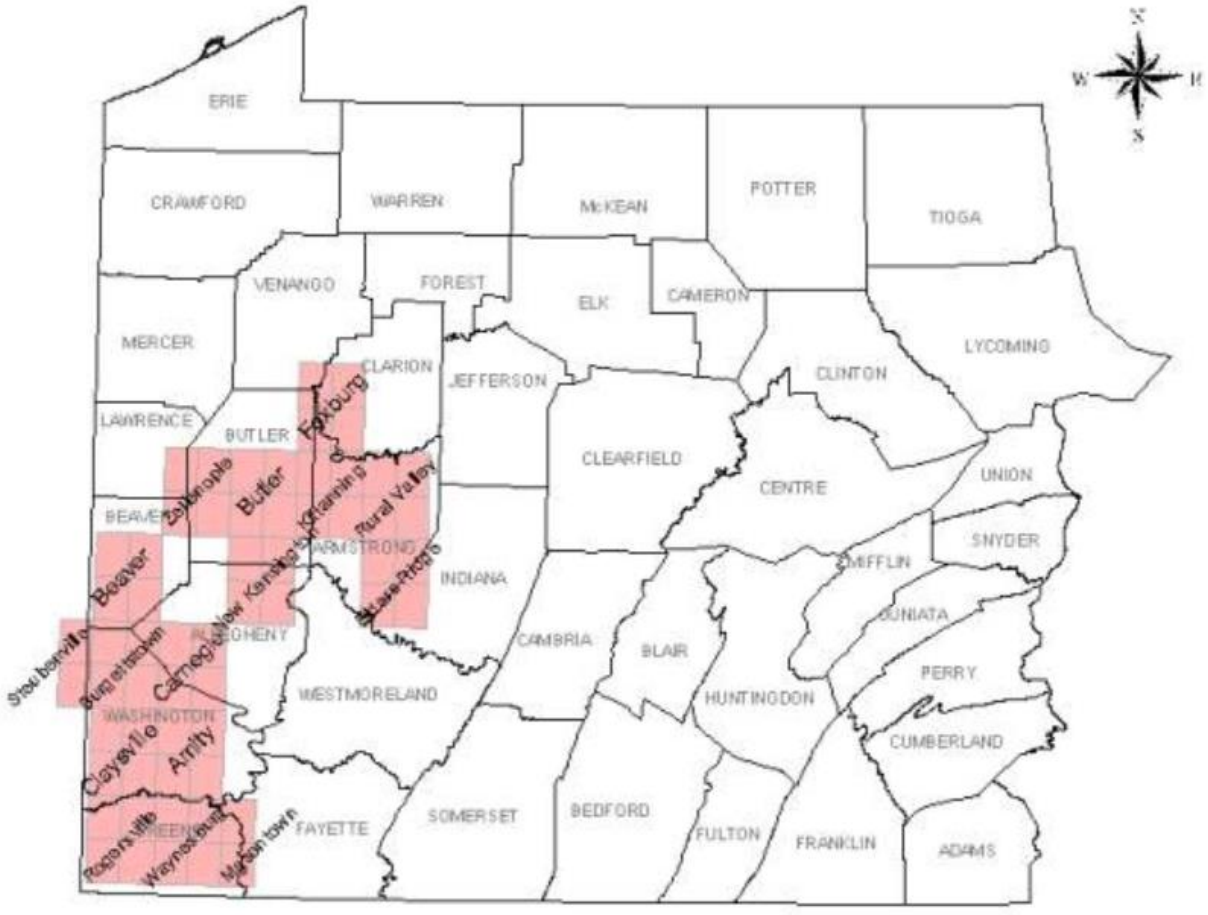
http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/usgsoilandgas_pubs/index.htm

Tabular Summary of United States Geological Survey Folio Reports

Report No. and Quadrangle

82	Masontown-Uniontown
92	Gaines
93	Elkland-Tioga
94	Brownsville-Connellsville
102	Indiana
110	Latrobe
115	Kittanning
121	Waynesburg
123	Elders Ridge
125	Rural Valley
133	Ebensburg
134	Beaver
144	Amity
146	Rogersville
160	Accident-Grantsville
170	Mercersburg-Chambersburg
172	Warren
174	Johnstown
176	Sewickley
177	Burgettstown-Carnegie
178	Foxburg-Clarion
179	Pawpaw-Hancock
180	Claysville
189	Barnsboro-Patton
224	Somerset-Windber
225	Fairfield-Gettysburg
227	Hollidaysburg-Huntingdon

Coverage for United States Geological Survey Bulletins



Source: DCNR, accessed December 2015

http://dcnr.state.pa.us/topogeo/econresource/oilandgas/resrefs/usgsoilandgas_pubs/index.htm

Tabular Summary of United States Geological Survey Bulletins

Publication No. and Quadrangle

256 Elders Ridge
279 Kittanning & Rural Valley
286 Beaver
300 Amity
304 Greene County (Rogersville, Waynesburg, Masontown)
318 Steubenville, Burgettstown & Claysville
454 Foxburg
456 Carnegie
829 New Kensington
873 Butler & Zelienople

APPENDIX C SUPPORTING TECHNICAL INFORMATION

Fundamentals of Risk

Risk-classification criteria specifically contemplate the following information:

(1) Character of the *hydraulic fracturing* activity: what kinds of treatment pressures, volumes, and pump durations are anticipated; and what kind of fracture propagation, e.g, vertical or horizontal extension, is expected at the interval(s) being targeted for production? Does the risk change as a function of what activity is being completed at the well undergoing stimulation?
(2) Character and location of wells in the AOR: for all wells that penetrate the *zone of hydraulic fracturing influence* – how close are offset wells to the well undergoing stimulation and what are the construction characteristics, age, and status of the offset wells? For *orphan*, *abandoned*, and plugged wells, what integrity concerns have been identified? For *active* and *inactive wells*, what integrity concerns have been identified?

To illustrate how the character of the *hydraulic fracturing* activity is influential in determining risk, the Department of Environmental Protection (DEP) coordinated a review of historical data with members of the Area of Review (AOR) Workgroup. Information relevant to treatment strategies at both *conventional* and *unconventional wells* was gathered and is summarized in Figure A below. The x-axis of the plot tracks surface treatment pressures use to break down the reservoir rock. The y-axis considers the *true vertical depth* of the treated interval. The points on the plot are scaled in consideration of the treatment volume for each stage or interval. Treatment volume estimates are based on pump rates and durations of the treatment on a per-stage/interval basis.

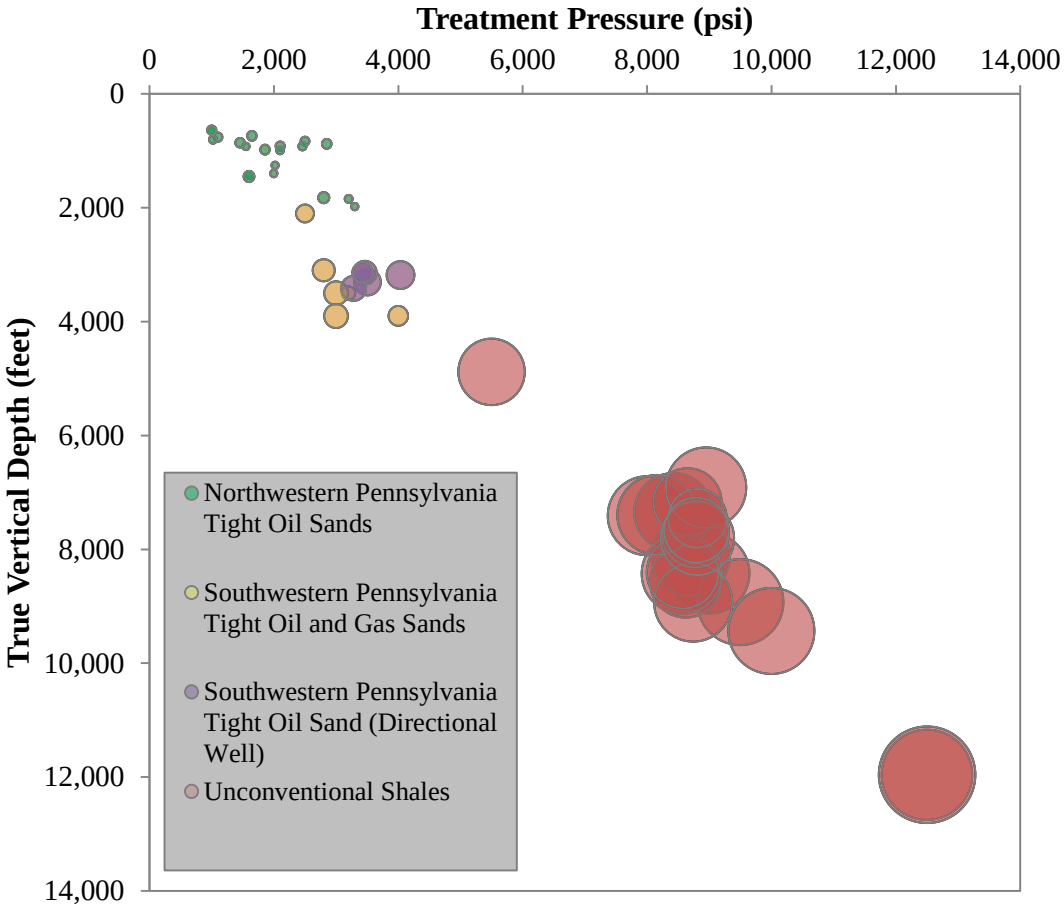


Figure A. Graphical summary of *hydraulic fracturing* study (n = 51). Treatment information is grouped according to different common types of reservoirs targeted in the state. Conventional formations produced in northwestern Pennsylvania are generally stratigraphically equivalent to units in southwestern Pennsylvania, but the basin deepens moving to the south. Note that *true vertical depths* for eight (8) of the locations were predicted using a simple linear regression model because completion depths were not available for all data points considered in the analysis.

Figure A illustrates a simple concept: the potential for environmental impact is higher in association with deeper treatments – in other words, when more fluids are used in the stimulation, and they are pumped at higher pressure, more may potentially be released at the surface if a nearby conduit such as an abandoned wellbore exists that prevents confinement of the *hydraulic fracturing* process to the targeted zone and adjacent formations.

Treatment pressure, as expected, is strongly correlated with reservoir depth and underscores the fact that when the reservoir's seal integrity is compromised by an open well bore, no matter if *hydraulic fracturing* communication occurs in association with a deeper treatment or a shallower treatment, flow at the surface will occur if the open well bore is completely filled with nothing but liquid of the same density, i.e., the pressures used in the fracture treatment are sufficiently higher than hydrostatic pressure and will displace adjacent well bore fluids.

Treatment volumes gathered as part of the data review are plotted in Figure B. The left side of the bar graph shows information for vertical *conventional wells* and cumulative volumes are depicted, i.e., total fracture fluid volume for the entire job. The right side of the bar graph, which is shaded in blue, compares single-stage treatment volumes for directional *conventional wells* and directional shale wells. The figure further quantifies environmental impact potential.

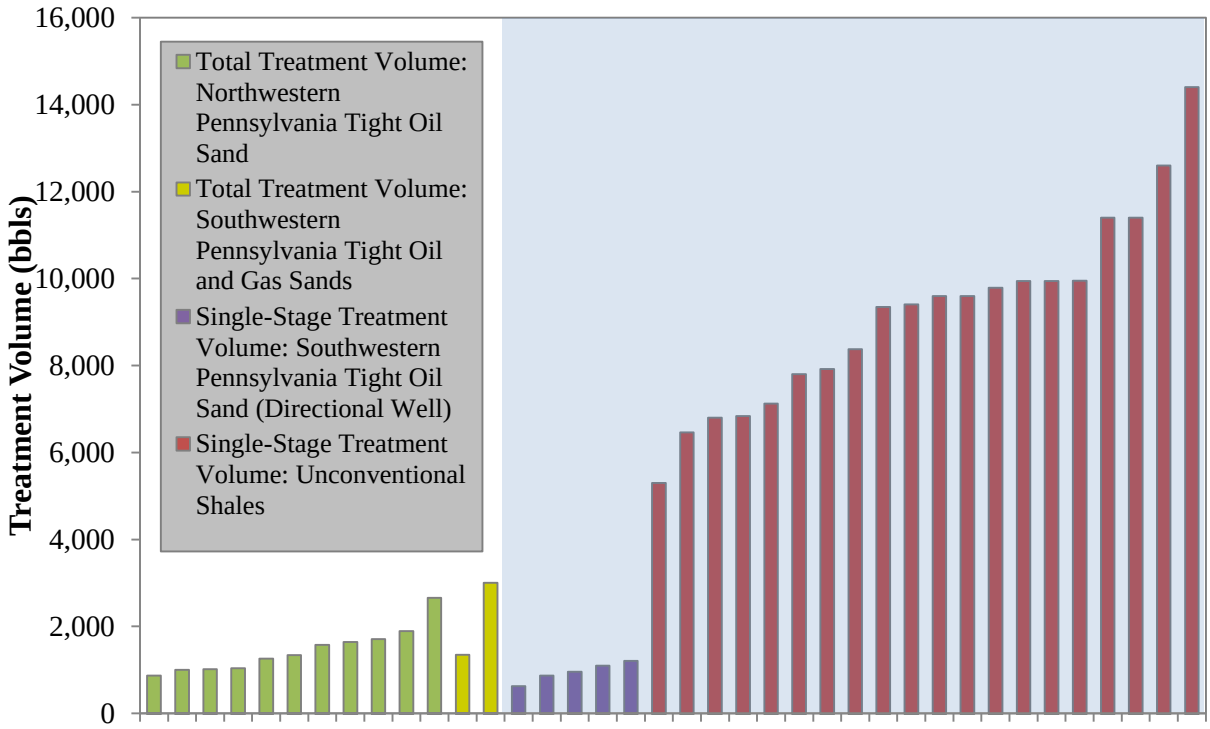


Figure B. Graphical summary of total and single-stage treatment volumes gathered as part of the *hydraulic fracturing* study. Blue-shaded portion of diagram highlights directional completions in Upper Devonian tight sands, the Marcellus shale, and the Utica shale.

Treatment Pressure and Volume Monitoring

Treatment pressure and volume monitoring are discussed in the AOR regulations of Chapters 78 and 78ain §§78.73(c)/78a.73(c). The following discussion considers the role of treatment pressure and/or volume monitoring as a direct surrogate for offset well monitoring in circumstances where either access cannot be secured or more efficient monitoring strategies may occur at the well that is the subject of the AOR.

Describing, to any reasonable approximation, the theoretical mechanism for *hydraulic fracturing*, is beyond the scope of the regulation and depends greatly on the local lateral and vertical stress fields, depths/pressures, and lithologies of the objective reservoir. Many competing models exist to describe fracture propagation and experts in the field are not aligned on a "standard" model. However, in general, the following statements can be made with some degree of certainty:

(1) It is important to distinguish between shallow-reservoir *hydraulic fracturing* models and deep-reservoir *hydraulic fracturing* models. In shallow reservoirs, horizontal "pancake" fractures propagate along bedding planes. In deeper reservoirs, tensile vertical fractures are generated when the overburden stress is no longer the least principal stress, i.e., the weight of overburden exceeds the "lift" generated by the hydraulic fracture pressure, causing the fracture to propagate vertically through the rock and laterally away from the well bore, rather than along a bedding plane. Transition from shallow-reservoir to deep-reservoir propagation types typically occurs at 1,000 to 3,000 feet below surface. Deep-reservoir models are generally assumed to be associated with the development of *unconventional* reservoirs and *conventional* reservoirs at depths greater than 2,000 feet below surface.

(2) In the simplest deep-reservoir model, two vertical "wing" fractures (180 degrees apart) are generated from the perforation point that extend away from the well bore. Azimuth orientation of the vertical fracture depends on the azimuths of the minimum and maximum horizontal stresses in the rock. However, this assumes a homogeneous reservoir (uniform stresses and rock properties through the volume of rock being stimulated by the hydraulic fracture). Any deviation from this, e.g., natural fractures, layering of rock with very different geomechanical characteristics, etc., would lead to a much more complex three-dimensional set of fractures.

(3) In the deep-reservoir case, hydraulic fractures may extend out hundreds of feet beyond the well bore in height and lateral extent, but probably not much more than a thousand feet beyond in most circumstances. The only exception may be scenarios where a pre-existing zone of weakness occurs, such as a fault. This is supported by microseismic data, which is the industry's standard tool for monitoring the extent of fracture propagation in the subsurface.

(4) Modern *hydraulic fracturing* is most often used in reservoirs with low porosity and permeability, e.g., porosity <10%, permeability < 1000 nD, referred to as a "tight" or *unconventional* reservoirs that cannot be otherwise developed with standard stimulation techniques. Typical examples include gas-bearing shales and siltstones.

During a *hydraulic fracturing* operation, variations in pressure and volume are common. A measurable treatment pressure or volume change that indicates a communication event with another well bore would be so small, relatively speaking, that it would not be possible to distinguish it from the normal variability in any event for high-volume, *hydraulic fracturing* treatments. Therefore, it is not appropriate to recommend a specific requirement for pressure or volume monitoring during an *unconventional* completion job.

Pressure and fluid communication with an adjacent producing well bore is relatively common, and indeed is often by design in the industry. The communication effects are usually detected in the adjacent well bore; however, not in pressure or volume changes in the well being completed. Communication effects can include pressure "spikes" and subsequent drops, changes in production rate, and the detection of chemical tracers, when used. The industry deliberately designs tests, e.g., downspacing trials, to see when intra-well communication starts to occur to optimally develop the hydrocarbon resource in an area. In such trials, adjacent producing wells are designed to handle moderate fluctuations in pressure and volume. These industry-standard

trials and variations are not the target of the AOR regulation and are not considered reportable incidents.

Any reporting of downhole pressure or volume changes during an *unconventional* completion job either in the well being completed or in adjacent, producing wells should be done only when a specific event occurs that could indicate a loss of mechanical integrity, i.e., containment, and that could pose a specific risk to the environment (surface or subsurface fluid release) or safety (*loss of well control*). This would amount to a sudden loss of pressure or a volume change that is clearly, statistically beyond the normal variability that a job has. However, these particular guidelines ("normal variability") cannot be quantified as a standard rule, as each completion job is unique. Therefore, action in these cases is left to the discretion and experience of the *operator*.

Conversely, for *shallow conventional hydraulic fracturing* operations completed at vertical wells, treatment pressure monitoring represents a useful tool for assessing whether or not communication with an offset well may have occurred during the course of the fracture treatment. This is mainly due to the relatively low pressures used to complete such wells, allowing for departures from the norm to be diagnostic of a communication incident. Such changes must be significant, e.g., 50% or more drop in pump pressure with no accompanying change in pump rate, sudden, and not readily explained by any operational changes or ancillary equipment failures at the well undergoing stimulation.

To determine where a continuous assessment of treatment pressure is most appropriate as a monitoring tool, historical completions data are once again evaluated. Figure D considers the same dataset contemplated in Figure A, but a simple linear regression model has been fitted to the data to understand how treatment pressure varies as a function of depth. Ninety-five percent (95%) upper and lower confidence intervals (UCL and LCL) have been plotted to graphically display the regression model variability and the chart has been subdivided into three regimes based on technical input provided in association with the AOR Workgroup's data assessment. These regimes establish depth intervals over which different monitoring plans are acceptable for *hydraulic fracturing* at *conventional wells*.

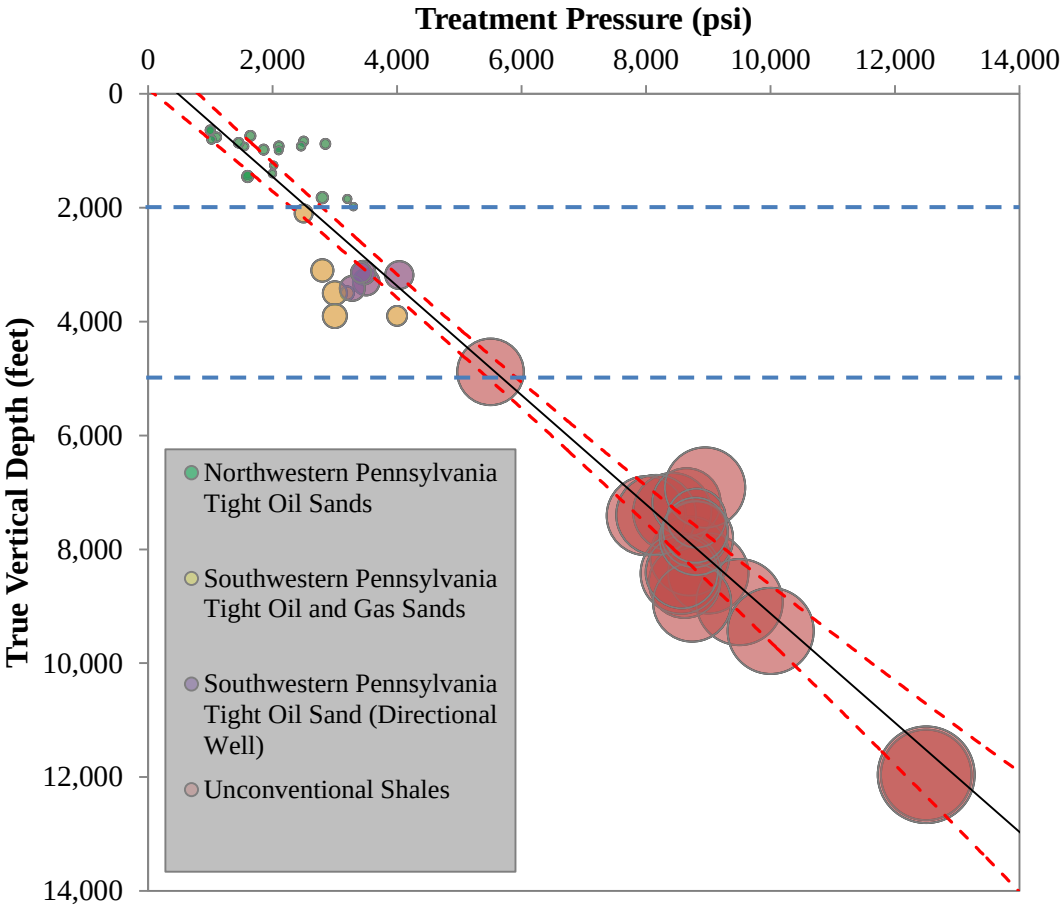


Figure D. Simple linear regression model (n = 43) establishing depth intervals over which different standard monitoring plans are appropriate based on risks associated with wells in the AOR. Average treatment pressures at the 2,000- and 5,000-foot intervals are 2,600 +/- 200 psi (95% CI) and 5,700 +/- 200 psi (95% CI), respectively.