



# INSTRUCTIONS FOR EVALUATING MECHANICAL INTEGRITY OF OPERATING OIL AND GAS WELLS

(Form 5500-PM-OGXXXX)

## GENERAL INFORMATION

The Well Mechanical Integrity Report is used to record information pertinent to operating oil and gas wells on a quarterly basis to reduce the potential for mechanical failure and subsequent environmental impact. For efficiency, one form that summarizes information from each quarterly inspection should be submitted annually to meet the reporting requirement in Section 78.88(e) of Chapter 78.

Pennsylvania has experienced a long history of oil and gas development and, as such, many different operating oil and gas well configurations exist. Because the Well Mechanical Integrity Report is used in conjunction with wells that vary substantially in both age and construction detail, and also since multiple types of wells must be monitored under the program, instructions and guidance are provided to assure timely and accurate completion and submittal of reports. If an item is not relevant to your well site, enter "NA" in that particular space.

If completing the report manually, please print legibly. Unreadable information will delay processing, and may result in the report being returned to you.

If you have any questions about completing the report, contact the appropriate DEP regional oil and gas office using the information that follows. A map denoting the counties that each regional oil and gas office is responsible for is included at the end of these instructions.

PA DEP  
Oil and Gas Management Program  
Northwest Regional Office Phone 814-332-6860  
230 Chestnut Street Fax 814-332-6121  
Meadville, PA 16335-3481

PA DEP  
Oil and Gas Management Program  
Southwest Regional Office Phone 412-442-4024  
400 Waterfront Drive Fax 412-442-4328  
Pittsburgh, PA 15222-4745

PA DEP  
Oil and Gas Management Program  
Northcentral Regional Office Phone 570-327-3636  
208 West Third Street Fax 570-327-3565  
Williamsport, PA 17701-6448

If you have problems using the forms on your personal computer or printing them, please contact:

PA DEP  
Bureau of Oil and Gas Management  
PO Box 8765 Phone 717-772-2199  
Harrisburg, PA 17105-8765 Fax 717-772-2291

## Form 5500-PM-OGXXXX, page 1

## WELL CONSTRUCTION

### 1. Casing/Tubing Diameter

Casing diameters, especially those associated with casing strings designed to protect fresh groundwater supplies and minable coal seams, should be appropriately sized with respect to the surrounding wellbore to ensure a continuous cement sheath of near equal thickness. Indicate the casing/tubing outer diameter (OD) in inches for each tubular installed within the wellbore.

### 2. Casing/Tubing Type

Different casing strings serve different, essential functions at any given well location, e.g. fresh groundwater protection, foundation for well control, containment of produced fluids, etc. List all drill casing and tubing strings associated with the well under inspection. For consistency and ease of review, it is suggested that the tubulars be identified from the shortest to the longest string installed within the wellbore. If multiple coal protective, water protective, and/or intermediate casing strings are used, it is recommended that they be numbered in sequence, assigning a "1" to the shortest string for each tubular type. If a particular tubular serves multiple purposes,

e.g., reservoir produced off of intermediate casing, both uses should be listed.

### 3. Casing/Tubing Length

The lengths of casing and tubing strings installed at a well location are reflective of efforts to optimize production and ensure environmental protection. Knowing the lengths of each tubular installed within a wellbore contributes toward effective troubleshooting of mechanical integrity problems by informing well logging and pressure testing decisions. Enter the length in feet below ground surface for each tubular listed under Item 2.

### 4. Depth to Cement in Casing Annular Space

The cement surrounding casing strings in oil and gas wells provides several critical functions. It secures the casing within the wellbore and also prevents the upward migration of potentially harmful fluids into fresh groundwater supplies or enclosed spaces by creating a physical barrier within the annular spaces of individual casing strings. Enter the depth in feet below ground surface to the top of each cement sheath for wells constructed using cemented casing strings.

## WELL PRESSURE AND FLUID MONITORING

### 5. Critical Pressure at Protected Casing Seat

Section 78.73(c) of Chapter 78 requires that pressure at the surface casing **or** coal protective casing seat be no more than 80% of the hydrostatic pressure at that depth. This provision is intended to minimize the potential for gas in the subsurface at the well location from creating an over-pressured condition which could result in migration of natural gas into fresh groundwater supplies or enclosed spaces. The calculation under this item only corresponds to one casing string: the innermost, i.e., deepest, water or coal protective string. For that string, multiply 80% (0.8) by a hydraulic pressure gradient of 0.433 psi/ft by the casing length in feet to determine the critical hydrostatic pressure in psi.

### 6. Fluid Level

Fluids within water protective casing strings have the potential to communicate with fresh groundwater supplies depending on hydraulic gradients and casing integrity. Additionally, such fluid columns add to the pressure at the casing seat.

Although this item generally pertains only to older operating wells that employ "one-string" designs, e.g., oil well equipped with production tubing and surface casing (see example on page 7), if possible, it is always recommended that the fluid level be gauged inside the deepest water or coal protective string installed within the wellbore. Enter the depth to water in feet below ground surface as measured within the relevant casing string.

### Pressure Measurement Data

An integral component of the mechanical integrity inspection protocol involves monitoring wellhead and annular pressures for operating gas or combined oil and gas wells. The intent is to check for significant, unexpected changes in production pressure which may indicate mechanical failures of well tubulars, cement sheaths, or packers; and to assess for the presence of over-pressured conditions at the critical casing seat. The next three items are important for assessing the mechanical integrity of wells where gas is produced. However, it may not be possible to provide pressure data for all locations described in many cases, as there is significant diversity in the design of operating wells.

Newer wells with multiple casing strings are typically equipped with ports for measuring pressures in many locations. For older wells, this may not be the case (see example on page 8). There is no expectation that older wells be retrofitted with pressure ports. In such cases, providing the wellhead pressure, i.e., producing back pressure or shut-in pressure, and summarizing observations regarding escaping or venting gas is sufficient. These procedures are discussed later in the document.

### 7. Producing Back Pressure or Shut-In Pressure at the Wellhead

Substantial changes in producing back pressure or shut-in pressure at a well location may indicate mechanical integrity problems (see example on page 9). Additionally, if a well is equipped with surface casing or coal protective casing that is serving as production casing, it is essential to keep the producing back pressure or shut-in pressure at or below 80% of the hydrostatic pressure at the casing seat. Report the producing back pressure or shut-in pressure in psi measured off of the production casing string or tubing.

## 8. Open Flow or Shut-In Pressure in Production Casing/Tubing Annular Space

Pressure in the annular space surrounding production casing or tubing may indicate mechanical failures of the production casing/tubing, cement sheath, or packers. It may also suggest that a shallower, non-targeted gas-bearing zone was not properly isolated during well construction (see example on page 10). This becomes critical in wells where only production casing and surface casing are utilized or where surface casing or coal protective casing is doubling as production casing, as it may result in an over-pressured condition at the surface casing seat. If the latter scenario describes a well's configuration accurately, this pressure reading will be reported under Item 7. Otherwise, report the open flow or shut-in pressure in psi for the production casing/tubing annular space.

## 9. Surface or Coal Protective Casing Open Flow or Shut-In Pressure

As discussed under Item 5, Section 78.73(c) of Chapter 78 requires that pressure at the surface casing or coal protective casing seat be no more than 80% of the hydrostatic pressure at that depth. For wells where surface or coal protective casing is serving as production casing, this pressure reading will be reported under Item 7. For wells equipped with only tubing and a production casing string, this pressure reading will be reported under Item 8. For more complicated well designs containing three or more casing strings, this pressure reading in psi should be acquired from the annular space between the deepest water or coal protective casing string and the next interior casing string, provided the next interior string is cemented to a depth that does not extend into the deepest surface or coal protective casing. In cases where the cement from the next interior string is run into the deepest surface or coal protective string, surface pressure readings may not reflect casing seat pressure conditions, and leaking gas should be monitored as described in Item 12.

## WELL INTEGRITY

### 10. Water Protection Depth Evaluation

If the well is configured in such a way that it is necessary or possible to obtain the fluid level measurement described under Item 6, compare this depth to the "water protection depth." The water protection depth is defined in Chapter 78 as *"the depth to a point 50 feet below the surface casing seat."*

If the water level in Item 6 is at a depth equal to or shallower than the water protection depth, check "yes", otherwise check "no." Note that when the produced zone is located within 100 feet of the surface casing seat, the location of the water protection depth will actually be shallower than 50 feet below the surface casing seat.

### 11. Critical Pressure Evaluation

Over-pressured gas or combined oil and gas wells are one of the principal causes of stray gas migration incidents, and can also result in the release of brines and/or other associated production contaminants to shallower intervals penetrated by the well. If the pressure associated with the pertinent casing string recorded in either Item 7, 8, or 9 is in excess of the pressure calculated in Item 5, check "yes." If the critical pressure is not exceeded, check "no."

### 12. Escaping or Vented Gas

Gas emissions emanating from annular spaces that were not designed specifically to allow for the extraction of natural gas from shallower, produced intervals are indicative of inadequate cement jobs, mechanical failure of well tubulars and/or cement sheaths, or other potential problems (see examples on pages 9 and 10). Venting gas observed beyond the outermost casing string confirms subsurface well integrity problems. Typically, escaping gas is heard or manifest as bubbles in pooled water at or around the wellhead.

The Department's expectation for operating gas wells is that gas should not be present in any quantity within the annular space of the surface casing or any coal protective casing strings. Flowing gas in these annular spaces is prohibited under Section 78.85(a)(5) of Chapter 78.

Any escaping or venting gas noted at the surface should be reported. Check "yes" if escaping gas is observed, otherwise check "no."

### 13. Escaping or Vented Gas Rate

The rate at which gas is escaping or being vented at the wellhead should be quantified. If multiple "leaks" or vent locations are present, provide a cumulative rate. If a direct measurement of the rate cannot be ascertained, an estimate should be made.

#### 14. Location of Escaping or Vented Gas

The location from which gas is escaping or being vented should be indicated, e.g., "annular space between 5-1/2" production casing and 9-5/8" surface casing strings." If multiple locations are observed, list all.

---

Form 5500-PM-OGXXXX, page 2

#### 15. Corrosion/Equipment Deterioration Survey

The survey described under this item initially applies only to surface wellhead apparatus that are accessible and critical for continued safe operations. Such equipment may include, but is not limited to, any apparatus used for the containment of hydrocarbons and other produced fluids, infrastructure used for the safe venting of gas or the separation of gas or oil from other produced fluids, devices used for pressure monitoring, and nearby gathering lines and all ancillary equipment in the vicinity of the wellhead. If pressure monitoring or other observations at the wellhead suggest downhole problems, this survey must include subsurface equipment including tubulars, packers, and other apparatus that may be responsible for the observed condition.

The specific intent of corrosion monitoring and inspections is to assist in material selection and also to determine whether or not any equipment should be replaced. Various technologies are available for achieving these objectives. NACE International provides several inspection protocols specific to the oil and gas industry.

For this item, a brief summary of the inspection results, including any potential problems, is expected along with supporting documentation and/or reports. Justification must be provided for any accessible equipment critical for ongoing safe operations that is not surveyed.

#### 16. Notification

The appropriate regional DEP oil and gas office should be contacted immediately if any problems are noted under Item 15 or if an over-pressured condition is observed at the relevant casing seat.

#### 17. Notification Date

Provide the date the appropriate regional Department oil and gas office is contacted regarding potential mechanical integrity problems at the inspection site.

#### 18. Department Representative

Provide the name of the regional Department oil and gas representative that was notified regarding potential mechanical integrity problems at the inspection site.

### WELL MITIGATION AND ADDITIONAL TESTING

19. Addressing Deficiencies	Well	Mechanical	Integrity
-----------------------------	------	------------	-----------

Section 78.88(d) describes specific steps that must be taken to address any observed well mechanical integrity deficiencies noted during the course of quarterly monitoring events. This portion of the instructions details the Department's expectations when well remediation and/or additional mechanical integrity testing is required.

If an over-pressured condition is noted in Item 11, measures must be implemented to reduce the pressure on the relevant casing seat as soon as possible. Steps taken to reduce pressure at the casing seat should be provided and a final pressure reported. If measures more detailed than venting are needed to affect compliance with Section 78.73(c) of Chapter 78, e.g., remedial cementing operations, supplemental reports and/or documentation should be appended to the form.

For wells not equipped with production casing where over-pressured conditions are observed, production casing must be installed to ensure ongoing compliance with Section 78.73(c) of Chapter 78. A representative from the appropriate regional DEP oil and gas office should be contacted **7 days** prior to commencement of production casing retrofitting. All relevant casing and cementing standards must be followed and the annular space surrounding the production casing must be capable of being vented to the atmosphere to avoid future over-pressured conditions at the well site. It is strongly recommended that the annular space be equipped with a port so that pressure measurements can be collected during future inspections as needed.

Well owners or operators must either install the production casing on a packer or cement it to the surface. If production casing is cemented to the surface, attach the cement job log and any other logging/activity reports relevant to casing installation and cementing activities at the well site. Additional appended information should minimally consist of casing specifications, including but not limited to the pressure rating; and the depth to which casing was installed. If the production casing retrofitted at the well where over-

pressured conditions are observed is installed on a permanent packer, all logging/activity reports relevant to casing installation at the well site should be submitted. Additional appended information should minimally consist of casing and packer specifications, including but not limited to the pressure ratings; the packer-set depth; and the depth to which casing was installed.

For any defective or deteriorating equipment identified under Item 15, a brief description of steps taken to repair or replace each item should be provided. All applicable Department rules and regulations should be followed during repair/replacement activities. Supplemental reports and/or documentation should be appended to the Well Mechanical Integrity Report as needed.

The Department retains the right to request additional mechanical integrity testing at wells where over-pressured conditions or other problems are noted. These tests may include, but are not limited to, pressure tests, caliper/temperature logging, downhole camera logging, cement bond-variable density logging, and isolation scanner logging.

If the Department, in consultation with the well owner or operator, deems it necessary to conduct additional mechanical integrity testing at the well where problems are observed, a summary of all testing conducted must be provided. Further, any additional problems noted during supplemental mechanical integrity testing must be reported to the appropriate regional DEP oil and gas office and a mitigation strategy must be implemented to ensure safe oil and/or gas extraction at the well location. Any test reports or logs generated as a result of additional mechanical integrity testing should be appended to the Well Mechanical Integrity Report.

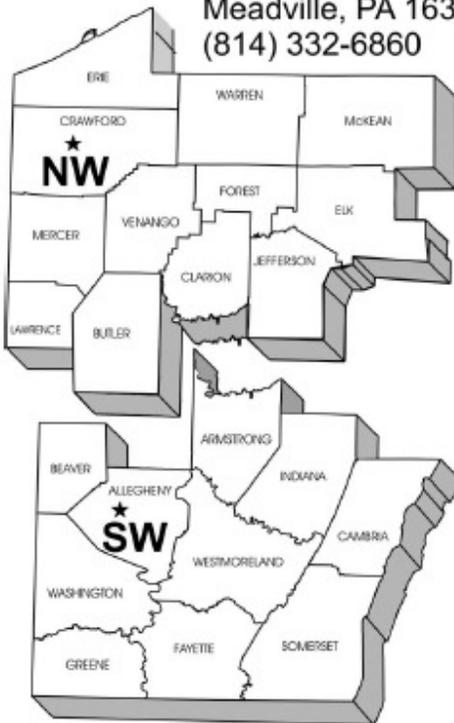


COMMONWEALTH OF PENNSYLVANIA - OIL & GAS OFFICES  
DEPARTMENT OF ENVIRONMENTAL PROTECTION

# Oil and Gas Regions

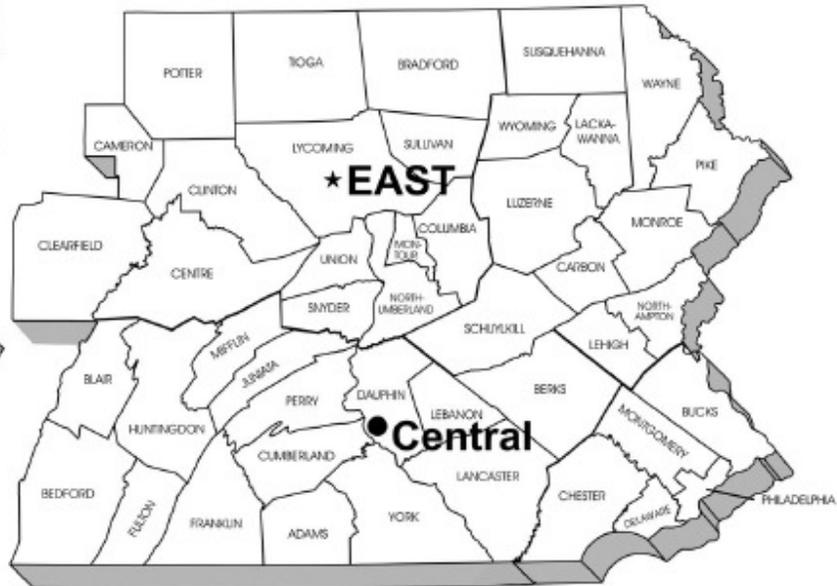
★ Northwest Region

230 Chestnut Street  
Meadville, PA 16335-3481  
(814) 332-6860



★ Eastern Region

208 West Third Street  
Williamsport, PA 17701-6448  
(570) 321-6550

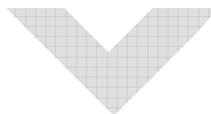


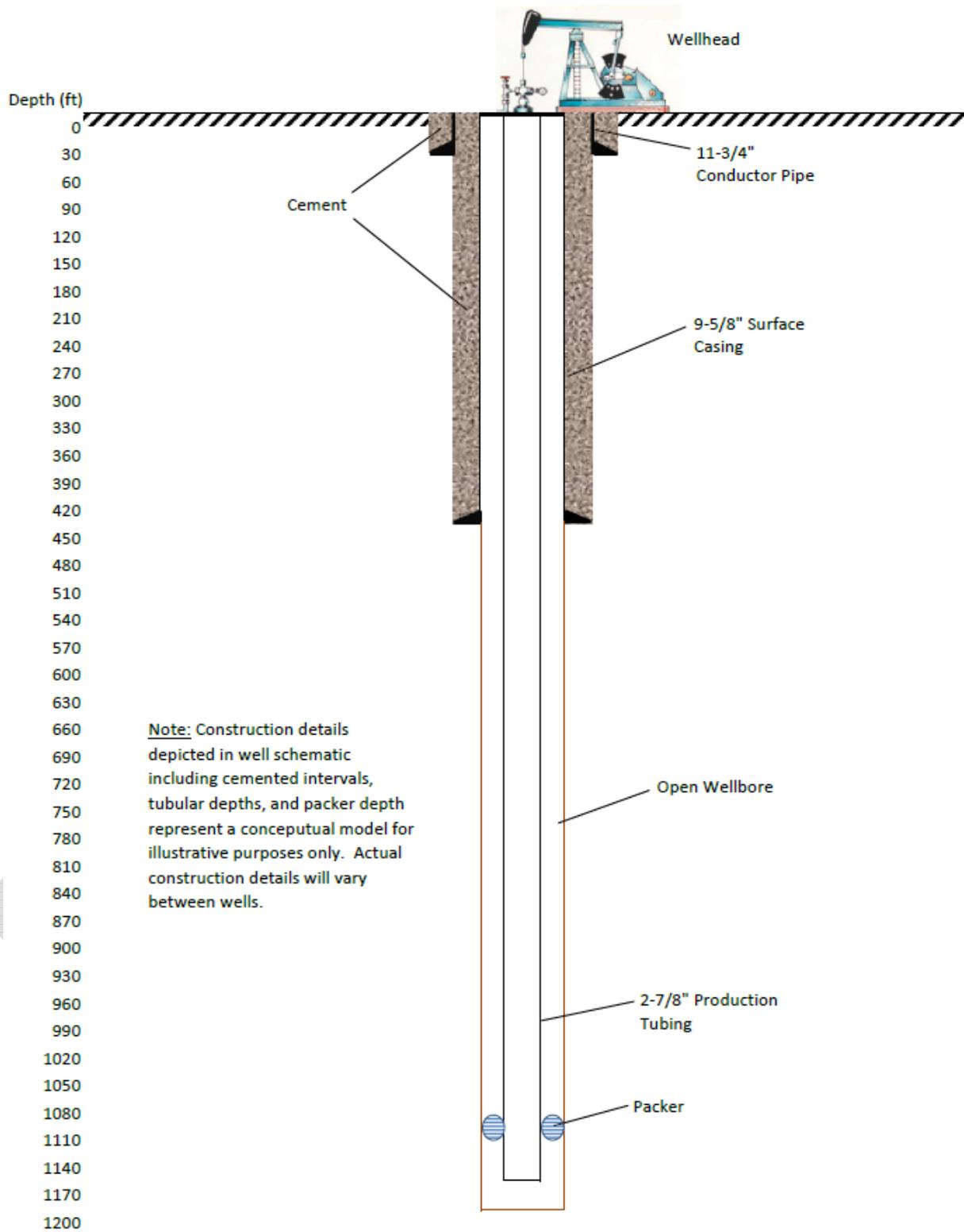
★ Southwest Region

400 Waterfront Drive  
Pittsburgh, PA 15222-4745  
(412) 442-4024

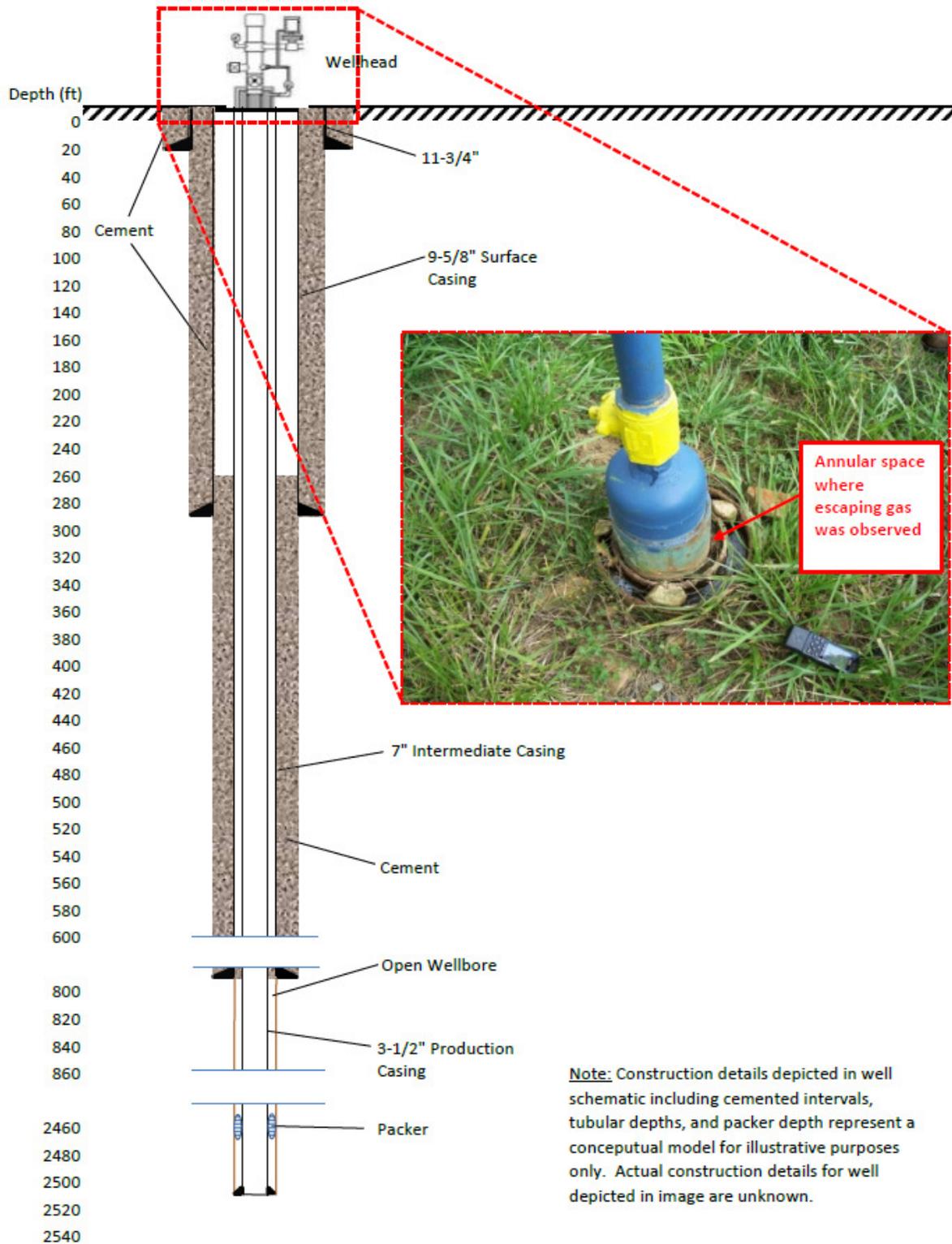
● Central Office

Bureau of Oil and Gas Management  
PO Box 8765  
Harrisburg, PA 17105-8765  
(717) 772-2199

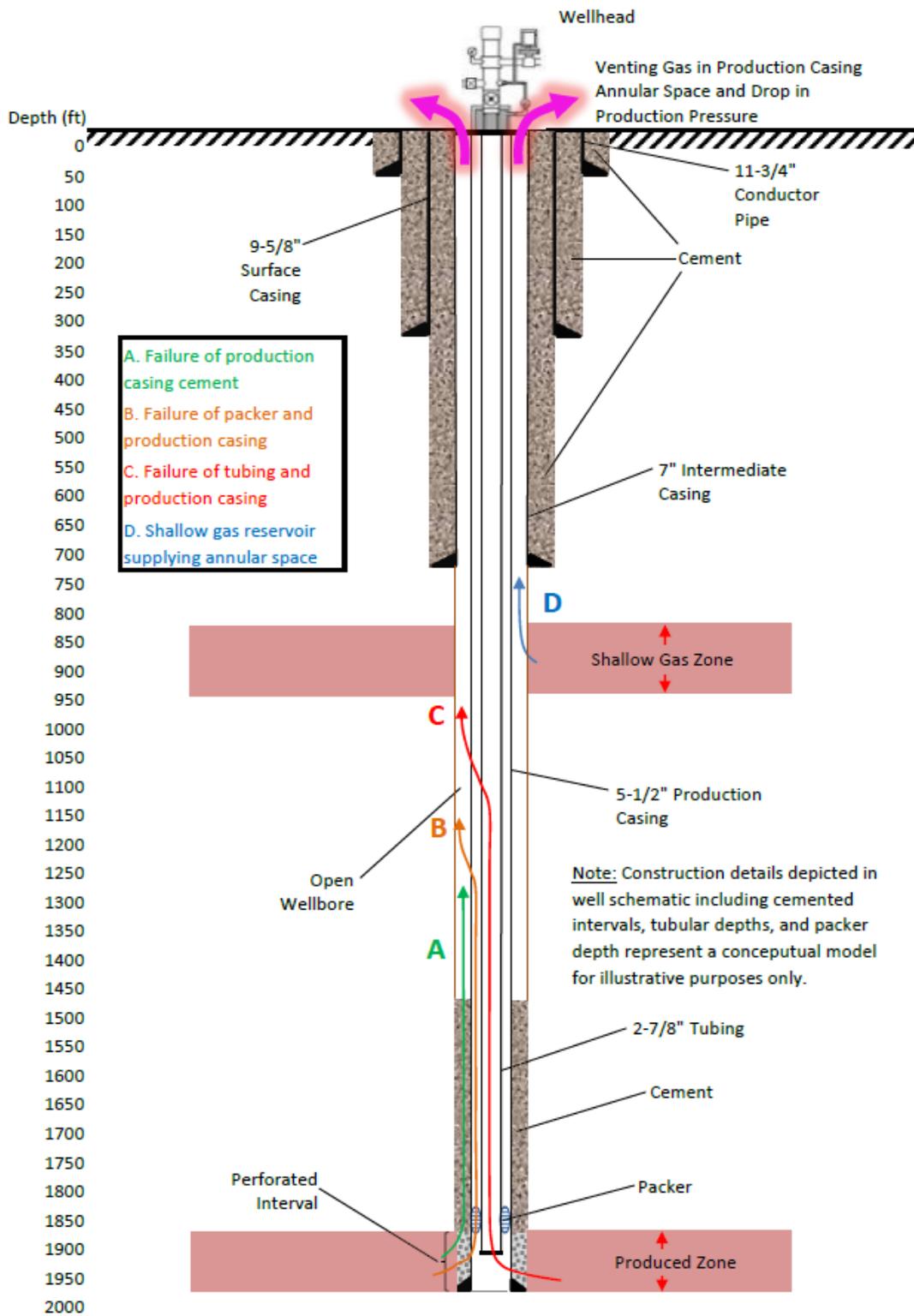




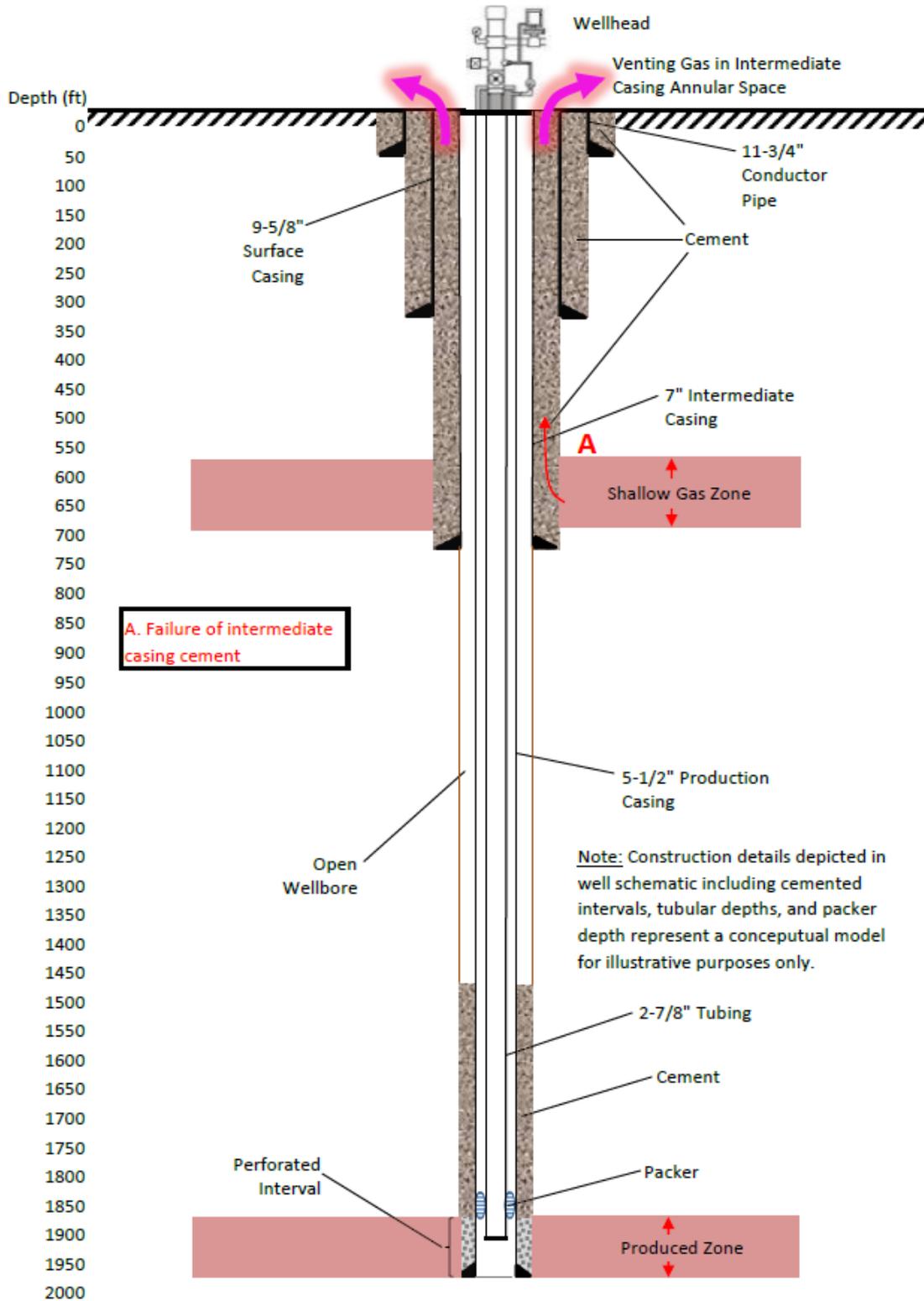
Schematic representing example of oil well where water level measurement may be appropriate



Schematic representing example of gas well not fitted for annular space pressure monitoring



Schematic representing mechanical integrity failures and well construction flaws that would generate open flow in annular space of production casing



Schematic representing mechanical integrity failure that would generate open flow in annular space of intermediate casing