pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

How to Avoid and Handle Acid-Producing Rock Formations Encountered During Well Site Development

Background

Coal and black shale typically contain pyrite, a mineral composed of iron and sulfur. When pyrite is exposed to the atmosphere, it weathers, producing sulfuric acid and iron. The sulfuric acid can dissolve additional undesirable elements from the rocks, such as aluminum and manganese (Ref. 1). If these acid-producing rocks (APR) are disturbed during well site construction and are not properly handled, streams and groundwater can become polluted.

Pursuant to the Clean Streams Law, it is unlawful to put, place, or allow a discharge of any substance that would result in pollution of the waters of the commonwealth. Therefore, well site construction activities must be conducted in a manner that will not result in water pollution. Causing pollution can result in compliance actions taken by the Department of Environmental Protection (DEP) and may result in long-term water treatment obligations. This fact sheet addresses how to avoid coal and other acid-producing rocks and how those rocks should be handled if encountered during construction activities.

Pollution Prevention Strategies

Strategies fall into two categories: avoidance and handling.

Avoidance: The best way to avoid pollution is to avoid disturbing the materials that cause pollution. If it is known that APRs, such as coal, will be encountered, the excavation should either be moved to an area that does not contain these rocks or the rocks must be dealt with in a way that reduces the risk of pollution.

Discussion on Avoidance: The best way to avoid encountering coal and associated APRs is to understand the bedrock geology. The majority of coal mined in the Bituminous Field comes from two geologic units: the Allegheny Group and the basal portion of the Monongahela Group. Other geologic units that can contain coal are the Pottsville, Conemaugh, and Dunkard Groups. Most coal in the Anthracite Region is associated with the Llewellyn Formation, although coal can also be found in the Pottsville Group (Chap. 8 in Ref. 1). Bedrock geologic maps exist for most portions of Pennsylvania's coal fields. These maps will give at least a general idea of where coal is located (Refs. 2 & 3). Sources of site specific data include DEP permit files and records maintained by the Pennsylvania Geologic Survey. Mine map repositories are also useful (Ref. 4). If site specific data is not available or is inadequate, it can be obtained or supplemented by drilling the site to determine if and where coal and APRs are present.

Typically the upper 25 to 35 feet of bedrock does not contain pyrite because pyrite is not stable under atmospheric conditions and will weather away. If excavations are shallower than 30 feet, the risk of acid drainage is generally minimal. This is particularly true if a site is located south of the glacial margin. Within the glaciated regions of Pennsylvania weathered bedrock may have been removed by glaciers and pyrite may exist closer to the surface. Unconsolidated sediments, such as glacial till, sand, and gravel, are not acid-producing and can be dug into without risk of acidic drainage (Ref. 1).

Handling: If coal or other APR is encountered, it can be removed from the site or handled on site. Removal from the site is the preferable option because it eliminates a potential pollution source for the well site. Handling coal on site creates two problems: (a) the potential for pollution and (b) the loss of a resource of value. If APRs must be left on site, it is very important that it be handled properly.

Discussion on Handling: If coal or other acid-producing rock must be handled on site, it should be sampled and analyzed for total percent sulfur (%S). The %S can be used to predict if the material is acid-producing and can also provide the ability to develop remedial strategies. To determine the %S, one 5-gallon bucket full of material should be collected for every 2,000 tons of potentially APR. Each bucket should represent a different area of the site. Each bucket of rock should be analyzed separately. No less than three buckets of material should be collected on site (that is, no less than three separate samples). Ref. 5 provides details on sampling and testing methods. If coal or another rock averages more than 0.5 percent sulfur it must be segregated and mixed with a sufficient amount of neutralizing materials (such as limestone, quick lime, or hydrated lime). This practice is called "alkaline addition." The amount of limestone (LS) needed to neutralize the acid from pyrite-bearing rock can be determined as follows:

$$(Acres\ \ of\ APR)*(Thickness\ in\ ft)*\frac{Tons\ APR}{Acre-ft}*\%S*\frac{62.5\ tons}{1{,}000\ tons}=\ Tons\ of\ \ LS$$

The "62.5 tons/1,000 tons" is a conversion factor (explanation in Chap. 1 of Ref. 1).

For example, if a pad will encounter coal over an area of 4.3 acres, the coal seam is 2.1 feet thick and has a sulfur content of 1.2 percent: the amount of LS needed to neutralize the acid can be calculated as follows:

$$4.3\ acres*2.1\ ft*\frac{1{,}766\ tons}{acre-ft}*1.2\%*\frac{62.5\ tons}{1{,}000\ tons}\ =\ 1{,}196\ tons\ LS$$

The weight of the coal in the above example (1,766 tons/acre-ft) is based on coal weighing 80 lbs/ft^3. Other rock types such as shale, limestone, claystone, sandstone, and siltstone typically weigh about 3,700 tons/acre-ft. Limestone is typically not pure calcium carbonate. If a limestone is 80 percent pure (for example, 80 percent calcium carbonate, 20 percent other minerals), then the tonnage calculated above (1,196) needs to be adjusted upwards to account for the impurity. Purity can be determined from the neutralization potential test (Ref. 5). The tonnage is adjusted by dividing 1,196 by 0.80. Thus, the amount of 80 percent pure LS needed to neutralize the potential acid is 1,495 tons of LS.

If spoiling of acid-producing coal/rock cannot be avoided, the APR should be mixed with the appropriate amount of neutralizing material and encapsulated with a layer of low permeability clay above and below the APR to reduce contact with water and oxygen. Clay is a fine-grained material with plasticity. The best on site clay is often the subsoil, but can include fine grained friable rocks. Polluted water draining from the well site should be collected and treated and an NPDES permit would need to be obtained.

Areas Unsuitable for Mining: The mining of coal in certain areas of the state is prohibited. 25 Pa. Code, Chapter 86, Section 86.130(b) lists areas and/or coal seams within those areas that are unsuitable for mining. The areas are also shown on Ref. 3, a map showing locations of APRs in Pennsylvania. The local District Mining Office will have information regarding these areas.

References and Other Resources:

1. *Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania*. (http://files.dep.state.pa.us/Mining/BureauOfMiningPrograms/BMPPortalFiles/Coal_Mine_Drainage_Prediction_and_Pollution_Prevention_in_Pennsylvania.pdf). Describes in detail the science and methods used to predict and prevent mine drainage pollution.
2. The PA Geological Survey and US Geological Survey have published geologic maps for most of the state. Their publications can be found in the libraries of colleges with geology departments and at the Pennsylvania Geological Survey library. A list of the publications is available at: www.dcnr.state.pa.us/topogeo/publications/index.htm.
3. *Geologic Units Containing Potentially Significant Acid-Producing Sulfide Minerals*, PA Geologic Survey Open-File Report OFMI-05-01.1. A map showing the distribution of coal-bearing and other acid-producing strata, and the location of areas unsuitable for mining. (www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_015857.zip).
4. Repositories of deep mine maps for the Bituminous Region are located at the California District Mining Office and the New Stanton Mine Safety Office. Anthracite Region deep mine maps are located at the Pottsville Mine Safety office. Delineations of surface mine permit boundaries are kept at the Bureau of Mining Programs in Harrisburg. Office locations are provided at: www.dep.pa.gov/Business/Land/Mining/BureauofDistrictMining/Pages/default.aspx.
5. *Overburden Sampling and Testing Manual* (1988) DEP Contract No. ME 86120, D.A. Noll, et al., Provides step by step procedures for sampling and analysis of overburden materials. (http://files.dep.state.pa.us/Mining/BureauofMiningPrograms/BMPPortalFiles/Overburden_Sampling_and_Testing_Manual.pdf).

For more information, visit www.dep.pa.gov.