U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Fort Necessity National Battlefield and Friendship Hill National Historical Site

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Fort Necessity National Battlefield and Friendship Hill National Historical Site

fone_frhi_geology.pdf

Version: 7/7/2021

Geologic Resources Inventory Map Document for Fort Necessity National Battlefield and Friendship Hill National Historical Site

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Geologic Resources Inventory Map Document

Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania

Document to Accompany Digital Geologic-GIS Data

fone_frhi_geology.pdf

Version: 7/7/2021

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania (FONE-FRHI).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.

3) **Map Unit List** – A listing of all geologic map units present on maps for this project, listed from youngest to oldest.

4) **Map Unit Descriptions** – Descriptions for all geologic map units.

5) **Geologic Cross Section** – The one geologic cross section graphic associated with one of the source maps.

6) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this includes a report document, (unit) explanation, symbols and feature notes present on the source map, and a location area map, as well as a index of geologic mapping for one source map.

7) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

Stephanie O'Meara
Geologist/GIS Specialist/Data Manager
Colorado State University Research Associate, Cooperator to the National Park Service
Fort Collins, CO 80523
phone: (970) 491-6655
email: stephanie_o'meara@partner.nps.gov

About the NPS Geologic Resources Inventory Program

Background

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter “GRI” as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a "Contact Us" link if you need additional information. You may also directly contact the program coordinator:

Jason Kenworthy
Inventory Coordinator
National Park Service Geologic Resources Division
P.O. Box 25287
Denver, CO 80225-0287
phone: (303) 987-6923
fax: (303) 987-6792
email: Jason_Kenworthy@nps.gov

The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania (FONE-FRHI):

Digital Geologic-GIS Map of Fort Necessity National Battlefield and Friendship Hill National Historical Site and Vicinity, Pennsylvania (*GRI MapCode F*ONE)

The above park extents and vicinity map was compiled from the two Pennsylvania Geological Survey county maps, Fayette County and Greene County, each also available as GRI digital geologic-GIS data.

Digital Geologic-GIS Map of Fayette County, Pennsylvania *(GRI MapCode FACO*)

The source map is listed below. The full extent of plate 1 was used and all geologic features on this plate were captured.

> McElroy, T.A., 1988, Groundwater Resources of Fayette County, Pennsylvania: Pennsylvania Geological Survey, Water Resource Report 60, 2 plates, scale 1:50,000 (*GRI Source Map 4457*)

Digital Geologic-GIS Map of Greene County, Pennsylvania (*GRI MapCode GRNC*)

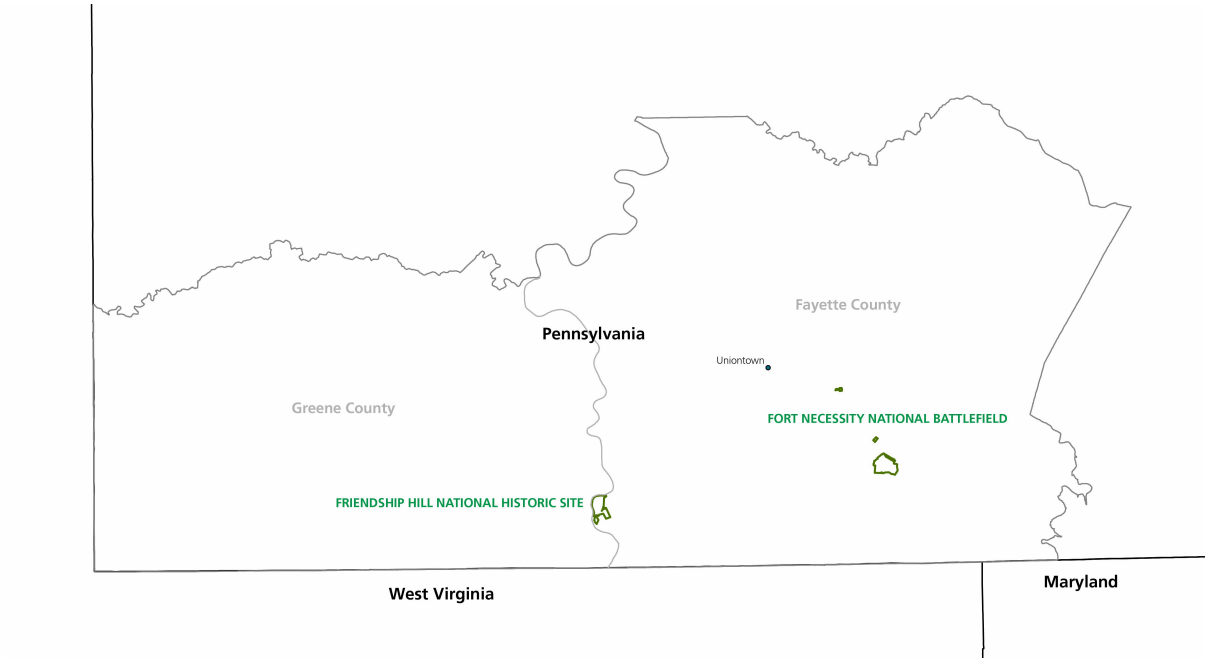
The source map is listed below. The full extent of plate 1 was used and all geologic features on this plate were captured.

> Stoner, J.D., Williams, D.R., Buckwalter, T.F., Felbinger, J.K., and Pattison, K.L., 1987, Water resources and the effects of coal mining, Greene County, Pennsylvania: Pennsylvania Geological Survey, Water Resource Report 63, 2 plates, scale 1:50,000 (*GRI Source Map 4656*)

Additional information pertaining to each source map is also presented in the GRI Source Map Information (FONEMAP) table included with the GRI digital geologic-GIS data.

Index Map

The following index map displays the extents of the GRI digital geologic-GIS maps produced for Fort Necessity National Battlefield and Friendship Hill National Historical Site (FONE-FRHI). The boundaries for Fort Necessity National Battlefield and Friendship Hill National Historical Site (as of July 2021) are outlined in green. The extent of the park and vicinity map, a compilation of both the Greene and Fayette county maps, is outlined in dark gray, and where the county boudnaries and states are coincide with a state boundary (in black) also serving as the map boundary. The extent of Greene and Fayette counties, available has individual maps, are defined by the map boundary as well as the light gray line that separates the two counties.



Index map by Stephanie O'Meara (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania (FONE-FRHI) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the GRI Geologic Unit Information (FONEUNIT) table included with the GRI digital geologic-GIS data. Some source unit symbols, those pertaining to the Pennsylvanian Period age were changed from "P" to 'PN' in this document and in the GRI digital geologic-GIS data.

Cenozoic Era

Quaternary Period

Qal - Alluvium (Quaternary)
Qacm - Alluvium and Carmichaels Formation, undifferentiated (Quaternary)
Qcm - Carmichaels Formation (Quaternary)

Mesozoic Era

Jk - Gates-Adah Dike (Jurassic)

Paleozoic Era

Permian Period

Pg - Greene Formation (Permian)
Pw - Washington Formation (Permian)

Permian and Pennsylvanian Periods

PPNw - Waynesburg Formation (Permian and Pennsylvanian)

Pennsylvanian Period

PNm - Monongahela Group (Pennsylvanian)
PNu - Uniontown Formation (Pennsylvanian)
PNpb - Pittsburgh Formation (Pennsylvanian)
PNcc - Casselman Formation (Pennsylvanian)
PNcg - Glenshaw Formation (Pennsylvanian)
PNa - Allegheny Group (Pennsylvanian)
PNp - Pottsville Group (Pennsylvanian)

Mississippian Period

Mmc - Mauch Chunk Formation (Mississippian)
Mb - Burgoon Sandstone (Mississippian)

Mississippian and Devonian Periods

MDso - Shenango Formation through Oswayo Formation, undivided (Mississippian and Devonian)

Devonian Period

Dck - Catskill Formation (Devonian)
Df - Foreknobs Formation (Devonian)

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Unit descriptions are from the source map or maps the unit is present on.

Qal - Alluvium (Quaternary)

Geologic Description:
Unconsolidated deposits of gravel, sand, silt, and clay that occupy the floodplains of streams and, in some places, form low terraces above the floodplains.

Well Yields:
Reported yields of three wells ranged from 3 to 300 gal/min.

Quality of Water:
Quality may be a problem, but data are insufficient to determine the extent of the problem.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Clay, silt, sand, gravel, and cobbles in and adjacent to streams. The material is derived mostly from local bedrock.

Hydrologic Properties:
Few wells have been completed in this unit. The data indicate wide variability in specific capaci-ty. One well tapping a thin layer of gravel had a 1-hour specific capacity of 1.6 (gal/min)/ft. Another well that penetrates mostly clay had a 1-hour specific capacity of 0.18 (gal/min)/ft. Some shallow dug wells are used for domestic needs; most owners report sufficient water, although conservation is often necessary during long dry periods. The few data available indicate that the water may exceed recommended limits of 300 µg/L for iron and 50 µg/L for manganese.

Above description and related text from source map PAGS Water Resource Report 63.

Qacm - Alluvium and Carmichaels Formation, undifferentiated (Quaternary)

See Qal and Qcm for descriptions and related unit text.

Qcm - Carmichaels Formation (Quaternary)

Geologic Description:
Unconsolidated deposits of gravel, sand, silt, and clay that occupy abandoned meanders of the Monongahela and Youghiogheny Rivers.

Well Yields:
Data from Fayette County are not available; however, in adjacent Greene County tested wells had a wide range of yields.

Quality of Water:
Data from Greene County indicate adequate quality.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Alluvium, unconsolidated and poorly sorted clay, silt, sand, gravel, cobbles, and boulders of sandstone. Small limonite nodules are abundant locally. The base of the deposit is about 910 feet above sea level and about 140 to 150 feet above the present Monongahela River level. Deposits are in ancient abandoned river channels and on rock terraces related to this ancient drainage network (Kent, 1969a). The Carmichaels Formation is limited in areal extent to the eastern half of the county.

Hydrologic Properties:
Limited data indicate that yields range widely. Two unused public-supply wells each produced about 40 gal/min. Domestic well yields generally were reported adequate; the exceptions were one dry well and another well that had a yield of less than 1 gal/min. Few data indicate that the water is soft to moderately hard. The pH is commonly less than the recommended limit of 6.5. Iron and manganese were above recommended limits in one of two samples.

Above description and related text from source map PAGS Water Resource Report 63.

Jk - Gates-Adah Dike (Jurassic)

Geologic Description:
Mica-peridotite dike, the only igneous rock found at the surface in Fayette County; actually consists of a swarm of three or more dikes.

Well Yields:
No data available.

Quality of Water:
No data available.

Above description and related text from source map PAGS Water Resource Report 60.

Pg - Greene Formation (Permian)

Geologic Description:
Predominantly greenish-gray, thin beds of fine-to very fine grained sandstone, siltstone, clay shale, claystone, limestone, and impure coal.

Well Yields:
No data available.

Quality of Water:
No data available.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Predominantly shale, sandstone, siltstone, and thin units of limestone, claystone, carbonaceous shale, and coal. Shale is locally interbedded with siltstone and sandstone. Shale locally has siderite nodules, is calcareous, and in part is silty. Sandstone is light to olive gray, micaceous, and mostly fine to medium grained. Beds are of variable thickness, planar to crossbedded, and locally massive. Siltstone is micaceous, generally light to medium gray, and locally contains ironstone and limestone nodules. Thin, lenticular, predominantly light- to dark-gray limestone beds are generally not persistent throughout the formation. Fossils in the limestone include freshwater ostracodes, *Spirorbis,* and fish remains. Claystone is light to dark gray, generally in layers less than 1 foot thick, and is associated with limestone, coal, and carbonaceous shale beds. The Ten Mile coal is generally impure and lenticular, is commonly less than 24 inches thick, and is the lowermost mappable unit, 20 to 50 feet above the base of the Greene Formation. Most of the surface rocks in the western half of the county are in the Greene Formation.

Hydrologic Properties:
Generally a poor aquifer. The median reported yield of 55 wells is 2 gal/min. A few wells, especially along hilltops, were abandoned after drilling because yields were less than several tenths of a gallon per minute. Only 25 percent of the wells had a reported yield of 5 gal/min or greater. The median discharge of 335 springs is 0.25 gal/min. Only 6 percent of the springs had yields greater than 3.0 gal/min. About 75 percent of the wells had iron and manganese above recommended limits. About half of the wells had very hard water. The pH of water from wells and springs was generally within the recommended range of from 6.5 to 8.5.

Above description and related text from source map PAGS Water Resource Report 63.

Pw - Washington Formation (Permian)

Geologic Description:
Predominantly greenish-gray, thin beds of mudstone, siltstone, and fine- to very fine grained sandstone; also contains two limestone units, red clay shale, and coal.

Well Yields:
Reported yields range from 1.5 to 17 gal/min; the median is 4.5 gal/min.

Quality of Water:
Based on a limited number of samples, water is hard to very hard; high concentrations of dissolved solids may be a problem.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Upper limestone member — Consists generally of an upper and lower limestone unit commonly separated by shale. Individual olive- to dark-gray limestone beds are generally from 0.5 to 2 feet thick. Fossils include freshwater ostracodes and some fish remains. Beds weather to a characteristic white color.

Middle member — Chiefly shale, siltstone, and locally massive, light- to olive-gray, micaceous sandstone. The shale contains siderite nodules. The Jollytown coal is commonly less than 24 inches thick, is locally impure, and in some places grades laterally to carbonaceous shale.

Lower limestone member — Limestone, where present, occurs in beds 0.5 to 2 feet thick, and is olive to medium gray, argillaceous, and interbedded with shale. Locally, where light-gray sandstone overlies the Washington coal, the middle and lower members can be indistinguishable. The Washington coal is as much as 48 inches thick but commonly is less than 24 inches thick. The coal is impure and shaly, and its horizon is locally represented by carbonaceous shale.
The Washington Formation crops out generally in the middle and upper portions of stream basins in the eastern half of the county and in some valley bottoms in Richhill Township.

Hydrologic Properties:
The median reported yield of 39 wells is 3.0 gal/min; the yields ranged from 0.08 to 26 gal/min. About 25 percent of the wells had a reported yield greater than or equal to 10 gal/min. The median discharge of 120 springs is 0.50 gal/min; most springs are perennial. About half of the wells and springs sampled had hard to very hard water. Two samples from wells had concentrations of hydrogen sulfide above the recommended limit of 0.05 mg/L. The concentration of barium in a sample from an observation well exceeded the recommended limit of 1,000 µg/L. About half of the samples from wells had iron and manganese concentrations above recommended limits.

Above description and related text from source map PAGS Water Resource Report 63.

PPNw - Waynesburg Formation (Permian and Pennsylvanian)

Geologic Description:
Typically thin beds of gray to olive-gray siltstone, claystone, mudstone, sandstone, limestone, and coal. The sandstone is locally massive and medium to coarse grained.

Well Yields:
Reported yields range from 2 to 27 gal/min; the median is 6 gal/min.

Quality of Water:
Of 10 wells tested, 60 percent have concentrations of iron and manganese above drinking water standards; 30 percent exceed the standard for sulfate and total dissolved solids; and 10 percent have an excess of calcium, magnesium, lead, and aluminum.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Upper member — Chiefly shale, gray to black, locally calcareous, containing siderite nodules, and medium-gray and light-gray sandstone. The basal unit is the Little Washington coal. The coal is typically thin and impure, and locally grades laterally to carbonaceous shale.

Middle member — Predominantly medium-gray shale, sandstone, and light-gray siltstone. The Waynesburg B coal generally occurs about 30 feet below the Little Washington coal and is up to 12 inches thick, locally impure, and shaly. The basal unit is the Waynesburg A coal. In some areas the coal is as much as 84 inches thick in two benches split by a claystone parting 12 to 36 inches thick, but it is commonly in one bench as much as 24 inches thick. The Waynesburg A coal is locally impure and in some places grades laterally to carbonaceous shale.

Lower member — Predominantly shale, sandstone, and siltstone. The Waynesburg sandstone is generally light gray, massive, fine to coarse grained, and crossbedded, and locally grades laterally and vertically to siltstone and shale. The Waynesburg coal is at the base of the Waynesburg Formation and

is overlain in some places by a dark shale. The Waynesburg coal is commonly in two, but locally in three, benches. Where two benches are present, the upper bench ranges from 3 to 33 inches in thickness, and the lower, or main, bench ranges from 15 to 64 inches in thickness; the two benches are separated by a claystone parting up to 48 inches thick. Locally a single bench is as much as 84 inches thick. The greatest thickness of the Waynesburg coal occurs in the eastern part of the county, where it is mined.
The Waynesburg Formation crops out along some of the lower portions of the stream basins in eastern Greene County.

Hydrologic Properties:
The median reported yield of wells is 3.8 gal/min. Two wells tapping the lower member of the Waynesburg Formation produced the two highest 1-hour specific capacities of the study (3.7 and 4.4 (gal/min)/ft; pumping rates of 24 and 32 gal/min, respectively). About 25 percent of the wells yielded 20.5 gal/min or more. The 1-hour specific capacities of this unit ranged from 0.01 to 4.4 (gal/min)/ft. The median discharge of springs is 0.50 gal/min. Iron and manganese concentrations were above recommended limits in about one half and one third, respectively, of the wells sampled. Water from two wells had a strong hydrogen sulfide odor (rotten egg smell); concentrations of total sulfide were 0.2 and 0.7 mg/L, which are above the recommended 0.05 mg/L limit. Three valley wells between 190 and 220 feet deep had chloride concentrations ranging from 3,100 to 3,700 mg/L (recommended limit is 250 mg/L). Most wells and springs had water within the recommended pH range of from 6.5 to 8.5. However, at selected sites where the Waynesburg coal has been surface mined, groundwater discharges at seeps had a low pH and high concentrations of sulfate, iron, manganese, and dissolved solids.

Above description and related text from source map PAGS Water Resource Report 63.

PNm - Monongahela Group (Pennsylvanian)

Geologic Description:
Black to light-gray, massive limestone; olive-gray argillaceous limestone having hackly cleavage and local yellow or yellow-orange staining; thin-bedded to massive, light- to very light gray, fine-to medium-grained sandstone; carbonaceous shale; and coal.

Well Yields:
Reported yields range from 0.1 to 50 gal/min; the median is 3 gal/min. The low yields are probably a consequence of extensive deep mining of the Pittsburgh coal and subsequent dewatering of the wells.

Quality of Water:
Water is hard to very hard; high concentrations of dissolved solids, iron, manganese, calcium, and magnesium are common.

Above description and related text from source map PAGS Water Resource Report 60.

See also the Uniontown (PNu) and the Pittsburgh (PNpb) formations within the Monongahela Group.

Above text from source map PAGS Water Resource Report 63.

PNu - Uniontown Formation (Pennsylvanian)

Geologic Description:
See also PNm, the Monongahela Group.

Well Yields:
See PNm, the Monongahela Group.

Quality of Water:
See PNm, the Monongahela Group.

Above text from source map PAGS Water Resource Report 60.

Geologic Description:
Upper member — Mostly shale, siltstone, sandstone, and coal. The basal unit is the Little Waynesburg coal, where present. The coal is thin and impure and is associated with carbonaceous shale.

Lower member — Chiefly limestone, shale, siltstone, sandstone, and coal. Limestone is light olive gray and argillaceous. Shale is locally calcareous. Sandstone is light gray, fine grained, and locally massive. The basal unit is the Uniontown coal, where present. The coal is commonly less than 24 inches thick, impure, and bony, and contains carbonaceous shale in places.

Hydrologic Properties:
The median reported yield of wells is 8 gal/min. One well, after a pumping test conducted with a discharge rate of 27 gal/min, had a 24-hour specific capacity of 1.4 (gal/min)/ft. Total iron concentration in six well samples ranged from 410 to 55,000 µg/L. Manganese concentrations in four of six samples from wells exceeded the 50 µg/L recommended limit and ranged from 60 to 560 µg/L. One sample from a deep flowing well (depth 374 feet) in which most of the flow is from the Uniontown Formation had a high chloride concentration of 2,700 mg/L. (W63)

Above description and related text from source map PAGS Water Resource Report 63.

PNpb - Pittsburgh Formation (Pennsylvanian)

Geologic Description:
See also PNm, the Monongahela Group.

Well Yields:
See PNm, the Monongahela Group.

Quality of Water:
See PNm, the Monongahela Group.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Upper member — Consists predominantly of limestone, sandstone, and shale. Limestone is light olive gray and argillaceous. Fossils include freshwater ostracodes, *Spirorbis,* fish remains, small pelecypods, and gastropods. Limestone beds are generally separated by shale, siltstone, and sandstone having a characteristic greenish-gray color. Locally some sandstone beds occur as crossbedded channel deposits.

Sewickley Member — Mostly limestone, shale, sandstone, siltstone, and coal. The limestone sequence that makes up most of the Sewickley Member is the Benwood limestone. The basal unit is the Sewickley coal. The coal is generally in one bench but is locally in two benches up to 110 inches thick, and has clay and shale partings up to 27 inches thick.

Fishpot Member — Chiefly sandstone, shale, carbonaceous shale, and, where present, a basal coal bed.

Redstone Member and lower member, undivided — Contains sandstone, siltstone, shale, limestone, carbonaceous shale, and coal. The upper part of the unit is chiefly limestone, olive-gray, crystalline, and argillaceous; shale containing limestone and siderite nodules; and sandstone. The Pittsburgh rider coal is locally minable in the southeastern corner of the county. There the coal may exceed 48 inches in thickness, and the interval between the base of the Pittsburgh rider coal and the base of the underlying Pittsburgh coal is locally greater than 60 feet. Elsewhere in the county, the interval between the two coals thins, and the thickness of the Pittsburgh rider is commonly less than 12 inches. A light-gray sandstone below the Pittsburgh rider coal and above the Pittsburgh coal occurs both as sheetlike and as channel-fill deposits. The Pittsburgh coal consists of two to four benches having clay or shale partings. The lower, or main, bench ranges from 36 to 104 inches in thickness, including minor clay partings up to 1 inch thick. Locally the coal is cut out by overlying sand-filled channels.

The Pittsburgh Formation crops out in the eastern third of the county and not much of it is exposed.

Hydrologic Properties:
Scanty data from existing wells indicate that yields are sufficient for most domestic needs in the eastern quarter of the county. However, one deep well (271 feet) had a 1-hour specific capacity of only 0.01 (gal/min)/ft. In the central and western parts of the county, the Pittsburgh Formation is not utilized for water supply because it is deep below land surface and most likely contains undesirable concentrations of chlorides and dissolved solids. Water pumped from several deep mines in the Pittsburgh coal in the north-central part of the county contained chloride concentrations of about 2,000 mg/L.

Above description and related text from source map PAGS Water Resource Report 63.

PNcc - Casselman Formation (Pennsylvanian)

Geologic Description:
Thin-bedded, green and red, commonly calcareous claystone; thin-bedded, gray siltstone; locally massive, fine- to medium-grained, gray sandstone; locally massive limestone; and thin, nonpersistent coal.

Well Yields:
Reported yields range from 0.1 to 200 gal/min; the median is 10 gal/min.

Quality of Water:
Water is generally hard to very hard; more than half of the wells tested exceed the standards for iron and manganese.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
Chiefly light-gray sandstone and gray shale. Sandstone and shale are locally massive. Coal stringers and coal beds are generally less than 24 inches thick. The Casselman Formation crops out in the southeastern corner of the county.

Hydrologic Properties:
Few data are available. One well had a 1-hour specific capacity of 0.34 (gal/min)/ft. Two laboratory analyses indicate that the water is very hard.

Above description and related text from source map PAGS Water Resource Report 63.

PNcg - Glenshaw Formation (Pennsylvanian)

Geologic Description:
Olive- to dark-gray, thin-bedded, fossiliferous, marine limestone and clay shale; red claystone; locally massive, fine- to coarse-grained sandstone; minor amounts of freshwater limestone; and thin, but generally persistent, coal.

Well Yields:
Reported yields range from 0 to 75 gal/min; the median is 7 gal/min.

Quality of Water:
Water is mostly hard to very hard; concentrations of iron and manganese exceeding drinking water standards are common; unsafe concentrations of aluminum and lead also occur.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Description:
The Ames marine zone is the uppermost unit of the Glenshaw Formation. The Ames is predominantly a highly fossiliferous limestone. The strata below this zone are poorly exposed. The Glenshaw Formation crops out along a small section of the Monongahela River in the extreme southeastern corner of the county.

Hydrologic Properties:
Due to the limited number of wells tapping the Glenshaw Formation, no information on water quality or water-bearing properties of this unit was obtained.

Above description and related text from source map PAGS Water Resource Report 63.

PNa - Allegheny Group (Pennsylvanian)

Geologic Description:
Olive- to dark-gray, nodular claystone; light-gray, thin- to massively bedded, fine- to coarse-grained sandstone containing stylolites; gray siltstone; nodules of limestone and siderite; local gray conglomerate; coal; and clay.

Well Yields:
Reported yields range from 0.5 to 25 gal/min; the median is 6 gal/min.

Quality of Water:
Water ranges from soft to very hard; iron, manganese, and aluminum concentrations exceeding drinking water standards are common; excessive concentrations of zinc, lead, dissolved solids, magnesium, and sulfate also occur.

Above description and related text from source map PAGS Water Resource Report 60.

PNp - Pottsville Group (Pennsylvanian)

Geologic Description:
Gray to light-gray crossbedded sandstone, quartz-pebble conglomerate, and siltstone; dark-gray, carbonaceous clay shale and claystone; and thin, nonpersistent coal. Massive beds of sandstone are not uncommon.

Well Yields:
Reported yields range from 3 to 15 gal/min; the median is 5 gal/min.

Quality of Water:
Water is generally soft; very high concentrations of iron and manganese are a common problem; high concentrations of aluminum may occur; dissolved solids are low.

Above description and related text from source map PAGS Water Resource Report 60.

Mmc - Mauch Chunk Formation (Mississippian)

Geologic Description:
Mostly grayish-red sequence of shale, siltstone, sandstone, and some conglomerate. Includes the fossiliferous Wymps Gap Limestone, the Deer Valley Limestone, and the highly crossbedded, gray, siliceous Loyalhanna Limestone.

Well Yields:
Reported yields of five wells range from 3 to 20 gal/min; the median is 8 gal/min.

Quality of Water:
Water from two wells tested soft and moderately hard; all constituents in the tested wells were within drinking water standards.

Above description and related text from source map PAGS Water Resource Report 60.

Mb - Burgoon Sandstone (Mississippian)

Geologic Description:
Buff, medium-grained, crossbedded sandstone containing some basal conglomerate.

Well Yields:
Reported yields of five wells range from 0.5 to 46 gal/min; the median is 4 gal/min.

Quality of Water:
Based on a limited number of samples, water is soft to moderately hard; iron and manganese may be a problem.

Above description and related text from source map PAGS Water Resource Report 60.

MDso - Shenango Formation through Oswayo Formation, undivided (Mississippian and Devonian)

Geologic Description:
Varying proportions of greenish-gray, olive, and buff sandstone and siltstone, and gray shale.

Well Yields:
Reported yield of one well is 5 gal/min.

Quality of Water:
No data available.

Above description and related text from source map PAGS Water Resource Report 60.

Dck - Catskill Formation (Devonian)

Geologic Description:
Predominantly grayish-red sequence of sandstone, siltstone, shale, and local conglomerate.

Well Yields:
No data available.

Quality of Water:
No data available.

Above description and related text from source map PAGS Water Resource Report 60.

Df - Foreknobs Formation (Devonian)

Geologic Description:
Interbedded sandstone, siltstone, and shale; gray to olive gray, red near top; substantial brownish-gray sandstone; some marine fossils; a few conglomerate beds at base and top. The formation has a limited exposure of about 1 square mile in Fayette County.

Well Yields:
No data available.

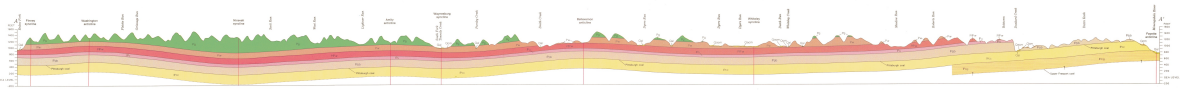
Quality of Water:
No data available.

Above description and related text from source map PAGS Water Resource Report 60.

Geologic Cross Section

The geologic cross section present in the GRI digital geologic-GIS data produced for Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania (<%PARKCODE%>) is presented below. The cross section graphic was scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Graphic from source map: PAGS Water Resource Report 63. Vertical exaggeration is x5.

Ancillary Source Map Information

The following section present ancillary source map information associated with sources used for this project.

PAGS Water Resources Report 60

The formal citation for this source.

> McElroy, T.A., 1988, Groundwater Resources of Fayette County, Pennsylvania: Pennsylvania Geological Survey, Water Resource Report 60, 2 plates, scale 1:50,000 (*GRI Source Map 4457*)

The source map, including both map plates, can be accessed via the U.S. Geological Survey National Geologic Map Database (NGMDB) record: https://ngmdb.usgs.gov/Prodesc/proddesc_32930.htm

The report document and prominent graphics associated with this source are presented on the following pages.

Report Document

The report document associated with the publication (double-click link to open the embedded document): W_60_text.pdf.

Explanation

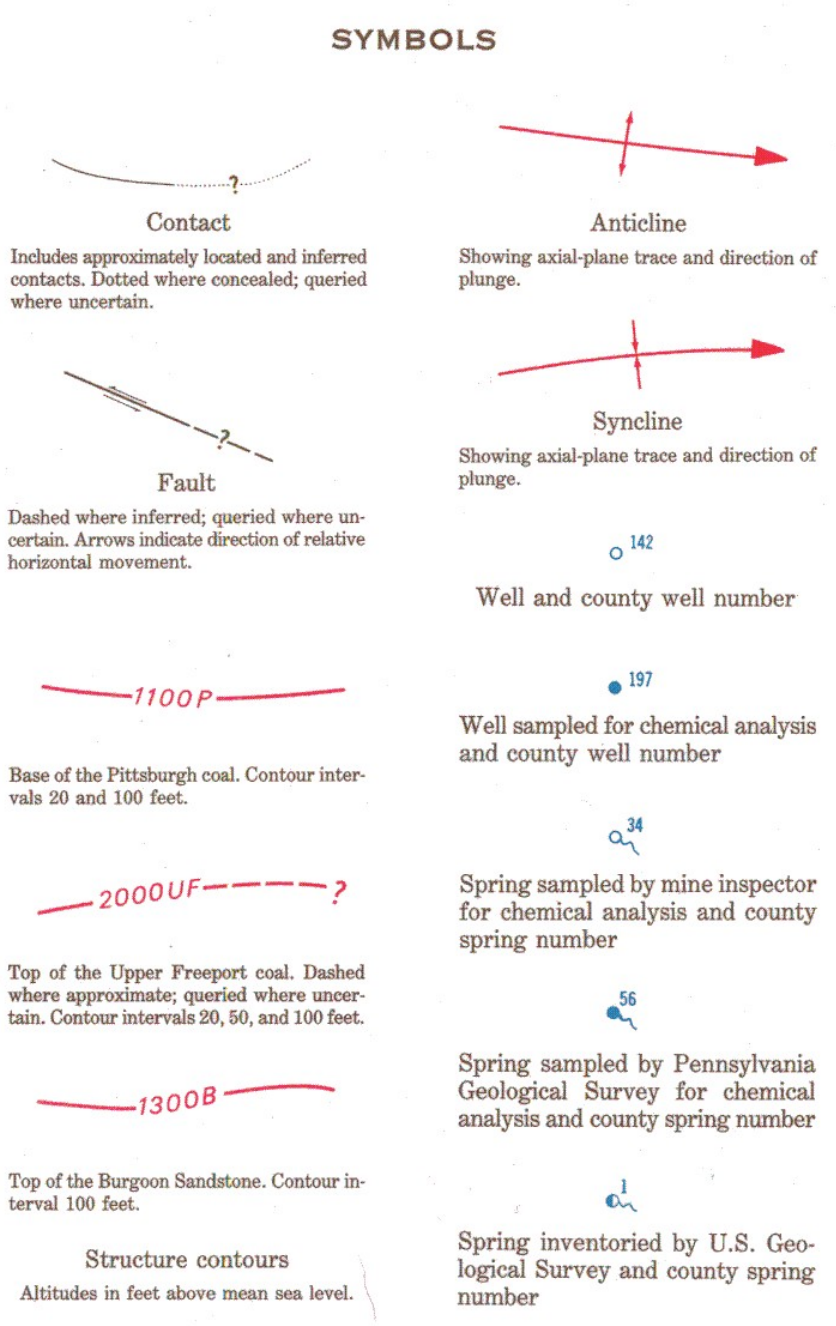
EXPLANATION

	UNIT	GEOLOGIC DESCRIPTION	WELL YIELDS	QUALITY OF WATER[1]
QUATERNARY	ALLUVIUM Qal	Unconsolidated deposits of gravel, sand, silt, and clay that occupy the floodplains of streams and, in some places, form low terraces above the floodplains.	Reported yields of three wells ranged from 3 to 300 gal/min.	Quality may be a problem, but data are insufficient to determine the extent of the problem.
	CARMICHAELS FORMATION Qcm	Unconsolidated deposits of gravel, sand, silt, and clay that occupy abandoned meanders of the Monongahela and Youghiogheny Rivers.	Data from Fayette County are not available; however, in adjacent Greene County tested wells had a wide range of yields.	Data from Greene County indicate adequate quality.
JURASSIC	GATES-ADAH DIKE Jk	Mica-peridotite dike, the only igneous rock found at the surface in Fayette County; actually consists of a swarm of three or more dikes.	No data available.	No data available.
PERMIAN	GREENE FORMATION Pg	Predominantly greenish-gray, thin beds of fine- to very fine grained sandstone, siltstone, clay shale, claystone, limestone, and impure coal.	No data available.	No data available.
	DUNKARD GROUP: WASHINGTON FORMATION Pw	Predominantly greenish-gray, thin beds of mudstone, siltstone, and fine- to very fine grained sandstone; also contains two limestone units, red clay shale, and coal.	Reported yields range from 1.5 to 17 gal/min; the median is 4.5 gal/min.	Based on a limited number of samples, water is hard to very hard; high concentrations of dissolved solids may be a problem.
	DUNKARD GROUP: WAYNESBURG FORMATION PPw	Typically thin beds of gray to olive-gray siltstone, claystone, mudstone, sandstone, limestone, and coal. The sandstone is locally massive and medium to coarse grained.	Reported yields range from 2 to 27 gal/min; the median is 6 gal/min.	Of 10 wells tested, 60 percent have concentrations of iron and manganese above drinking water standards; 30 percent exceed the standard for sulfate and total dissolved solids; and 10 percent have an excess of calcium, magnesium, lead, and aluminum.
PENNSYLVANIAN	MONONGAHELA GROUP IPm	Black to light-gray, massive limestone; olive-gray argillaceous limestone having hackly cleavage and local yellow or yellow-orange staining; thin-bedded to massive, light- to very light gray, fine- to medium-grained sandstone; carbonaceous shale; and coal.	Reported yields range from 0.1 to 50 gal/min; the median is 3 gal/min. The low yields are probably a consequence of extensive deep mining of the Pittsburgh coal and subsequent dewatering of the wells.	Water is hard to very hard; high concentrations of dissolved solids, iron, manganese, calcium, and magnesium are common.
	CONEMAUGH GROUP: CASSELMAN FORMATION IPcc	Thin-bedded, green and red, commonly calcareous claystone; thin-bedded, gray siltstone; locally massive, fine- to medium-grained, gray sandstone; locally massive limestone; and thin, non-persistent coal.	Reported yields range from 0.1 to 200 gal/min; the median is 10 gal/min.	Water is generally hard to very hard; more than half of the wells tested exceed the standards for iron and manganese.
	CONEMAUGH GROUP: GLENSHAW FORMATION IPcg	Olive- to dark-gray, thin-bedded, fossiliferous, marine limestone and clay shale; red claystone; locally massive, fine- to coarse-grained sandstone; minor amounts of freshwater limestone; and thin, but generally persistent, coal.	Reported yields range from 0 to 75 gal/min; the median is 7 gal/min.	Water is mostly hard to very hard; concentrations of iron and manganese exceeding drinking water standards are common; unsafe concentrations of aluminum and lead also occur.
	ALLEGHENY GROUP IPa	Olive- to dark-gray, nodular claystone; light-gray, thin- to massively bedded, fine- to coarse-grained sandstone containing stylolites; gray siltstone; nodules of limestone and siderite; local gray conglomerate; coal; and clay.	Reported yields range from 0.5 to 25 gal/min; the median is 6 gal/min.	Water ranges from soft to very hard; iron, manganese, and aluminum concentrations exceeding drinking water standards are common; excessive concentrations of zinc, lead, dissolved solids, magnesium, and sulfate also occur.
	POTTSVILLE GROUP IPp	Gray to light-gray crossbedded sandstone, quartz-pebble conglomerate, and siltstone; dark-gray, carbonaceous clay shale and claystone; and thin, nonpersistent coal. Massive beds of sandstone are not uncommon.	Reported yields range from 3 to 15 gal/min; the median is 5 gal/min.	Water is generally soft; very high concentrations of iron and manganese are a common problem; high concentrations of aluminum may occur; dissolved solids are low.
MISSISSIPPIAN	MAUCH CHUNK FORMATION Mmc	Mostly grayish-red sequence of shale, siltstone, sandstone, and some conglomerate. Includes the fossiliferous Wymps Gap Limestone, the Deer Valley Limestone, and the highly crossbedded, gray, siliceous Loyalhanna Limestone.	Reported yields of five wells range from 3 to 20 gal/min; the median is 8 gal/min.	Water from two wells tested soft and moderately hard; all constituents in the tested wells were within drinking water standards.
	BURGOON SANDSTONE Mb	Buff, medium-grained, crossbedded sandstone containing some basal conglomerate.	Reported yields of five wells range from 0.5 to 46 gal/min; the median is 4 gal/min.	Based on a limited number of samples, water is soft to moderately hard; iron and manganese may be a problem.
	SHENANGO FORMATION THROUGH OSWAYO FORMATION, UNDIVIDED MDso	Varying proportions of greenish-gray, olive, and buff sandstone and siltstone, and gray shale.	Reported yield of one well is 5 gal/min.	No data available.
DEVONIAN	CATSKILL FORMATION Dck	Predominantly grayish-red sequence of sandstone, siltstone, shale, and local conglomerate.	No data available.	No data available.
	FOREKNOBS FORMATION Df	Interbedded sandstone, siltstone, and shale; gray to olive gray, red near top; substantial brownish-gray sandstone; some marine fossils; a few conglomerate beds at base and top. The formation has a limited exposure of about 1 square mile in Fayette County.	No data available.	No data available.

[1]Drinking water standards are from Cooke and Miles (1980) for aluminum and from Department of Environmental Resources (1986) for other constituents.

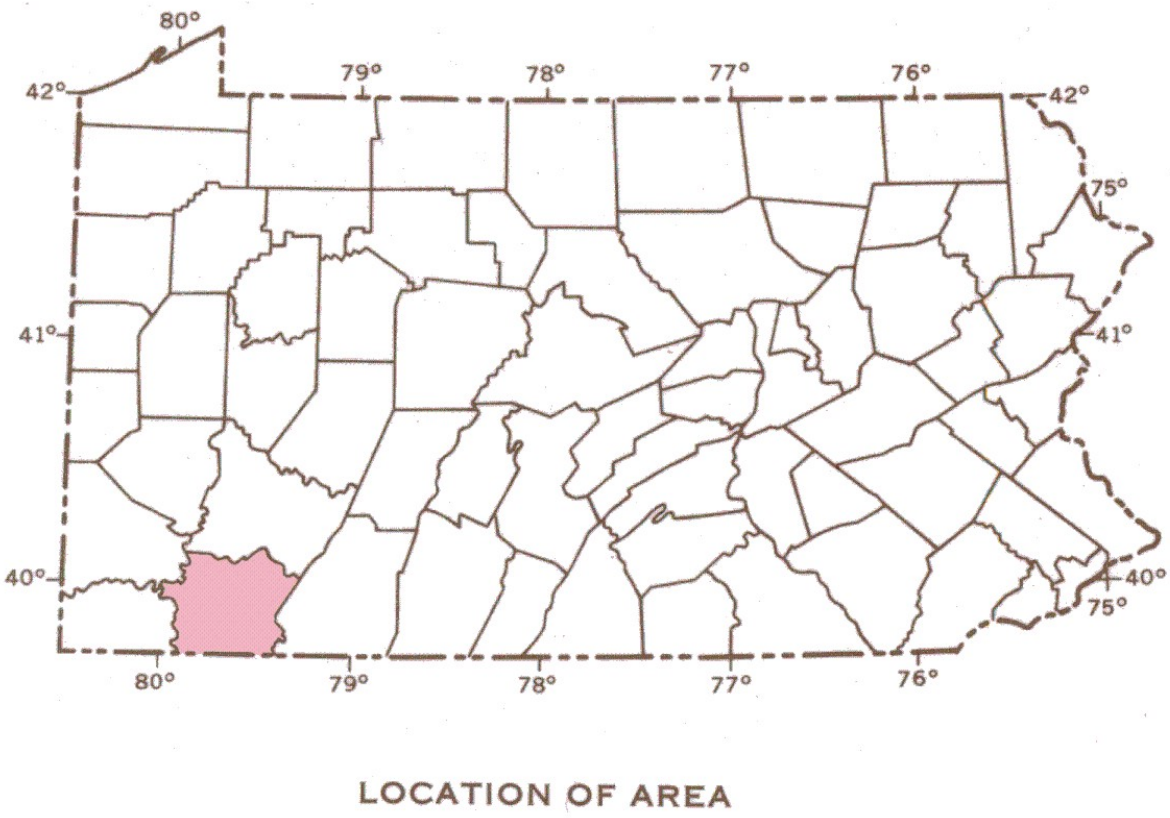
Graphic from source map: PAGS Water Resource Report 60.

Symbols



Graphic from source map: PAGS Water Resource Report 60.

Location of Area



Graphic from source map: PAGS Water Resource Report 60.

PAGS Water Resources Report 63

The formal citation for this source.

> Stoner, J.D., Williams, D.R., Buckwalter, T.F., Felbinger, J.K., and Pattison, K.L., 1987, Water resources and the effects of coal mining, Greene County, Pennsylvania: Pennsylvania Geological Survey, Water Resource Report 63, 2 plates, scale 1:50,000 (*GRI Source Map 4656*)

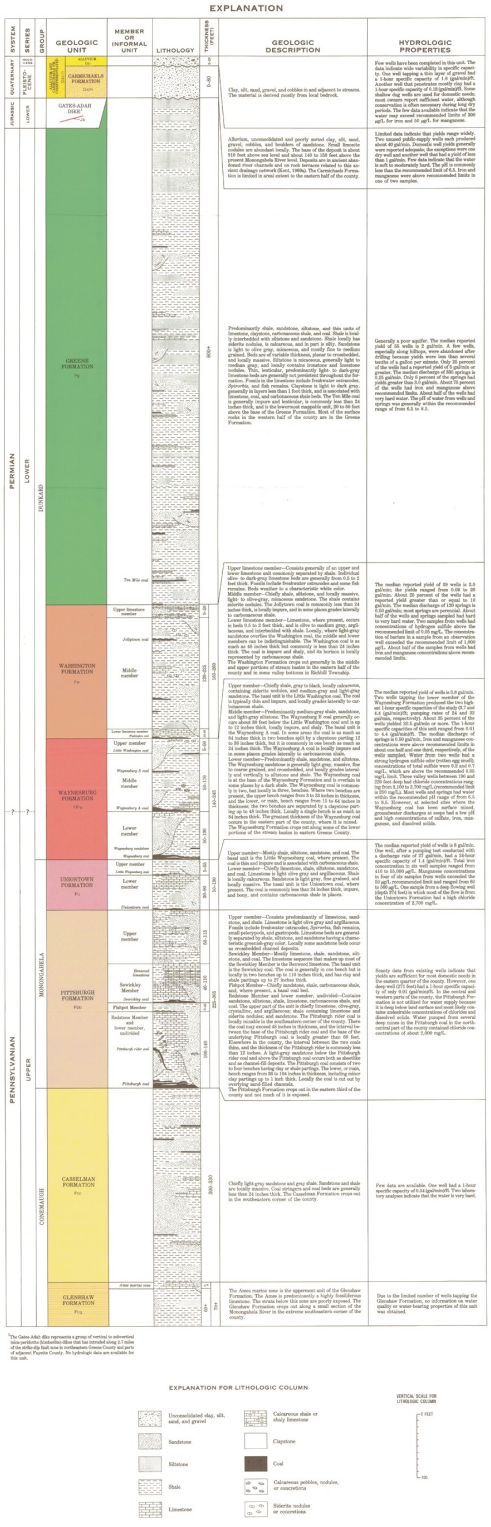
The source map, including both map plates, can be accessed via the U.S. Geological Survey National Geologic Map Database (NGMDB) record: https://ngmdb.usgs.gov/Prodesc/proddesc_32948.htm

The report document and prominent graphics associated with this source are presented on the following pages.

Report Document

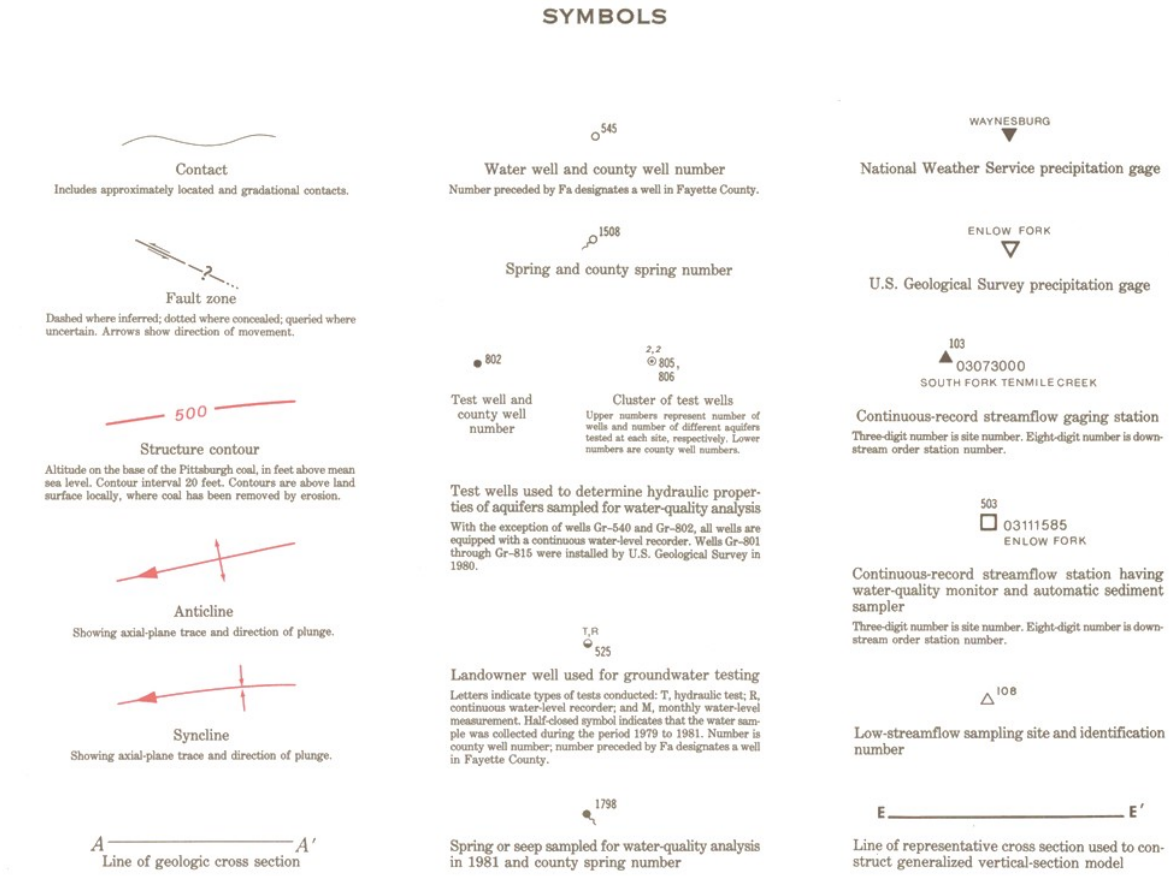
The report document associated with the publication (double-click link to open the embedded document): W_063_text.pdf.

Explanation



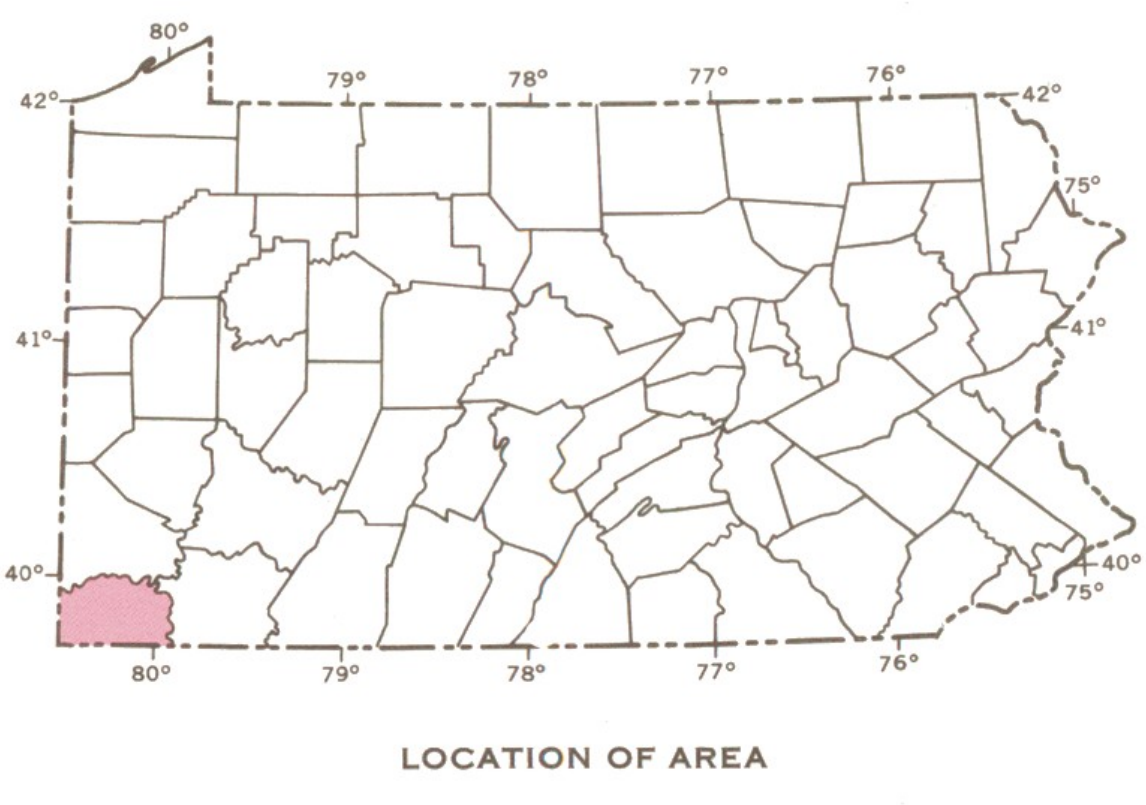
Graphic from source map: [PAGS Water Resource Report 63](#).

Symbols



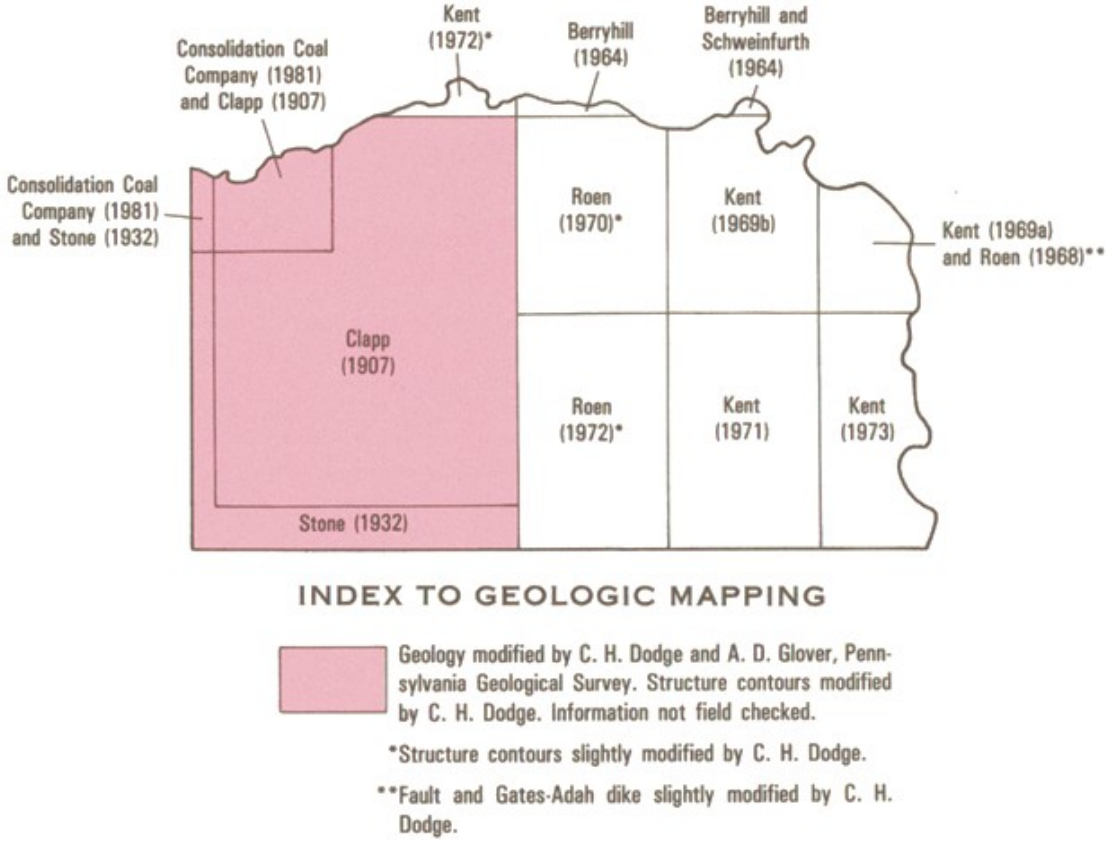
Graphic from source map: PAGS Water Resource Report 63.

Location of Area



Graphic from source map: PAGS Water Resource Report 63.

Index of Geologic Mapping



Graphic from source map: PAGS Water Resource Report 63.

GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Ron Karpilo (Colorado State University)

The information in this document was compiled from GRI source maps, and is intended to accompany the digital geologic-GIS maps and other digital data for Fort Necessity National Battlefield and Friendship Hill National Historical Site, Pennsylvania (FONE-FRHI) developed by Stephanie O'Meara (see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps). The initial GRI digital geologic-GIS data was produced by Heather Stanton and Georgia Hybels (Colorado State University).

GRI finalization by Stephanie O'Meara.

GRI program coordination and scoping provided by Bruce Heise, Jason Kenworthy and Tim Connors (NPS GRD, Lakewood, Colorado).