2.6 GEOLOGY

This section contains a brief description of the geologic conditions that are present at and in the vicinity of the BBNPP site. Groundwater and surface water are discussed in Section 2.3. The BBNPP Final Safety Analysis Report (FSAR) presents detailed geological, seismological and geotechnical site evaluations in FSAR Section 2.5.

2.6.1 GEOLOGIC SETTING

The BBNPP site area lies within the Ridge and Valley Physiographic Province (Inners, 1978) as shown in Figure 2.6-1 (Fenneman, 2002).

The BBNPP site is blanketed by glacio fluvial deposits, and was subjected to both glacial and periglacial events during the Quaternary period. Underneath this glacio fluvial overburden lies middle Devonian bedrock. Erosion and downcutting from the Susquehanna River, and its tributary streams, have dissected the overburden, leaving many isolated outcrops throughout much of the site area. Topographic relief of the Ridge and Valley varies from about 440 to 2,775 ft (134 to 846 m) msl throughout the 50 mi (80 km) region, but the average elevation at the BBNPP site is approximately 660 ft (201 m). The highest land feature within a 5 mi (8 km) radius of the site is Nescopeck Mountain, to the southeast of the site, which reaches an elevation of approximately 2,342 ft (714 m) (DeLorme, 2006). The Susquehanna River elbows around the site area to the east and south and is approximately 7,000 ft (2,134 m) from the site (at the closest point). Its floodplain, on average, is about 0.75 mi (1.2 km) wide, with an average surface elevation of about 513 ft (156 m) msl. The nominal Susquehanna River level is 500 ft (152 m) msl.

The area between the BBNPP site and the Susquehanna River is only slightly dissected by tributaries due to the relatively thin layer of overburden. These tributaries include primarily an unnamed tributary south of the site and Walker Run, which traverses and drains the site, and has a gradient drop of almost 290 ft (88 m) within a distance of approximately 4 mi (6 km).

The BBNPP will be constructed at a grade elevation of approximately 674 ft (205 m) msl. The bearing layer over which the foundation of the plant will be placed is the Mahantango Formation, part of the Hamilton Group. This formation is characterized by dark gray, slightly fossiliferous, hard shale and was found to be at least 400 ft (122 m) thick based upon the BBNPP site geotechnical investigation (FSAR Section 2.5.4). A past report places the total thickness of the Mahantango Formation at approximately 1,500 ft (457 m) (Inners, 1978).

2.6.2 STRATIGRAPHY

The sequence of overburden and lithified formations underlying the site area are shown on the site specific stratigraphic column (Table 2.6-1). This column is based on data obtained from the Susquehanna Steam Electric Station (SSES) Units 1 and 2 FSAR borings (SSES, 1975), the BBNPP FSAR borings in the site area, and on published literature. Sediments and rocks present at the site area range primarily from the Cambrian to Quaternary.

Superjacent the Precambrian metamorphic/igneous basement, the oldest inferred Cambrian formation underlying the site area is the Waynesboro Formation. The Waynesboro Formation consists of sandstone with interbedded red and green shales and has a thickness of approximately 1,000 ft (305 m) or more (Kauffman, 1999). Overlying the Waynesboro Formation is the Pleasant Hill Formation, which is primarily a limestone formation with interbedded sandy and silty layers throughout (Kauffman, 1999). Overlying the Pleasant Hill Formation is the Warrior Formation. Defined by Kauffman (Kauffman, 1999), it is a dark, fossiliferous, fine grained limestone interbedded with silty dolomite with a thickness up to

1,340 ft (408 m). Overlying the Warrior Formation, and marking the Cambrian-Ordovician boundary, is the Gatesburg Formation. The Gatesburg consists of a series of sequential sandstone and dolomite units that are also fossiliferous (Ryder, 1992) with a thickness of approximately 1,211 ft (369 m) (Gold, 2003). Both the Warrior Formation and Gatesburg Formation likely represent a shallow-water carbonate bank or shelf that was subjected to periodic episodes of near-drying conditions (Kauffman, 1999).

Overlying the Gatesburg Formation are formations that comprise the Beekmantown Group. These Early Ordovician formations, from oldest to most recent, include the Stonehenge Formation, Nittany Dolomite, Axemann Limestone, and Bellefonte Dolomite. They are composed primarily of dolomite-limestone (Harper, 2004) and reach a combined thickness of up to 4,200 ft (1,280 m) (Thompson, 1999). The Middle Ordovician age rock of the site area is best described as the Loysburg Formation. The Loysburg Formation is typically a dolomitic and stromatalite rich limestone underlying a coarse grained, fossiliferous limestone (Thompson, 1999) with a thickness of up to 475 ft (145 m). Overlying the Loysburg Formation, and representing the first unit (in ascending order) of the Upper Ordovician, is the Black River Group which mainly consists of Snyder and Linden Hall formations (Thompson, 1999) and attains a thickness of about 632 ft (193 m). These formations are composed primarily of siliciclastic clay and shale and underlay the fine-grained, black, graded limestone-shale of the Solona and Coburn formations of the Trenton Group (Thompson, 1999). Rocks of the Beekmantown Group, Loysburg Formation, Black River Group, Solona Formation, and Coburn Formation were deposited in marine to marginal-marine environments where a platform existed and the seas over top of this platform, shallowed progressively where depositional environments became more intertidal (Thompson, 1999). The upper most units within the Trenton Group is the Antes Formation, a fossiliferous, generally black, shale (Thompson, 1999) that was likely deposited in shallow water, above the wave base. The Antes, Coburn, and Salona formations collectively attain a thickness of up to 850 ft (259 m).

Above the Trenton Group lies the Reedsville Formation. Overlying the Reedsville Formation are the Bald Eagle and Juniata formations (in ascending order). The Reedsville, Bald Eagle, and Juniata formations represent the uppermost units of the Upper Ordovician period. The Reedsville Formation, with a thickness of approximately 600-1800 ft (183-549 m) (Thompson, 1999) (Gold, 2003), is comprised mainly of interbedded shale and sandstone beds with some limestone (Thompson, 1999) and, like the Antes Formation underlying it, was likely deposited in shallow water. The Bald Eagle Formation and the Juniata Formation, which are 700 to 1,313 ft (213 to 400 m) and 600 to 1,125 ft (183 to 343 m) thick respectively (Gold, 2003) (Thompson, 1999), are both represented by nonfossiliferous sandstones, conglomerates, and mudstones but differ in color with the Bald Eagle Formation being gray and the Juniata Formation red (Thompson, 1999). Unlike the Reedsville Formation, the Bald Eagle and Juniata formations are non-fossiliferous and non-marine, leading their depositional environment to likely be that of low sinuosity streams on alluvial fans (Thompson, 1999).

The Tuscarora Formation typically marks the boundary between Upper Ordovician and Silurian formations. The Lower Silurian Tuscarora Formation is quartzose, sublithic, and argillaceous sandstone with few shale beds throughout (Laughrey, 1999). The thickness of the Tuscarora Formation ranges between 400 ft (122 m) and 700 ft (213 m), is extremely resistant to erosional processes, and generally represents a fluvial depositional environment (Laughrey, 1999) (Gold, 2003). Overlying the Tuscarora Formation (in ascending order) are the Rose Hill, Keefer, Mifflintown, Bloomsburg, Wills Creek, Tonoloway, and Keyser formations.

The Rose Hill Formation is olive shale with interbedded layers of hematitic sandstone, purplish shale, and fossiliferous limestone (Laughrey, 1999). Above the Rose Hill Formation lies the

Keefer Formation, a quartzose and hematitic sandstone with some mudstone. The Rose Hill and Keefer formations combine for a thickness that ranges between 670 ft (204 m) and 1,070 ft (326 m) (Gold, 2003). The Mifflintown Formation reaches a thickness of about 336 ft (103 m) (Gold, 2003) and is composed of mudrocks and limestone of a shallow marine setting (Laughrey, 1999). The likely depositional environment for the Rose Hill, Keefer, and Mifflintown formations is that of a submarine ramp that deepened from the proximal basin margin (Laughrey, 1999) during the Taconic Orogeny.

Conformably overlying the Mifflintown Formation is the Bloomsburg Formation, a grayish-red clay-siltstone with some interbedded fine to coarse grained sandstone that attains an average thickness of about 464 ft (142 m). The Bloomsburg Formation is very slightly fossiliferous and probably represents sediments deposited in deltaic waters with a high enough salinity to allow some fauna to exist (Laughrey, 1999). The Wills Creek Formation, conformably overlying the Bloomsburg Formation, is mostly a claystone to silty claystone with some argillaceous limestone and has an approximate thickness of 750 ft (229 m) (Inners, 1978). The Tonoloway Formation is primarily a thinly-bedded limestone with a few thin beds of calcareous shale (Laughrey, 1999) with a thickness of about 100 ft (30 m) (Inners, 1978). Both the Wills Creek and Tonoloway formations represent numerous shallowing-upward cycles that have been interpreted as repeated progradational events on very large tidal flats (Laughrey, 1999).

The Keyser Formation conformably overlies the Tonoloway Formation and is mainly a gray, fossiliferous limestone with some dark gray cherty nodules present toward the upper part of the formation. The Keyser Formation straddles the boundary between the Late Silurian and Early Devonian as the formation represents continuous carbonate sedimentation from both periods and has a thickness of about 125 ft (38 m) (Inners, 1978).

The Devonian system of rocks is described by Harper (Harper, 1999) as a westward-thinning wedge of sediments with a thickness of almost 11,000 ft (3,353 m) through much of Pennsylvania, though considerably less at the BBNPP site (average approximately 2,150 ft (655 m)). The Upper Keyser Formation, about 125 ft (38 m) thick, makes up the basal unit for the Devonian period formations. Overlying the Keyser is the Old Port Formation which consists of (in ascending order) the Corriganville Limestone, the Mandata Shale, Shriver Chert, and Ridgeley Sandstone (Harper, 1999). The Corriganville Limestone, which consists of finely crystalline, thick to thinly bedded limestone, ranges from 10 ft (3 m) to 30 ft (9 m) thick (Harper, 1999). The Mandata Shale is dark gray to black, thinly bedded, siliceous, and ranges in thickness from 20 ft (6 m) to 100 ft (30 m) (Harper, 1999). Light colored cherty, mudstones and calcareous siltstones characterize the Shriver Chert (Harper, 1999), which ranges in thickness from 80 ft (24 m) to 170 ft (52 m). The Ridgeley Sandstone ranges in thickness from 8 ft (2 m) to 150 ft (46 m) and is generally white to light-gray, medium grained, quartzose sandstone (Harper, 1999). These units of the Old Port Formation represent the gradual deepening of the Appalachian basin and range in overall thickness within the site from 100 ft (30 m) to 150 ft (46 m) (Inners, 1978). Disconformably overlying the Old Port Formation is the Onondaga Formation which reaches a thickness of about 175 ft (53 m) (Inners, 1978). The Onondaga Formation consists of silty, shaley, and cherty limestones, in ascending order, and likely represents a shelf margin depositional environment (Harper, 1999).

The middle unit of the Middle Devonian rock system is the Marcellus Formation. The Marcellus Formation, part of the Hamilton Group, consists of approximately 350 ft (107 m) (Inners, 1978) of dark-gray to black shales that are carbonaceous, containing pyrite and few fossils (Harper, 1999). The Marcellus Formation, likely deposited in a variety of shallow-water anoxic environments (Harper, 1999), underlies the Mahantango Formation, which is the uppermost bedrock of the BBNPP site. Harper (Harper, 1999) describes the Mahantango Formation as "a

complex series of interbedded shales, siltstones, and sandstones ranging from 1,200 ft (366 m) to 2,200 ft (671 m)" although Inners (Inners, 1978) reports a site specific thickness of approximately 1,500 ft (457 m). The shales and siltstones encountered during the BBNPP site investigation were typically dark gray, ranged in hardness from soft to moderately hard, increased progressively in the level of calcareous content with depth, and were slightly pyritic and fossiliferous throughout. Harper (Harper, 1999) suggests that the Mahantango Formation was deposited as a prograding marine shoreline during the early stages of the Catskill delta. While the Mahantango Formation is the uppermost bedrock of the site, younger formations that were deposited after the Mahantango exist near the site area. These formations comprise many of the outcrops and bedrocks of Lee Mountain, to the north of the site, and Nescopeck Mountain, to the south of the site. Because these formations are not present at the BBNPP site, they have not been included on Table 2.6-1. However, because these formations are present in the vicinity of the BBNPP site, they are described below.

Conformably overlying the Mahantango Formation, and marking the initial unit of the Upper Devonian within the site area, is the Harrell Formation. The Harrell Formation is typically represented by dark colored, organic-rich shales (Harper, 1999) which reach about 120 ft (37 m) in thickness (Inners, 1978). The Trimmers Rock Formation, referred to as the Brallier Formation by Harper (1999), is primarily medium to dark gray, thinly bedded siltstones with some fine grained sandstones and few layers of subfissle shale (Inners, 1978) (Harper, 1999). The Trimmers Rock Formation has a calculated thickness of approximately 3,000 ft (914 m) (Inners, 1978) and likely represents a delta fed submarine slope of the Appalachian Basin. Above the Trimmers Rock Formation, within the site area, lie the members of the Catskill Formation including (in ascending order) the Irish Valley, Sherman Creek, and Duncannon members. Each member of the Catskill Formation ranges in thickness from 150 ft (46 m) to 3,700 ft (1,128 m) and generally consists of gray to red mudstones, claystones, siltstones, and conglomerates that were deposited in mixed continental, fluvial-deltaic, and marginal-marine environments (Harper, 1999). The uppermost unit of Devonian age rocks in the site area is the Spechty Kopf Formation, which also spans into, and identifies the beginning of the Carboniferous Period. The Spechty Kopf Formation has a thickness of about 575 ft (175 m) (Inners, 1978) and is comprised mainly of medium gray to olive sandstone with other components including siltstone, shale, and conglomerates (Berg, 1999). The likely depositional environment of the Spechty Kopf Formation was that of ephemeral lakes formed on the surface of the Catskill alluvial plain (Berg, 1999).

Carboniferous formations are commonly broken down into the Mississippian Epoch and the Pennsylvanian Epoch. While Mississippian rocks of the site area represent a transition from the prograding deltas of the Late Devonian (Brezinski, 1999), Pennsylvanian rocks primarily represent the sedimentation within an elongate basin aligned in a northeast to southwest direction (Edmunds, 1999).

The Mississippian Period is marked by the presence of the Spechty Kopf Formation. Unconformably overlying the Spechty Kopf Formation is the Pocono Formation, which was likely deposited on a high-gradient alluvial plain or alluvial fan, is represented by the non-red beds of medium to coarse grained sandstone, siltstone, and conglomerates (Brezinski, 1999) with a thickness of about 600 to 650 ft (183 to 198 m) (Inners, 1978). Overlying the Pocono Formation, within the 5 mi (8 km) site area radius, is the Mauch Chunk Formation, easily recognizable by it's red to reddish-brown mudstone and siltstone with reddish-brown and greenish-gray sandstones and conglomerates (Brezinski, 1999). The Mauch Chunk Formation ranges in thickness throughout the site area but has been estimated to be between 3,000 ft (914 m) and 4,000 ft (1,219 m) (Brezinski, 1999). The depositional environment of the Mauch Chunk Formation was likely that of a broad alluvial plain in which sediments came from two

distinct sources. The first source was red clastics, likely derived from the taconic highlands, and the second was the non-red, quartz sand from the erosion of the previously deposited sandstones (Brezinski, 1999).

The Mississippian-Pennsylvanian boundary in the site area is generally the top of the Mauch Chunk Formation and bottom of the Pottsville Formation. The Pennsylvanian Pottsville Formation overlies the Mauch Chunk Formation conformably and ranges in thickness from 100 ft (30 m) to 1,600 ft (488 m) (Edmunds, 1999). The Pottsville Formation consists mainly of a cobble and pebble conglomerate with some sandstones and finer clastics and coal (Edmunds, 1999). The youngest rock formation within a 5 mi (8 km) radius of the site area and overlying the Pottsville Formation is the Llewellyn Formation. The Llewellyn Formation reaches a thickness of approximately 3,500 ft (1,067 m) and generally consists of subgraywacke clastics, ranging from conglomerates to clay shale and containing numerous coal beds (Edmunds, 1999). The Llewellyn Formation forms the uppermost geologic unit within the 5 mile radius of the site, appearing at the peak of Lee Mountain near the town of the Shickshinny.

Quaternary deposits of the site area are primarily the result of glacial deposits from at least three known glacial events that are believed to have impacted the site area. Of these three events, Quaternary deposits from two of them comprise the soil overburdens present within the site area. The earliest deposit is of Late Illinoian age and can be stratigraphically correlated to that of the Titusville Till in Northwestern Pennsylvania. The Titusville Till is described as a thin, gray to brown and grayish-red clay and sand (Sevon, 2000). This was almost entirely eroded away during the next period of glaciation through the site, the Wisconsinan (Crowl, 1999). The resulting glacial deposits from the Wisconsinan event is known as Olean Till, which is described as moderately thick, gray to grayish-red sandy till (Sevon, 2000).

In addition to glacial till, the site area has also been impacted by stratified drift. Stratified drift, as defined by Sevon (2000) is sand and gravel in eskers, kame terraces, and outwash. Stratified drift has been impacting the site area since the Late Illinoian (Sevon, 2000), during glacial melts/retreats, and continues to deposit along the banks of the Susquehanna River from upstream (Inners, 1978).

2.6.3 GEOLOGIC IMPACT EVALUATION

Based on the SSES site and vicinity geologic conditions described in the previous subsection, long-termand short-term adverse impacts on the geology are not anticipated as a result of construction or operation of the BBNPP site.

This conclusion is reached based upon evaluating several considerations including the following

Long-Term Impacts

- The drilling and geophysical investigation show no indication of capable faults (as discussed in FSAR Sections 2.5.1 and 2.5.3) at the BBNPP site, eliminating the possibility for a surface fault rupture as a result of construction or operation of the proposed facility.

- Surface settlement (as a result of facility construction) could affect the drainage of surface water. However, should such settlement occur, it will likely take place during construction and can be mitigated by re-grading the BBNPP site area.

- Although there is a natural slope in proximity to the proposed facility, it is not steep enough to be adversely impacted by: foundation excavation, loading resulting from construction of the proposed structures, or infiltration of precipitation as a result of surface modifications.

- Any potentially negative impacts that could result from the placement of fill in the proposed plant area will be mitigated by the earthwork design.

Short-Term Impacts

- Some short-term geologic impacts could occur during construction. These impacts could be a result of excavation, or temporary dewatering.

- Disposal of excavated material will likely be required onsite. Generally accepted methods will be used to mitigate the potential for erosion of this material at the disposal site. Such methods may include the use of silt fences, seeding, and drainage control. Excavated soil surfaces exposed during construction will be protected to mitigate their erosion and control surface runoff.

- Temporary dewatering of foundation excavations could result in an impact on water levels in the water table aquifer. However, these impacts are not expected to be significant.

2.6.4 REFERENCES

Berg, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 8: Devonian-Mississippian Transition, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 128-137, T.M. Berg, 1999.

Brezinski, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 9: Mississippian, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 138-147, D.K. Brezinski, 1999.

Crangle, 2002. Stratigraphic Framework of Cambrian and Ordovician Rocks in the Central Appalachian Basin from Medina County, Ohio, through Southwestern and South-Central Pennsylvania to Hampshire County, West Virginia, Revised and Digitized from Ryder, Stratigraphic Framework of Cambrian and Ordovician Rocks in the Central Appalachian Basin from Medina County, Ohio, through Southwestern and South-Central Pennsylvania to Hampshire County, West Virginia, R.D. Crangle Jr, 2002.

Crowl, 1999. Quaternary, The Geology of Pennsylvania, Part II: Stratigraphy and Sedimentary Tectonics, Chapter 15, p224-232, G.H. Crowl and W.D. Sevon, 1999.

DeLorme, 2006. Pennsylvania Atlas & Gazette, 9th Edition, Page 52, DeLorme, 2006.

Edmunds, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 10: Pennsylvanian, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 148-169, W.E. Edmunds, V.W. Skema, and N.K. Flint, 1999.

Fenneman, 2002. Physiographic Divisions in the Conterminous U.S., Map, USGS, Washington, DC, Fenneman, N.M., and Johnson, D.W., 2002.

Gold, 2003. Geological Report on the Skytop Road Cuts, Pennsylvania State University, Department of Geosciences, p 1-27, D.P. Gold and A.G. Doden, 2003.

Harper, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 7: Devonian, in C.H. Shultz ed., The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 108-127, J.A. Harper, 1999.

Harper, 2004. Ordovincian Carbonates in Central Pennsylvania, Trenton and Black River Carbonates in the Union Furnace Area of Blair and Huntingdon Counties, Pennsylvania, A Field Trip Guidebook for the Eastern Section AAPG Meeting, J. Harper, September, 2003.

Inners, 1978. Geology and Mineral Resources of the Berwick Quadrangle, Luzerne and Columbia Counties, Pennsylvania, Pennsylvania Geological Survey, Fourth Series, p 1-34, J.D. Inners, 1978.

Kauffman, 1999. Part II Stratigraphy and Sedimentary Tectonics, Chapter 4: Eocambrian, Cambrian, and Transition to Devonian, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 59-73, M.E. Kauffman, 1999.

Laughrey, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 6: Silurian and Transition to Devonian, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of Topographic and Geologic Survey Special Publication 1, p 91-107, C.D. Laughrey, 1999.

McElroy, 2007. Bedrock Geologic Map of the Allensville Quadrangle, Huntingdon, and Mifflin Counties, Pennsylvania, Pennsylvania Geological Survey, T.A. McElroy and D.M. Hoskins, 2007.

Ryder, 1992. Stratigraphic Framework of Cambrian and Ordovician Rocks in the Central Appalachian Basin from Medina County, Ohio, through Southwestern and South-Central Pennsylvania to Hampshire County, West Virginia, US Geological Survey Bulletin 1839, p 1-40, R.T. Ryder, A.G. Harris, and J.E. Repetski, 1992.

Sevon, 2000. Regolith in the Piedmont Upland Section, Piedmont Province, York, Lancaster and Chester Counties, Southeastern Pennsylvania, Southeastern Geology, Volume 39, No. 3 and 4, p 223-241, W. Sevon, October 2000.

SSES, 1975. Geology, Siesmology, and Geotechnical Engineering, SSES-FSAR, Revision 58, Section 2.5, 1975.

Thompson, 1999. Part II, Stratigraphy and Sedimentary Tectonics, Chapter 5: Ordovician, in C.H. Shultz ed, The Geology of Pennsylvania: Pennsylvania Bureau of topographic and Geologic Survey Special Publication 1, p 74-89, A.M. Thompson, 1999.

Table 2.6-1—Site Specific Stratigraphic Column

Era*	Period*	Epoch [1]	Age (Ma) [2]	Unit	Thickness (ft)
Cenozoic	Quaternary	Holocene	0.01	Stratified Drift	38.5
		Pleistocene	1.8		
Paleozoic	Devonian	Middle	370	Mahantango Formation	1,500
				Marcellus Formation	350
				Onondaga Formation	175
		Lower	391	Old Port Formation	100-150
	Silurian	Upper	417	Keyser Formation	125
				Tonoloway Formation	100
				Wills Creek Formation	750
		Lower	423	Bloomsburg Formation	464
				Mifflintown Formation	336
				Keefer Formation	670-1,070
				Rose Hill Formation	
				Tuscarora Formation	400-700
	Ordovician	Upper	443	Juniata Formation	600-1,125
				Bald Eagle Formation	700-1,313
				Reedsville Formation	600-1,800
		Middle	458	Trenton Group	842
				Antes Shale	
				Coburn Limestone	
				Salona Limestone	
				Black River Group	632
				Loysburg Formation	263-475
		Lower	470	Beekmantown Group	3,159-4,200
				Bellefonte Dolomite	
				Axemann Limestone	
				Nittany Dolomite	
				Stonehenge Formation	
	Cambrian	Upper	490	Gatesburg Formation	1,211
		Middle	510	Warrior Formation	400-1,340
				Pleasant Hill Formation	Not Reported
		Lower	520	Waynesboro Formation	1,000+
Neo-Proterozoic	Ediacaran		543	Metamorphic/Igneous	

Notes:
(1) USGS Geologic Time Scale
(2) Ma = Million years ago.

References: (Crangle, 2002) (Gold, 2003) (Inners, 1978) (Kauffman, 1999) (Laughrey, 1999) (McElroy, 2007) (Thompson, 1999)

Figure 2.6-1—Map of Regional Physiographic Provinces