I ANDERSON CREEK WATERSHED
GENERAL INFORMATION

LOCATION AND DESCRIPTION

The Anderson Creek Watershed is located in Central Pennsylvania, in Clearfield County, occupying portions of Bloom, Brady, Pike, Pine and Union Townships. The Watershed lies approximately 5 miles east of the City of DuBois and 7 miles west of Clearfield Borough.

The Anderson Creek Watershed covers an area of approximately 78 square miles. The Boroughs of Curwensville, Grampian and Hepburnia lie in the southern part of the Watershed, and the towns of Chestnut Grove and Rockton lie in the western and northwestern part of the Watershed respectively. The 210 acre DuBois Reservoir is located in the northwestern part of the Watershed on the upper reaches of Anderson Creek, and a portion of the Moshannon State Forest occupies approximately 172 square miles in the northeastern section of the Watershed. Interstate Route 80 crosses the Watershed just north of the reservoir. Approximately 8000 people live in the study area, representing 10.7% of the Clearfield County's population. Of the 8000 people living in the study area 3,189 live in the Borough of Curwensville located at the mouth of Anderson Creek.

GEOGRAPHY

Topography

The project area lies in the Appalachian Plateau Province. The Allegheny Front lies a short distance to the southeast. In general, the land is composed of broad, fairly even, rounded and occasionally flat divides from which the surface descends rapidly to streams having little bottom land, described as narrow V-shaped valleys separated by broad to narrow uplands. The valleys may be as much as 400 feet to 600 feet deep in places. Elevations range from a low of 1140 feet at Curwensville to a high of 2380 feet in the northeastern section of the Watershed. Generally, the valleys in the south lie at elevations between 1100 feet and 1350 feet and the highlands' between 1700 feet and 2000 feet. These elevations increase to the north by several hundred feet.

The principal topographical features of the project area are shown on the Curwensville, Mahaffey, Luthersburg, Elliott Park, and Penfield, 7 1/2 minute U.S.G.S. Topographic Quadrangles.

Drainage

Anderson Creek and its tributaries which include Kratzer Run, Whitney Run, Burns Run, Bear Run, Irvin Branch, Little Anderson Creek, Panther Run, Montgomery Run, Coupler Run, Dressler Run, Blanchard Run, Stony Run and several unnamed tributaries drain approximately 78 square miles. Anderson Creek itself flows a distance of about 20 miles with a vertical drop of 960 feet from a high of 2080 feet at its headwaters to an elevation of 1120 feet at its mouth near Curwensville where it flows into the West Branch of the Susquehanna River. The two major tributaries of Anderson Creek are Kratzer Run and Little Anderson Creek.

Kratzer Run flows about 5.7 miles and shows a vertical drop of 420 feet from a high of 1600 feet at Hepburnia to a low of 1180 feet at its confluence with Anderson Creek. Kratzer Run enters Anderson Creek about 2 miles upstream from the West Branch of the Susquehanna River. The major tributaries of Kratzer Run are Hughey Run, Bilger Run, and Fenton Run.

Little Anderson Creek flows 9.7 miles and has a vertical drop of 460 feet, from a high of 1960 feet at its headwaters to a low of 1500 feet at its confluence with Anderson Creek. Little Anderson Creek enters Anderson Creek about 91 miles upstream from the West Branch of the Susquehanna River. The tributaries of Little Anderson Cr eek include Rock Run, and 7 small, unnamed tributaries. The valley system ranges from nearly non-existent to about 1400 feet in width.

It is important to note that at the time of the Second Pennsylvania Geologic Survey the stream now known as Kratzer Run was commonly referred to as Little Anderson Creek. One must be careful not to confuse this stream with the stream presently called Little Anderson Creek which lies further to the north.

GEOLOGY

Geologic History

From early Cambrian time (approximately 550 million years ago) to near the end of Permian time (approximately 200 million years ago), the area, now Pennsylvania, was a shallow sea. This sea received terrestrial sediments from a large land area located to the southeast. As the sea filled with these sediments, the underlying land subsided causing the land mass to the east to rise. Consequently, these new highlands were weathered and eroded. By the end of Carboniferous time, 30,000 feet of sediments had accumulated east of the Allegheny Mountains; however, the sediments were somewhat thinner to the west. Limestones and shales indicate deeper marine environments and, hence, lowlands to the east. Orogenic forces, near the end of Carboniferous time, pushed the accumulated sediments westward, crushing and stretching those to the east. Sediments in the central area were extensively folded and faulted, although not deformed as severely as those to the east. The rocks west of the Allegheny Front were only mildly folded as they escaped the immediate effects of this mountain building process.

Occurring with and immediately following this folding, erosion cut down the folds and ultimately wore them down to a plane or peneplane, just above sea level. The final peneplane, however, from which the present topography was carved following uplift, dates only from late Tertiary or about 10 million years ago. It should be noted that prior to glaciation all of the westward drainage flowed northwest to a master stream in what is now the Lake Erie basin. When the glacial ice closed these outlets the drainage was directed to the southwest around the ice front, resulting in the present Ohio and Allegheny Rivers. The original drainage probably flowed toward the southwest corner of the State, following the bottom of the lower folds around the periphery of the anticlines. Later, swift southeast-flowing streams penetrated the mountains and captured the drainage from this area and diverted it to the southeast. This type of stream capture and diversion is still actively going on in the area. At the time of the formation of the Schooley (final) peneplane the drainage was relatively well established as far west as the Anderson Creek Watershed. Sometime during middle or late Miocene time this peneplane began to rise and be eroded. Uplift in this area probably continued until late Pliocene time.

Following the uplift, downcutting etched out the new topography by a number of varied geologic activities. In some instances a stream was greatly hindered in its downcutting when a hard, massive, resistant sandstone was encountered. When this occurred the softer rocks within the drainage area above were slowly reduced to a nearly level plane on which the stream eventually acquired a meandering course. It is possible that such delayed downcutting has created the general uniformity of the hilltops in the Watershed as well as the meanderings of the West Branch of the Susquehanna River to the south. Other areas exhibit relatively level and even hilltops for another reason; the uniform mineralogical character and the homogeneous structure has resulted in a consistent erosion process. Erosion has lowered this surface uniformly so that at any time it represents the level character of the peneplane from which it was formed. In many cases erosion cut the surface of the peneplane down until hard sandstones were encountered, so that today a hilltop may represent a stripped bed of sandstone. The height and dimension of the hill will depend upon the structure and attitude of the sandstone.

Present drainage lines were developed in the final stage of down-cutting. This was accomplished primarily by the advance and capture of the westward-flowing streams by the eastward-flowing streams which, because of their shorter distance to the sea, have steeper gradients. With steeper gradients these streams also have, of course, a greater cutting power. The headwaters of Anderson Creek were diverted to the West Branch of the Susquehanna River so recently that the gaps in the mountains through which they ran west are still plainly visible.

Structural Features

The surface formations in the area which includes the Anderson Creek Watershed are entirely of sedimentary origin. These rocks are primarily of the Allegheny and Pottsville Formations of Middle Pennsylvanian age. Some higher locations in the southern part of the Watershed, particularly around Grampian, have exposures of the Conemaugh Formation, which immediately overlies the Allegheny Formation and is also of Pennsylvanian age. The rocks of the Mauch Chunk and Pocono Formations of Mississippian age are present along Anderson Creek. The Mauch Chunk Formation is present along Bear Run as well, and it is also present to a lesser extent along several of the major tributaries of Anderson Creek. In some locations, but to a very limited extent, rocks of the upper Devonian, particularly those of the Oswayo Formation, are found. This is the case along Anderson Creek at some locations particularly south of its confluence with Little Anderson Creek.

A pronounced structural feature in this area is the Chestnut Ridge Anticline. This Anticline was known as the Driftwood Anticline in many of the works of the earlier Pennsylvania Geological Surveys but was later associated with the Chestnut Ridge. Anticline of southwestern Pennsylvania and became known as such. The Anticline trends southwest-northeast across Clearfield and Elk Counties. The Anticline enters the Watershed about three miles southwest of Chestnut Grove and proceeds across the Watershed in a northeasterly direction. It plunges at both ends with a dome centered 2 to 3 miles northwest of the Watershed. The dome is approximately 18 miles long with an average width of 3 miles. This surface structural closure is determined by the lowest closing contour of 2100. The configuration of the contour closure suggests that there may be a saddle present just west of the Pine Township line. If so, then there would be "twin highs" on the dome. Dips are relatively steep on the south flank of the Anticline and more gentle to the north. Dips on the southern flank reach 350 feet to 400 feet to the mile. Topographically this Anticline produces the highest ground in the Watershed, in some places over 2300 feet. This anticline exposes the pre-Pennsylvanian, uppermost Devonian strata where cut by streams. See PLATE 4 for these structural features.

In the area west of the Allegheny Front the folding is quite gentle in contrast to the close folding and faulting to be found in the Appalachian Valley and eastward. In those portions of the project area divorced from the Chestnut Ridge Anticline, particularly to the south and northwest, the strata lie nearly flat or are only slightly folded. Faults are of no major consequence in this area and are present only of a slight magnitude locally. For geologic cross sections showing regional structure see Exhibit No. 1.

Geologic Column

The surface formations in the project area are sedimentary strata, primarily of Pennsylvanian age of the Allegheny and Pottsville Formations. Very limited exposures of Conemaugh Formation rocks are evident; and some Mississippian and Devonian age rocks also occur. Coals and clays in the Watershed usually occur in beds less than five feet thick. The sandstones and shales in the Watershed are quite variable with some beds reaching 50 feet to 75 feet thick. The sandstones and shales frequently grade into each other vertically and horizontally with no distinct delineation between beds. The sandstones are often massive and are very abundant. Limestone beds in the Watershed are limited and those beds encountered are usually thin and impure. The underclays are perhaps the most persistent beds in the Watershed, even more so than the coals. The clays range from 1 foot to 18 feet thick with an average thickness of from 2 feet to 4 feet.

Only the lowermost members of the Conemaugh Formation are present in the project area. The lower beds of the Mahoning member are present primarily on hilltops in the synclines. The Conemaugh Group extends from the top of the Upper Freeport coal to the floor of the Pittsburgh coal underclay. Below the Conemaugh Group end covering the greater pert of the Watershed is the Allegheny Formation. This formation has a vertical thickness of approximately 300 feet. One must remember that the thickness of most of the strata in this area is very variable and lateral extent of the beds are at best inconsistent, so that in talking about a geologic column for an, area such as this one only a generalized and theoretical column can be considered, as the column would probably not be the same at any two locations in the area.

The uppermost bed of the Allegheny Formation is the Upper Freeport coal which is among the most persistent and workable beds in the area. It is usually present as a single bed occasionally reaching a thickness of 6 feet but usually is less then 4 feet thick. The Upper Freeport coal is overlain by fine grained shales of an olive or yellowish-green cast which grade into a flinty shale. Limestone is found underlying this seem more so then any other. The Upper Freeport clay almost invariably underlies the coal. With an average thickness of 2 feet to 4 feet it is the thickest regular clay in the group. Underneath is the Upper Freeport limestone which is present only locally. This limestone, when present, ranges from less then a foot to 5 feet in thickness. Often occurring with, and underlying this limestone is the Boliver fire clay. This clay is second only to the Mercer clay of the Pottsville Formation in economic significance in this area. Underlying the Bolivar fire clay is a dark gray to purple shale often containing layers of sandstone. The shale ranges from 20 feet to 60 feet thick and overlies the Lower Freeport coal. The Lower Freeport seam generally produces a coal of high quality and may appear as one bed or as two separate seams ranging from 1 1/2 feet to 6 feet thick. The Lower Freeport clay and limestone are often absent. The Freeport sandstone separates the Lower Freeport coal from the Kittanning coals and is generally around 40 feet thick. The Upper Kittanning seam is usually quite thin compared to the other coals of the area, often less than a foot thick. The Upper Kittanning coal is underlain by approximately 50 feet of shales and some local sandstones. The Middle Kittanning coal seam is also thin and is often absent. Drab shales with rider coal and local sandstones underlie this seam. The Lower Kittanning coal is perhaps the most valuable seam in the area. The Lower Kittanning coal is very persistent and ranges from 2 feet to 4 1/2 feet in thickness with an average thickness of 2 feet to 2 1/2 feet. It is underlain everywhere by clay 2 feet to 20 feet in thickness and averaging 6 feet to 8 feet thick. The VanPort limestone, which is usually a key bed, is almost entirely absent in this area. Below the VanPort limestone lies the Clarion coal seam, another thin seam mined locally. The Clarion coal overlies the Clarion sandstone, which is very massive, and the Clarion flint clay. At the base of the Allegheny Formation is the Brookville coal and its clay underlier. The Brookville coal ranges from thin to 4 feet thick.

The Pottsville Formation is from 150 feet to 200 feet thick in this area. Its uppermost member is the Homewood sandstone. The Homewood sandstone is the most massive member of the group being coarse grained and often conglomeratic. The Homewood sandstone is generally light brown and often streaked with iron oxide. It may contain quartz pebbles an inch in diameter. The sandstone ranges from 20 feet to 80 feet thick and is economically important having been quarried extensively near Curwensville. Underlying the Homewood sandstone is a thin layer of shale and the Mercer coal. The Mercer coal seam is usually less than 2 feet thick and overlies the Mercer clay. The Mercer clay is the most economically significant clay in the area. It is usually 8 feet to 10 feet thick and may reach a thickness of 18 feet. The bottom member of the Pottsville Formation, locally, is the Connoquenessing sandstone. It is fine grained and quite shaly in places, often nearly entirely replaced by sandy shale.

The Mauch Chunk and Pocono Formations of Mississippian age appear in some of the deeper stream valleys. In some deep stream valleys crossing the Chestnut Ridge Anticline rocks of the Upper Devonian Oswayo or Catskill Formations may outcrop. A generalized geologic column of the rocks of the Watershed is shown on Exhibit No. 2.

Coal Seams

Practically all of the coal mined in the project area is that of the Allegheny Group, originally known as the Lower Productive Coal

Measures. The only possible exception might be the Mercer coal seam which may be mined locally on a very limited scope. In general this group increases in thickness from west to east and the number of coal beds increases in the same direction. Fixed carbon increases from we st to east also. There may be as many as fifteen or more coal beds in this area, four of which are quite widely workable and many more mined locally. These beds are on the average a little thinner in the project area than elsewhere in the county. Workable beds range from slightly less than 2 feet in thickness to about 52 feet thick. The coal beds in this area are generally quite shallow, none being over 1000 feet deep and as a rule most are considerably less than 400 feet deep. Over part of the area, particularly in the lower lying portions along the Chestnut Ridge Anticline, some or all of the Allegheny coals have been removed by erosion. The beds are underlain practically everywhere by clay. The principal coals of the Anderson Creek Watershed area are as follows:

Upper Freeport - Also known as E or cap seam. The Upper Freeport coal is one of the most valuable and persistent beds of the group. In this area it may reach a thickness of 6 feet but is most commonly less than 4 feet thick. The Upper Freeport coa l is usually found as a single bed. The Upper Freeport in this area is overlain by olive or yellow green, fine grained shales that may grade into a flinty shale. Limestone frequently underlies the underclay of the Upper Freeport and often a layer of flint clay is present.

Lower Freeport - Also known as D or Moshannon seam. The Lower Freeport generally lies 20 feet to 60 feet below the Upper Freeport coal the average being about 40 feet. The Lower Freeport is a very variable bed and in some parts of the county, particularly to the southeast of the watershed, it splits into two seams which are separated by as much as 55 feet. The Lower Freeport coal seam is generally of high quality averaging about 2 feet to 2 1/2 feet thick but reaching a thickness of 5 feet near Grampian.

Upper Kittanning - Also known as C'. The Upper Kittanning coal is of only minor importance. It is usually quite thin compared to other coals and commonly averages around a foot thick. Most of the cannel coal in the State appears to occur at this horizon.

Middle Kittanning - Also known as C. Several coals occur between the Upper and Lower Kittanning seams. In the Watershed there are at least three horizons in this interval and perhaps as many as five in some parts of the County. It has been suggested that the variable vertical position of coals in this space may be due to the occurrence of non-persistent coals at several distinct horizons. The seams in the Watershed are generally a foot or less thick. As a rule these coals are of little value commercially but in some locations it is thick enough to attract commercial exploitation.

Lower Kittanning - Also known as B seam. The Lower Kittanning is probably the most important coal in Clearfield County and is the most persistent coal of the Allegheny Group. It is not a very thick bed but is generally a bed of fine quality. It ranges from 1 foot 8 inches to about 5 feet in thickness and averages about 2 feet to 2 1/2 feet thick. It is underlain everywhere by clay ranging in thickness from 2 feet to 20 feet but generally being 6 feet to 8 feet thick.

Clarion - Also known as A'. The Clarion coals are commonly quite thin and of little commercial value, but like the other minor coals of the Allegheny group they thicken locally so as to be of value. Generally in this area they are a foot or less in thickness.

Brookville - Also known as A. This is the bottom coal of the Allegheny Group. This is generally not of too much importance in Pennsylvania. In the project area it is approximately a foot thick and has a tendency to carry a high percentage of ash.

Mercer - This is the uppermost coal of the Pottsville Series but is not of much consequence economically in the project area. It is usually about a foot thick. At some places there are as many as four or five seams at this horizon. Generally of more interest than the coal is the Mercer clay which underlies it. This clay has been both deep mined and strip mined quite extensively throughout the Watershed with many of the inactive clay operations being among the chief acid producers.

MINING HISTORY

The Anderson Creek Watershed was first settled in 1785, when the first white settler arrived in Brady Township. Around 1800 the first person settled at the site of Curwensville where a blacksmith shop and store were opened in 1805. A few miles west of Curwensville a group of Quakers settled the small village of Pennville, now Grampian. The first record of any commercial mining was in 1804 when a barge load of coal was mined from the river bed east of Curwensville and floated down the Susquehanna River to Columbia.

The principal occupation in the area first settled was lumbering throughout the first half of the 1800's. Around 1840 farming began to gain a foothold. During much of the 19th and 20th centuries the locally massive Homewood sandstone was quarried for building stone, particularly north of Curwensviile along Anderson Creek. Mining didn't develop rapidly until the arrival of the railroad. Prior to the arrival of the railroad all the coal mining activity was concentrated around Curwensville since coal had to be shipped by barge down the Susquehanna River. In the late 1860's the Tyrone and Clearfield Railroad was extended to Curwensville. About 1883 the railroad at Curwensville was extended to Grampian. Mines were soon opened and Grampian became an important mining center. During the early part of the 20th century the following mines were operating around Grampian: The Belfast Mine of Atherton and Barnes, the Penn Nos. 2 and 3 of Burns, Bigler and Wright (B.D.A. Clearfield and Grampian Coal Co.), and the Priscilla #2 and #3 of the Priscilla Coal Mining Company.

In later years a few dozen more mines were operated in the area including innumerable small drifts which were usually one or two man operations. At the present time there are no active deep mining operations in the Anderson Creek Watershed; however, there are presently five active goal strip mining operations. Companies presently active include Hepburnia Coal Company, Benjamin Coal Company, and Thomas Bros. Coal Co. (see Exhibit No. 3). In recent years strip mining has been widespread in that portion of the project area south of the DuBois Reservoir. In fact, about 20% of this area has been disturbed by stripping operations
at one time or another. (See PLATE 3.) Strip mining in Clearfield County has produced 118,117,677 tons of coal from 1943 to 1970, by far the highest figure in the State. This compares with 52,786,897 tons of coal deep mined in Clearfield County over the same period. Estimates indicate a total in-ground reserve of 3,307,013,757 tons for Clearfield County. Despite increasing production figures the percentage of workers employed in mining has dropped, largely as a result of increased mechanization and technology in mining methods. In 1954, 26% of the industrially employed persons of the county were involved in mining; a 44% drop from 1951. In 1970 only 7% of the total employed population of the County were involved with mining. (1)

Clay has played a significant role in the mining and economy of the area. All of the many coal seams present have underclays. Throughout central Clearfield County, these underclays are extensively used in the manufacture of building brick, tile, and other clay products. They are also mixed

1 Deasey. "Atlas of Coal and Coal Mining"

with flint clay in the production of refractory wares. The underclays differ chemically from other clays and shales, having smaller amounts of fluxing elements (oxides of iron, lime, magnesia, soda, and potash). The absence of these elements gives the underclay a much higher melting temperature. The small percentage of fluxing elements present in the underclays has been attributed to their association to the plant life which formed the overlying coal seam. The fluxes have alledgedly been removed by the plant roots for use by the plant. The Lower Kittanning underclay is probably the most important underclay in this area. It is the thickest clay, being generally 5 to 8 feet in thickness. The Upper Freeport underclay is also important and usually ranges from 3 to 9 feet thick. Underclays of the A and B seams have also been mined in the southern portion of the Watershed.

Flint clay or fire clay by comparison contains almost no fluxing elements and therefore has a high refractory value. These clays are chiefly associated with and are very possibly a modification of the underclays. A fire clay is defined as "a clay comparatively free from iron and alkalies, not easily fusible and therefore suitable for use in making fire brick, blocks, pots, etc." (2) Flint clay is of two types: block clay and nodular clay. Block clay resembles limestone in appearance having a sharp, flint-like fracture and breaking with smooth conchoidal surfaces. It is hard enough to ring under a hammer and does not weather to a plastic mud as do most clays. Nodular clay, on the other hand, has

2. Shaw, J. B. "Fire Clays of Pennsylvania" Pennsylvania Geological Survey 4th Series M-10.

low rounded protuberances and breaks unevenly; however, there is no general qualitative difference between the two types.

Flint clay, if ground and molded by itself, will not bond into brick but must be mixed with a certain proportion of plastic clay. The Mercer flint clay is by far the most important in the Watershed. It has been extensively mined by deep and strip methods. It has been deep mined around Stronach and along both sides of Anderson Creek as well as other places in the Watershed. The clay in this area generally ranges from 5 to 18 feet thick. In general it is immediately overlain by a few feet of shale or poor quality clay followed by a coal seam from 6 inches to 18 inches thick. The major miners of the Mercer clay have been Harbison Walker Refractories Company and North American Refractories Company (and its predecessors). Harbison Walker operated the Way Mine above Curwensville; the Pearce, Korb, and Spencer Mines in the vicinity of Chestnut Grove and the Widemire and Irvin Mines near Stronach. North American operated the Rankin Mine along Route 322 above Grampian; the Draucker #1 and #2 Mines and the Wingert and Pentz Mines above Chestnut Grove. There have been numerous smaller deep mines in the area as well as a considerable amount of clay strip mining. At this time there are no deep clay mines in operation in the study area. There are active clay stripping operations with underclays being stripped by Union Clay Co. north of Bridgeport and by Clearfield Clay Co. southeast of Luthersburg. The Mercer Clay is being stripped around the location of the old Korb Mine by Harbison Walker Refractories Company and J. H. France Refractories Company and on the Wise Tract near Greenville and the Deemer Tract west of Greenwood Road to the east of Anderson Creek by North American Refractories Company. (See Exhibit No. 3).

Several areas in the Watershed have experienced a considerable amount of surface subsidence as a result of deep mine operations. Nearly all of the deep mine operations in the study area involved the Mercer clay which is usually much thicker than the average coal seam. At some locations in the county the Mercer clay may be 15 feet thick and some of the deep mines in this area commonly contained 8 feet or more of good clay. The mining of such a thick seam produced larger than average voids, hence resulting in more severe subsidence than is usually the case.

Deep mine subsidence presents two major problems in the abatement of acid mine drainage. The subsidence areas serve as small surface reservoirs which collect surface water and channel it down into the deep mine through acid producing materials forming acid mine drainage. Secondly, deep mine subsidence inhibits the air sealing of deep mines to prevent acid mine drainage.

The major subsidence areas include the areas underlain by the Draucker #1 Mine and the Spencer Mine. Also suffering from surface subsidence but to a lesser extent are the areas of the Widemire Mine, Draucker #2 Mine, Irvin Mine and numerous smaller drifts. In these cases the subsidence is primarily limited to caving for a short distance in from the mine entry. Many of the smaller drifts were dug with very shallow cover and as a result much or all of these smaller drifts have collapsed.