INTRODUCTION

The publication of this booklet is a direct result of a community-based effort to properly manage the natural and cultural resources of the Lititz Run Watershed. There is broad-based community interest in the watershed, with support from many sectors of the community, including local businesses, the Warwick School District, Donegal Chapter of Trout Unlimited, Lancaster County Planning and GIS Departments, Lititz Borough, Warwick Township and many concerned citizens. This community interest and support led to the formation of the Lititz Run Watershed Alliance (LRWA) in 1997. The LRWA meets monthly and encourages all citizens with an interest in the Lititz Run Watershed to get involved. There are many projects currently underway within the watershed and the time to get involved is now. To get more information on the Lititz Run Watershed Alliance, please call 717 626-8900. The active input of all interested individuals is important to bring about positive changes to ensure the livability and sustainability of our watershed.

What is a Watershed?

A watershed is an area of land draining into a river, river system or other body of water. A watershed is thus a catchment basin that is bound by topographic features such as ridge tops. Starting with small headwater streams, the size of these watersheds are quite small. As tributaries join to form streams and streams join to form rivers, the size of the watershed continues to increase. For example, the Lititz Run is fed by the Santo Domingo, Huber Run and several unnamed tributaries. The Lititz Run is a tributary to the Conestoga River, which is itself a tributary to the Susquehanna River. The Susquehanna River is a major watershed draining into the Chesapeake Bay. These watershed systems are interconnected so that the water quality of the Lititz Run has an effect on the health of the Chesapeake Bay. As members of the Lititz Run Watershed community it is important to understand how the activities of our daily lives affect the watershed and water quality in both positive and negative ways.

Why Watershed Planning?

A comprehensive approach to water resource management is needed to address the wide range of water quality problems that exist today from nonpoint and point sources as well as from habitat degradation. Watershed based planning and resource management is a strategy for more effective protection and restoration of aquatic ecosystems and for protection of human health. To properly manage natural resources, and assess the results of management and land planning decisions, the watershed is the ideal scale at which to work.

Watershed based planning emphasizes all aspects of water quality, including chemical water quality (e.g.., toxins, and conventional pollutants), physical water quality (e.g., temperature, flow, and circulation), habitat quality (e.g., stream channel morphology, substrate composition, and riparian zone characteristics), and biological health and biodiversity (e.g., species abundance, diversity and range) (METRO 1994).

A watershed should be managed as a single unit. Each small piece of the landscape has an important role in the overall health of the watershed. Paying attention primarily to the riparian zone will not make up for lack of attention to the watershed's uplands. It is seamless management of the entire watershed, and an understanding of the hydrologic process, that ensures watershed health (METRO 1994).

Watershed based planning can provide benefits to individual citizens, the public sector, and the private sector. Individual citizens benefit when watershed protection improves the environment and the livability of an area. The public sector benefits because agencies can accomplish more through cooperation with other stakeholders than they can working solo with limited resources. Local grassroots participation at the local watershed level ensures that those who are most familiar with a watershed, its problems and possible solutions, play a major role in watershed stewardship. The private sector can benefit because the burden of water resource protection is distributed more equitably among pollution sources (METRO 1994).

The Lititz Run Watershed is rich in scenic, natural and historical resources that have made the area a popular place to live and visit. These attributes, in combination with the area's proximity to major metropolitan centers, have made this region one of the fastest growing in Pennsylvania. At the same time the scenic and natural features that make this area so inviting are being lost because of ever increasing development pressure.

If we are to maintain or improve the quality of life in our watershed there needs to develop a proper balance between development and the preservation and conservation of our natural resource. If growth is going to continue, like it is expected to, wise planning is required (The Nature Conservancy 1990).

About this Booklet

The purpose of this booklet is to assist the local community, business owners, teachers, planners and elected officials in developing an understanding of the Lititz Run and an ability to view the watershed as a whole, instead of as a series of independent political jurisdictions. This is the first step in the creation of a vision for the watershed's future. The Lititz Run Watershed presents an opportunity to plan for the future in ways that retain the rural character of the area while improving the health of the environment and the community.

This booklet has three components: watershed inventory, watershed analysis and watershed plan. The watershed inventory compiles information on the current status of the cultural and natural resources of the Lititz Run Watershed. The watershed analysis section uses the inventory information to identify problem areas, restoration and conservation opportunities and areas best suited for development. Finally, the watershed plan asks us to look into the future to envision what we want our community and watershed to look like for our children and our children's children.

I. WATERSHED INVENTORY

OVERVIEW OF THE LITITZ RUN WATERSHED

The Lititz Run drains over 11,000 acres of farmland, forest and suburban / urban land and is fed by several unnamed tributaries, the Santo Domingo and Hubers Run. The problems associated with the watershed are from both non-point sources linked to agriculture and suburban/urban areas, and point source pollution such as stormwater discharge and effluent from the wastewater treatment facility.

Physical Features

The source of Lititz Run is a stone headwall located downtown in Lititz Spring Park. Tributaries to Lititz Run have their sources scattered throughout the agricultural uplands of the watershed. The Santo Domingo drains a large agricultural area to the west of Lititz Borough, while Hubers Run drains an agricultural / suburban area to the north of town.

Political Features

Political boundaries often have little relation to natural, topographic boundaries. The Lititz Run Watershed stretches beyond political boundaries. The watershed is located in Lititz Borough and Warwick, Ephrata, Penn and Elizabeth Townships, with a majority of the watershed located within Warwick Township. This patchwork of political boundaries has the legal responsibility for managing the watershed's resources. As a result, until now, there has been no comprehensive management plan for the Lititz Run Watershed.

Base Map

The base map lies behind all of the other data maps. It shows the Lititz Run Watershed boundary with the stream system, roads, and political boundaries.

LANDSCAPE ECOLOGY

There are three major components in understanding ecological systems: structures, functions, and the interactions among them. The structures are the physical elements that make up any system and are things you can touch, see and feel. These structural elements can be either living or non-living, mobile or fixed. Functions are the activities, roles or processes performed by the structures.

Landscapes are commonly described as having three kinds of structures which are referred to collectively as 'landscape elements.' These landscape elements are: matrix, corridors and patches. The matrix is defined as the most connected portion of the landscape. Patches are areas on the landscape that are relatively homogeneous internally, and that differ from what surrounds them (the matrix or other patches). Corridors are landscape elements that connect similar patches through a dissimilar matrix or aggregation of patches. Patches connected by corridors are often called nodes. Corridor effectiveness in providing connectivity often depends on how wide it is, and how frequently breaks, or discontinuities, are encountered. The pattern of the matrix, patches and corridors in the landscape is of primary interest, since it is really the spatial arrangements of these elements that determines the function of a landscape as an ecological system.

Ecosystem resilience is an important concept in land planning and natural resource management. It can be defined as the ability of an ecological system to maintain its functions (capture + production + cycling + storage + output) in the face of change or disturbance. Since ecosystem functions are dependent on the structures that perform them, it follows that changes which eliminate certain structural features can cause loss of function in the system. Proper natural resource management attempts to sustain ecological resilience by identifying and protecting individual types of structural, functional and interactive relationships, with the objective of maintaining the overall function of the whole (Diaz and Apostol 1992).

If the premise that ecosystem resilience derives in part from diversity is accepted, the next task is to characterize elements of a diverse landscape. Diversity has been characterized as having three components: compositional, structural and process. Compositional diversity at the landscape level refers to the variation in types of landscape elements or vegetation types, their relative proportions within the landscape, their degree of rarity or commonness. Structural diversity describes the variation in sizes and shapes of landscape elements, as well as diversity of pattern (heterogeneity) (Noss 1990). Finally, process diversity relates to the variety of landscape flows, functions and processes present. All three types are thought to be important in sustaining resilient landscapes (Diaz and Apostol 1992).

What constitutes a diverse, resilient landscape? That is a difficult question to answer because it varies so much from one landscape to another. But there are some generalizations that can be made about diversity objectives. First, a landscape should have nodes or patches of natural areas that are connected by corridors or through the matrix. Secondly, there needs to be protection given to rare, unique or diversity-enhancing landscape elements (rare plant or animal habitats, wetlands, woodlands, etc.).

Landscape Ecology Applied to the Lititz Run Watershed

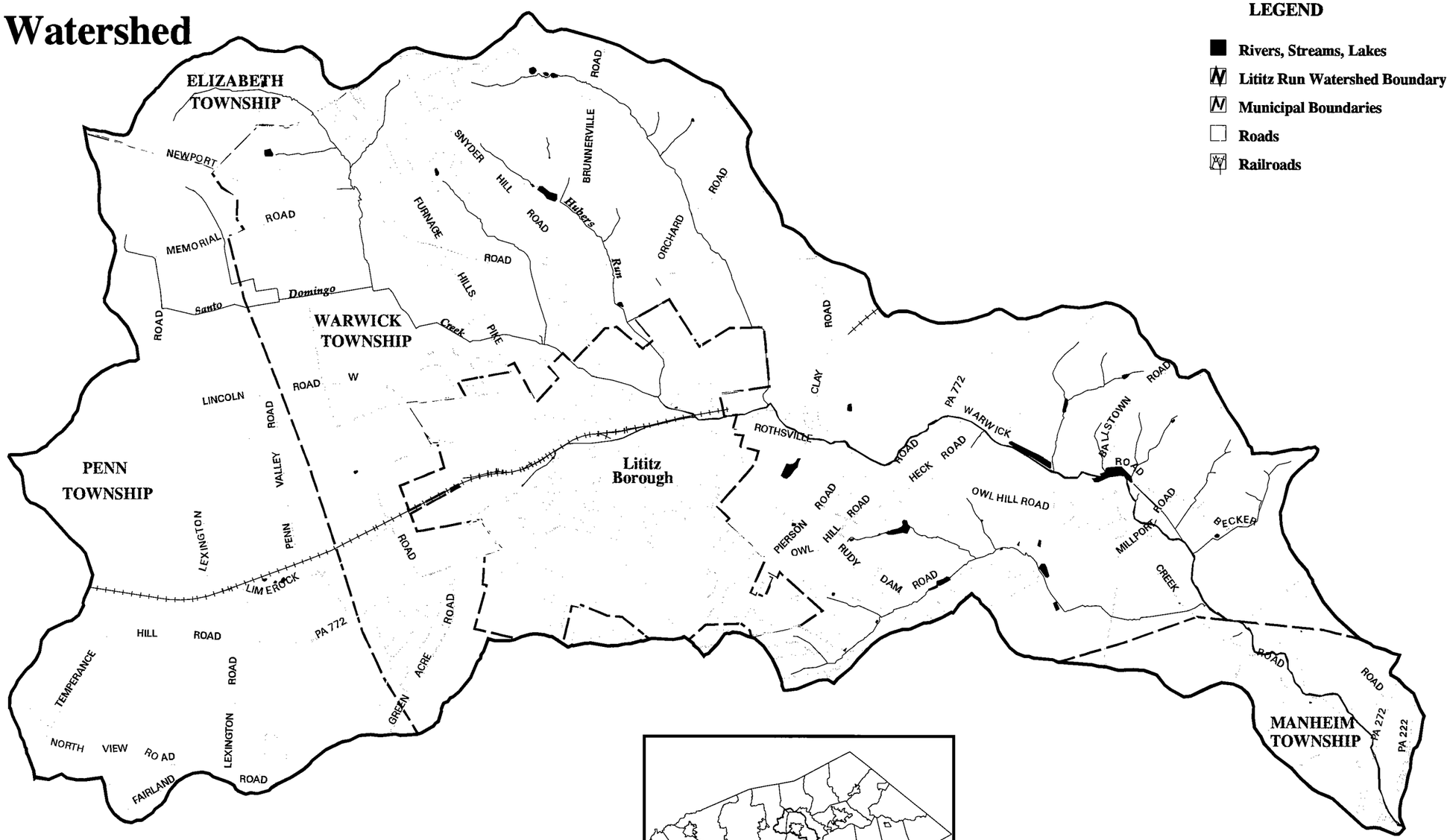
Specific to the Lititz Run Watershed, the landscape pattern has changed dramatically over the last 300 years. In presettlement time, the Lititz Run Watershed was believed to be a forest matrix with patches of Native American villages and agricultural fields, and corridors of trails and streams.

Due to the mild climate and excellent soils typical of Lancaster County, settlers to the region cleared the native forest to convert the land to agriculture. After settlement, the matrix of the watershed became agricultural fields, with patches of towns, villages and forest, and corridors of roads, streams and hedgerows.

The largest changes to the landscape in recent decades have resulted from the 'suburbanization' of the Lititz Run Watershed. Patches of towns and villages are growing in size as the matrix of agricultural land is being reduced. Patches of woodland and forest are remaining fairly constant. Soil fertility in the Lititz Run Watershed has maintained profitable farming operations, so very little of the watershed is currently forested whereas in other parts of Pennsylvania, forest land is increasing as abandoned farmland converts back to woodland.

The drastic modification of the landscape structure over time, likely caused significant changes to the landscape function, testing the resilience of the system. The effect of this forest-to-agricultural-to-urban/suburban land conversion needs to be understood so that we can understand the current ecology of the watershed, and better understand how our actions will affect the watershed in the future.

Lititz Run Watershed Base Map



LANCASTER COUNTY GEOGRAPHIC INFORMATION SYSTEM
PLANNING COMMISSION

HISTORY

There is a long rich history to the Lititz Run Watershed. The following is a time-line of the history of the Lititz Run Watershed, with particular attention paid to man-made modification of the streams and use of natural resources. Information for the time-line was provided by the Lititz Historical Foundation.

Pre-History- The area had long been a choice hunting ground by the Native Americans. The big spring was the scene of many discussions among tribes. The main Native American groups to inhabit the area were the Susquehannock, which were from the same racial stock as the Iroquois; other groups in the area were the Shawnees, Conoys and the Nanticokes. Archeologists say findings prove human habitation in the area extends to at least 10,000 years before present. According to Pennsylvania Historical and Museum Commission, most of the watershed has not been surveyed for archaeological resources. However, such resources are suspected based upon findings made in other locations that have similar landscape features. Recorded archaeological sites tend to possess many of the same environmental variables. Many of these indicator variables relate directly to water, including spring heads, streams, floodplains and swamps. Other indicators include soil type, topographic setting, and slope direction.

1664- Iroquois nation declares war on the Susquehannock. Susquehannock braves gathered to determine the best way to combat the Iroquois. A ten year war was waged which resulted in the defeat of the Susquehannocks. Only a few remnants of the Susquehannock survived to form small tribes.

1716- Richard Carter was the first settler in the general area; he settled near the mouth of the Conestoga River. Carter is credited for naming Warwick Township after his birthplace Warwickshire, England. the original name of Lititz Run was Carter's Run.

1727- Christian Bomberger became the earliest European settler in the immediate Lititz area, settling northwest of the present day Borough of Lititz on the northern bank of a trail that would later become Newport Road. Newport Road was so named because its ultimate destination was Newport, Delaware. Christian Bomberger chose his homestead site in close proximity to the Santo Domingo Creek. The Bomberger land, comprising 564 acres, was a land grant received directly from the Penn family. There is a marker denoting the site of Christian Bombergers homestead near the intersection of Newport Road and Memorial Road.

1729- Lancaster County was formed out of Chester County, and at the same time Warwick Township was formed. Warwick Township was one of the original seventeen townships in Lancaster County, and was established on June 9, 1729.

1720 to 1740- The population of the Pennsylvania colony more than doubled from 31,000 to 85,000. This drastic increase in population came mostly from Scotch-Irish, who joined English Quakers and German Pietists who had arrived earlier. By 1740, the leading edge of effective settlement in Pennsylvania had reached the Blue Mountain, which included all or most of Lancaster County (Miller 1995).

1740's- Last Native Americans (Nanticokes) recorded seen along Lititz Run.

1741- John George Klein Farm established. The barn is still standing (Water Street) and is the oldest building in Lititz.

1755- John George Klein deeded 491 acres of land to the Moravian Community for the establishment of a town. Klein was influenced to do this by the preaching of Ludwig Von Zinzendorf. In a letter from June, 1756, Zinzendorf named the town Litiz for a town in Bohemia where followers of John Hus (1372-1415), the martyred spiritual father of the Moravian Church, had found refuge 300 years earlier. The name of the town later changed to its current spelling of Lititz.

1756- The town of Lititz was founded. The town was a closed community, open only to members of the Moravian Church. The new Moravian settlement of Lititz was surveyed and laid out in lots 33' x 200'.

1757- Elizabeth Township was formed from Warwick Township.

Rome Mill, located on Lititz Run Road, was established in 1815. This mill, at one time, functioned as a distillery, which is said to have produced the finest malt whiskey and rye in Lancaster county. (Photo: from Robert "Sketch" Mearig's collection)

Rome Dam and Mill Lock. (Photo: from Robert "Sketch" Mearig's collection)

1757- Bender Dam and the Lititz Mill (Rome Mill) was constructed near the current day Lititz Run Road.

1759- Community Regulations were established. These regulations, which were enforced by a group of overseers, controlled the social and business life of the town's citizens. The church owned all the land, and home lots were leased by the church to the homeowners.

1765- Wool Carding Mill located on Oak Street, Lititz. The mill was run with water that was collected from the Lititz Run and the Santo Domingo.

1770- Irrigation system. Believed to be the only project of its kind in the colonies, a ditch was dug from a pond / swamp that was located within the present day Lititz Spring Park. The ditch paralleled the south side of Front Street and ultimately emptied into the Santo Domingo. Along the way the ditch irrigated 20 grazing plots. This irrigation system was constructed to ensure sufficient forage for livestock even in dry years.

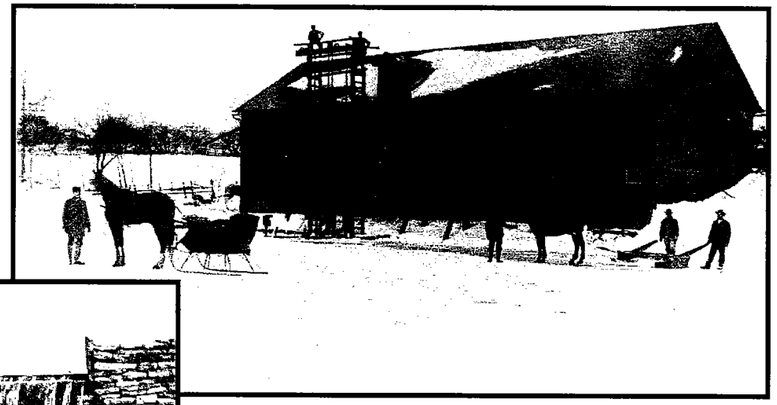
1775- Compass Mill was completed. This mill is located on Rothsville Road opposite Pierson Road. The mill represents the general design and scale of other Germanic inspired mills of Lancaster County.

1790- Rothsville was established. This town was named for the Roth family, with the earliest settlement traced to Phillip Roth who built a tavern there about 1790.

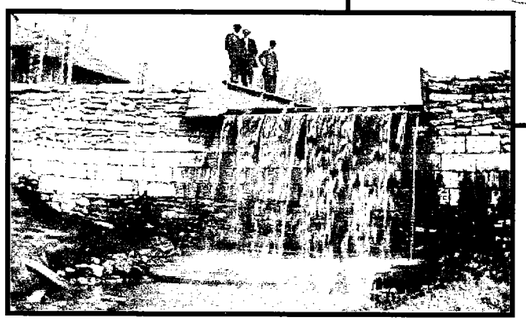
1793- Pfautz Mill was constructed. This mill is located near the intersection of Rothsville and Heck Road.

1813- Millport was laid out by Christian Kauffman.

1820's- Brunnerville at the northern edge of the watershed was formed and catered to teamsters on their route to Philadelphia. Brunnerville was originally named Whitehall, but in 1861 officially changed its name to honor the Brunner family who started a foundry and wagon shop in town.



Yerger's Ice Dam produced block ice by horses pulling saws over the ice. The ice was stored in the barn, and layers of sawdust kept the ice from melting during the summer months. (Photo: early 1900's, from Robert "Sketch" Mearig's collection)



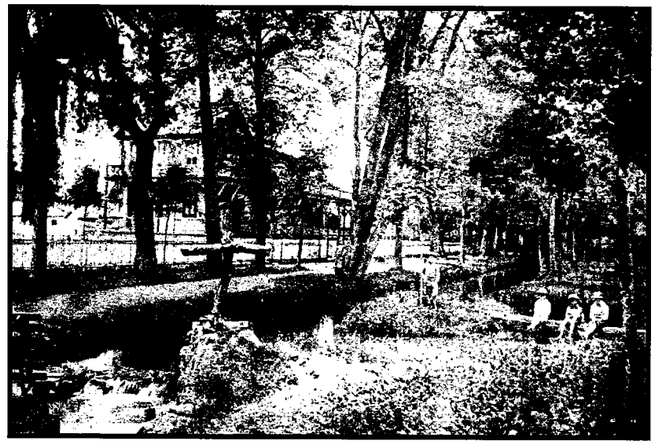
Yerger's Ice Dam was approximately 15' in height. The dam was located northeast of the intersection of Brunnerville Road and Newport Road. (Photo: early 1900's, from Robert "Sketch" Mearig's collection)

1820 to 1840- German settlers began arriving. These settlers were attracted to the area because of the fertile soils.

1846- Penn Township was formed from Warwick Township.

1855- Lititz becomes an open community. The lots owned by the church were sold, and could be purchased by non-Moravians.

1880- It became fashionable to "take in the waters." To sip and soak in the waters of the Lititz Run was touted as a cure for rheumatism, arthritis, tuberculosis and other afflictions.



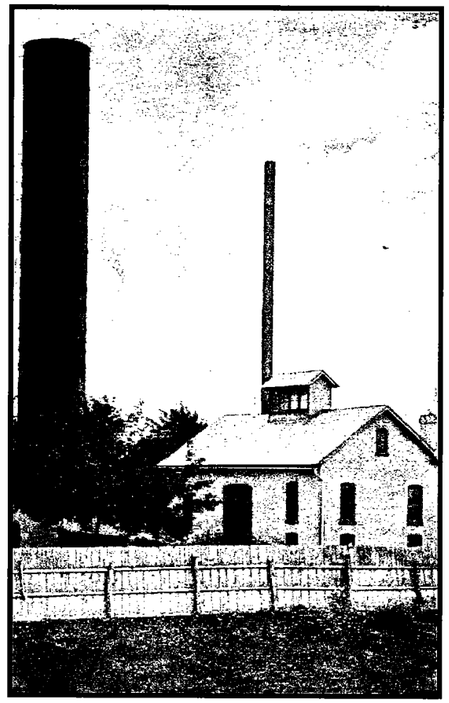
An 1880 photograph of the Park House hotel which was located adjacent to Lititz Spring Park. (Photo: from Robert "Sketch" Mearig's collection)

1888- Incorporation of the Borough of Lititz.

1900's- Yerger's Ice Dam and Ice House. A 15' stone dam was constructed on Huber's run for the purpose of producing block ice. The ice was stored in the ice house and with the help of sawdust for insulation, the ice lasted through the summer months.

1915- Borough of Lititz boundary extended to take in the village of Warwick. Warwick, located north of Front Street and northwest of Cedar Street, was always an open community.

In the late 1920's Ben Lutz built a swimming pool for the youth of Lititz. The pool was constructed from concrete and filled with water from two on-site springs. Lutz's pool was located on Locust and Front Streets, Lititz. (Photo: from Robert "Sketch" Mearig's collection)



Standpipe and power house of the Lititz Water Works. Water was pumped into the standpipe to produce pressure for the public water system. (Photo: from Robert "Sketch" Mearig's collection)

Historic photograph showing a farmstead near the corner of Oak Street and East Main Street, Lititz. The stream channel is very different today. The Lititz Run today is channelized and constricted by the Oak Street Bridge. (Photo: from Robert "Sketch" Mearig's collection)

HISTORICAL ECOLOGY

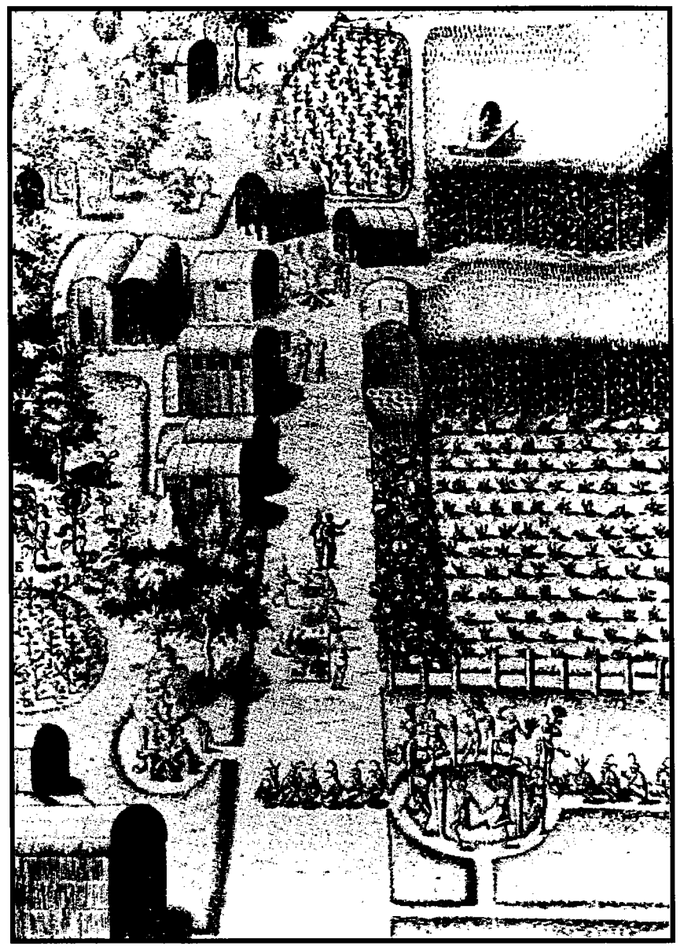
"An endless feedback loop:
Past functioning has produced today's structure;
today's structure produces today's functioning;
today's functioning will produce future structure."
(Forman and Godron 1986).

To understand the structure, function, and interactions of today's ecological systems, you need to understand the history of the given site. Settlement and land use practices of the past greatly influence the sites current condition and future potential. Historical ecology seeks to explain many enigmatic features of present ecosystems and landscapes by deciphering the legacies of past human activities (Bilsky 1980).

Native American Utilization of the Land
A virgin forest existed in the State of Pennsylvania when settlement began in the seventeenth century. Estimates are that only about 2 or 3 percent of Pennsylvania was not forest. (Schein and Miller 1995).

Native Americans are thought to have had a significant impact on the pre-European forest through their use of fire and agricultural practices (Spur and Barnes 1980; MacCleery 1992; Williams 1992). Most Native Americans lived in villages throughout the northeastern United States and each village included at least several hectares of clearings that contained home sites. These clearings were expanded to obtain timber in the vicinity of homesites for building materials for homes, utensils, canoes, and other items, particularly for use as a fuel.

The Iroquois and other tribes relied greatly on agriculture to provide foodstuffs, such as beans, maize, squash, and sunflowers, grown in clearings of the forest created by fires that were deliberately set or occurred naturally. Fires were used selectively by Native Americans to create forest edges and openings for deer, turkey and other wildlife, which were important as food.



Native American village showing a clearing for home sites and crop production. (from MacCleery, 1992)

A combination of factors may have made the Lititz Run Watershed more intensively deforested than other parts of the state. The Susquehannock, being from the same racial stock as the Iroquois, were likely to have had a fairly well developed system of agriculture. This, coupled with the fertility of the soil, may have encouraged the clearing of the forests for agriculture.

There is other historical evidence that suggests that fairly large areas of land had been cleared by the Native Americans. It was said that the Bomberger Home (built 1727) was "located in close proximity to 'indian woods' a small wooded grove approximately 1/4 mile south" (Lititz Museum 1997). This suggests that at least in places that the open meadow / agricultural land may have formed the matrix, while the forests and woodlands may have formed the patches of the landscape structure. It is advisable, however, to have some skepticism when evaluating these vague written accounts.

Pre-European Conditions
In general the Piedmont region and the State of Pennsylvania as a whole was well characterized when it was called 'Penn's Woods.' The Lititz Run Watershed is located in the original Oak-Chestnut Forest Region, Piedmont Section (Braun 1950). The Oak-Chestnut forest extended from southern New England to northern Georgia. Oaks, and formerly chestnuts, were the tree species that characterized these forests. Nothing remains of the original primary vegetation because of the demise of the chestnut from the chestnut blight caused by the parasitic fungus (*Endothia parasitica*) introduced to America in 1904. To underscore the enormity of the loss of the chestnut, it is estimated that they accounted for one tree in five in the Pennsylvania woods (Schein and Miller 1995).

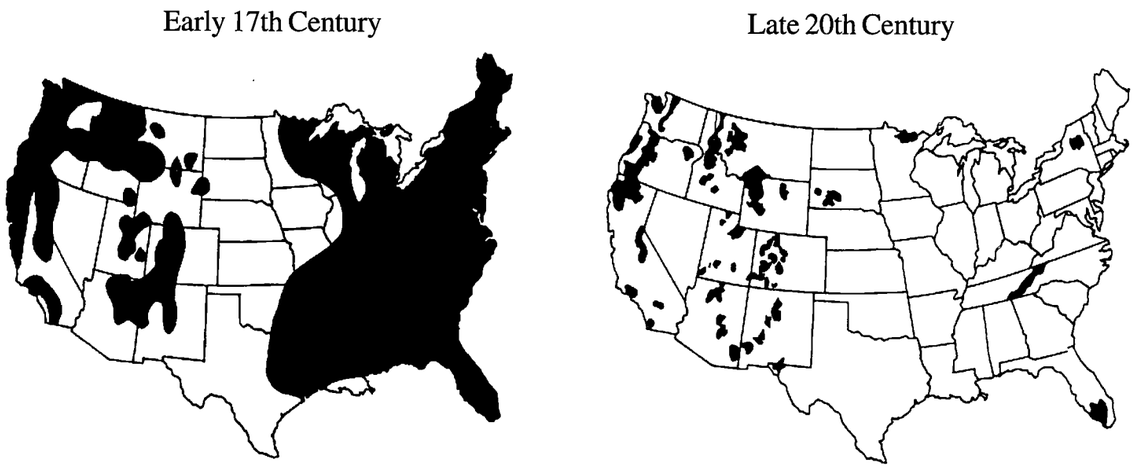
A native northern temperate zone woodland has a six-layer stratification: a canopy of the largest trees (which name the forest), an understory of spreading, shorter trees (such as dogwoods and witch hazels), a shrub and sapling layer, an herb layer, a moss or ground layer and a subterranean layer of roots and microflora. None of these layers is continuous, except perhaps, the subterranean layer. The richness of the herb layer is greatest in the Piedmont because of the superior soils and milder winters (Schein and Miller 1995).

Early travelers in eastern Pennsylvania commented in superlatives on the height and density of the canopy trees and the thickness of the shrub and herb layers. This forest was viewed by different people in different ways. Settlers and visitors saw the forest density as a positive indication of soil fertility. Travelers, on the other hand, saw it as an impedance of nearly insurmountable proportions (Schein and Miller 1995).

European Settlement of the Watershed
Ecologically, the impact of farmers was orders of magnitude greater than that of the Native American hunter-gathers. It accelerated the introduction of non-native species and deforestation, both for land and for wood products, led to erosion, changed fire frequencies, and produced the surpluses necessary for industrialization (Russell 1997).

Wooded areas required vast amounts of labor before crops could be planted. The methods used to clear the forest were different among different settler groups. Generally, the English and Scotch-Irish did not clear the land initially, but used the Native American's practice of girdling the trees. Their crops were planted among the trees and the dead trees were removed over a period of time (Miller 1995). In contrast, German settlers employed a much more intensive method of clearing the forest; they cut the trees, grubbed out the underbrush and stumps and burned the wood, adding nutrients to the soil (Miller 1995). Both of these ethnic groups would have been present in the Lititz Run Watershed.

The transformation of the land from forest to agriculture at the time of European settlement likely increased stream flow due to the removal of the transpiring native trees and shrubs. Increased flow, and the loss of the forest's extensive root systems would have increased erosion potential of upland areas causing sedimentation of streams and rivers. Sedimentation would likely have caused streams or rivers to aggrade, or fill, raising the level of the bed of a stream by deposition of sediment.



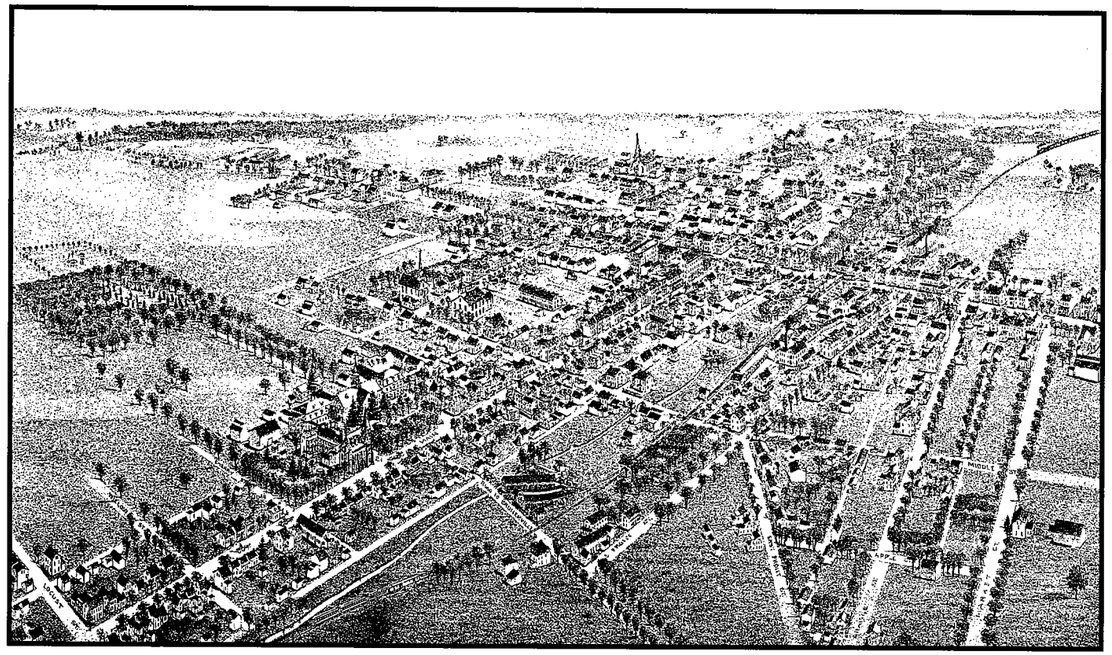
Comparison of the distribution of old-growth forest in the lower 48 states in the early seventeenth century and the late twentieth century. (from Miller 1990)

Fire is likely to have modified the composition of remaining forests and woodlands. Fires, which characterized much of northeastern North America after European settlement, produced what are known as sprout forests (Braun 1950). Oaks and chestnuts are two of the species that resprout after being cut and their numbers increased as a result of the frequent cutting in the eighteenth and nineteenth centuries (Webb 1973; Russell 1980; Davis 1985; Mc Andrews 1988). There was an increase in the amount of disturbance species like birches and decreases in species that were more sensitive to fire, like beech and hemlock. These changes in composition were evident in the pollen record as well as in forest surveys (Russell 1997).

Some more subtle changes in forest composition may be related to the usefulness of various tree species. White oak was, and still is, an especially prized timber tree. In some areas a comparison of historical surveys with current forest composition shows a decrease since the late seventeenth to early eighteenth centuries in white oak and replacement by the less favored, vigorous sprouters black, scarlet and red oaks and by the earlier successional red maple and white pine (Whitney and Davis 1986).

The areas still remaining as woodland have been logged repeatedly for lumber and fuelwood (Keever 1972), and during each harvest, specific tree species are often selected.

The chestnut blight and cutting changed the species composition of the forests of Lancaster County. The blight and cutting opened the forest canopy and allowed species that required plenty of sunlight the opportunity to grow. The species that most benefited from the opening of the canopy were the Tulip poplar (*Liriodendron tulipifera*), which was a minor component of the original Oak-Chestnut Forest (Braun 1950).



An historic isometric map of the towns of Lititz and Warwick from an 1887 drawing by T.M. Fowler. (Courtesy of the Lititz Historical Foundation)

GEOLOGY AND SOILS

Bedrock geology and soils have been important factors in the formation of natural vegetation and land-use patterns of Lancaster County. Also, geology is a primary determinant of groundwater quality and quantity. Certain rock types, such as limestone, convey water better and yield more abundant well sources.

Lancaster County Geology
Lancaster County may be defined by three broad bands of rock groupings. In the north are Triassic sediments and igneous intrusives. The Triassic rocks represent sediments deposited when a rift was created during the last opening of the Atlantic Ocean. The rift was intruded by igneous rocks (diabase) and the current hills are the result of resistance to weathering. The gently-dipping sediments (sandstones and shales) are generally good aquifers, while igneous rocks are generally poor aquifers. The central region of the county is composed of folded and overturned carbonates (limestone sedimentary rocks). The carbonates provide excellent quantities of water, however, the solution channels and sinkholes which characterize this geology make groundwater highly vulnerable to contamination. The southern region is dominated by metamorphic schist with some quartzites, and some serpentines in the very southern portion of the county. The central and southern bands of metamorphic and sedimentary rocks are Cambro-Ordovician or older in age and represent an ocean shelf environment at the edge of the then continent. The carbonates are shallow, warm-water deposits while the schists are derived from clay-rich muds found at depth off-shore and the quartzites are derived from sandstone (Custer 1985; Lancaster County Planning Commission 1996).

The northern and the middle sections of the Lititz Run Watershed are located in the Cocalico Formation which consists of bluish-black to dark gray shale and purple and green shale that contains a thick quartzite bed near the base (Poth 1977). The Epler Formation is found located between the two Cocalico Formation areas and consists of very finely crystalline, medium-gray limestone interbedded with gray dolomite (Geyer and Wilshusen 1982).

Geochemistry of the Lititz Run
Rock type and structure can affect the chemical properties of groundwater. The limestone geology contributes to a high pH, which in turn means that threats such as acid rain are easily dealt with since the stream simply neutralizes the acidity of the rain; this is termed "buffering capacity" (Armstrong 1992). The water of Lititz Run is fed continuously by springs and seeps. Limestone areas are well known for their prolific springs and wells; the water is very hard, there is a lot of it, and it is cold. The hardness comes from dissolved minerals which are nutrients for a wide variety of life forms. Aquatic vegetation is often plentiful and provides the basis for an abundant food chain as well as hiding places for all manner of stream life. Nutrients and aquatic vegetation form the basis for a healthy, productive food chain (Armstrong 1992).

Soils of the Region
Soils in this region of Pennsylvania vary in quality, but include the best in the state of Pennsylvania, and some of the best in the eastern United States (Miller 1995). Fifty-five percent of Lancaster County's soils are considered to be prime, and another 22% are defined as soils of Statewide Importance. Lancaster County has the highest proportion of prime soils and soils of Statewide Importance of any county in the State (Lancaster County Planning Commission 1996).

These soils have enabled Lancaster County and its farmers to attain State and national distinction as one of the most productive sources of agricultural products. Agriculture's continuing role as the County's dominant land use is attributable to the County's high quality soils, mild climate, market accessibility, and strong tradition of family farming (Lancaster County Planning Commission 1996).

A majority of Warwick Township (83%) is in prime agricultural soils. The township is characterized by scattered ridges and floodplains that reduce the productivity of these prime soils. These same attributes (steep slopes and flooding) also inhibit their suitability for future development. Given these factors, it is apparent that future development within the township can only occur via the conversion of prime farmland.

Soils often reflect past human activities (Limbrey 1975). Plowing, for example, homogenizes the surface horizons of the soil, destroying or obscuring the upper level zonation (Buol et al. 1980). In some soils, cutting of forest cover precipitates severe erosion, the results of which may persist long after agriculture or logging has ceased (Kain and Hooke 1982). Due to the slow process at which soil is formed, disturbances affecting the soil will have long term ecological consequences.

Agricultural use of the land often raises the pH of soil by bringing base-rich minerals from lower horizons as well as by the addition of lime, whereas the regeneration of forests can cause detectable decreases in pH (Krug and Frink 1983).

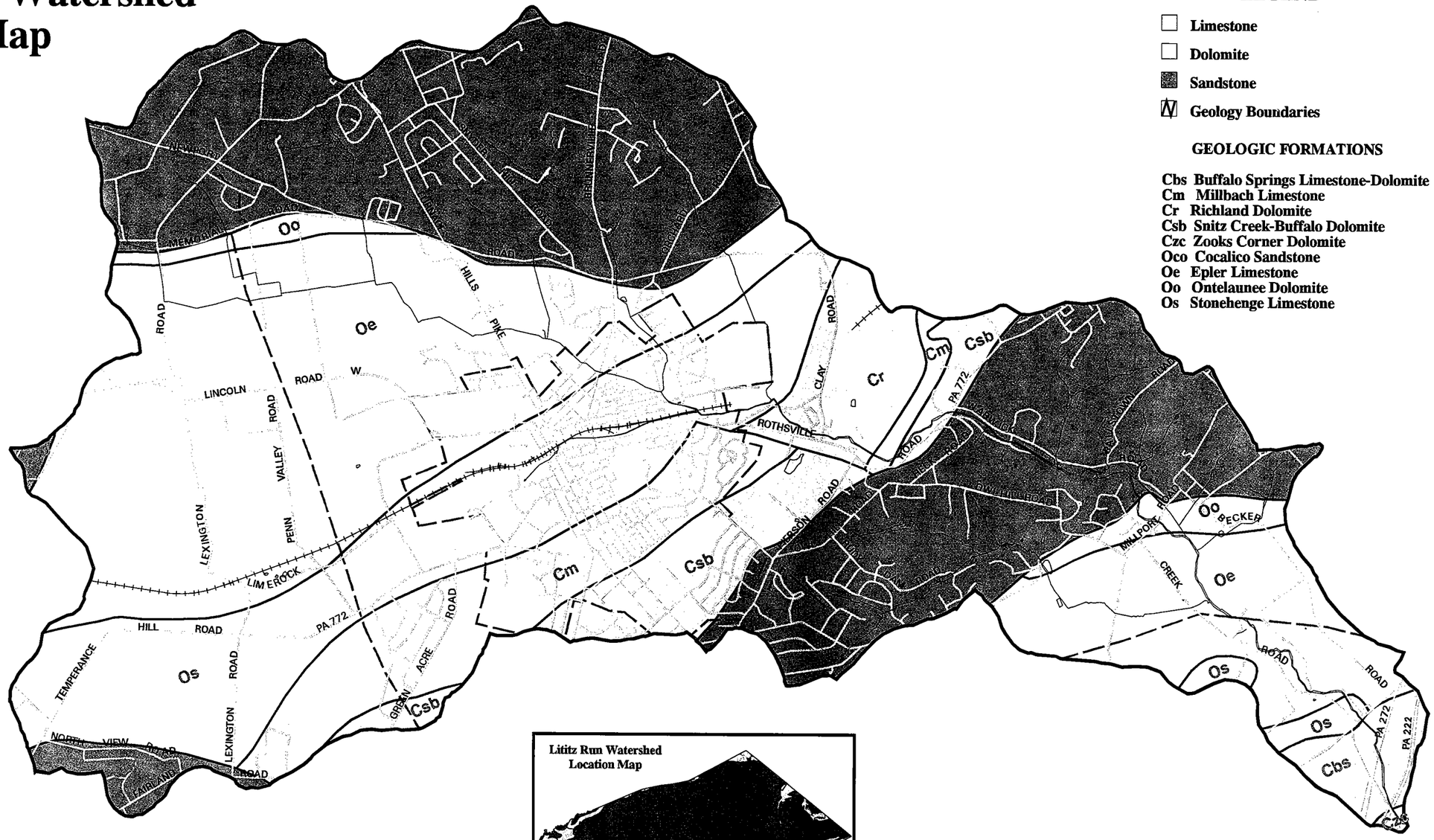
It is important to understand soil properties to understand how they would respond to the various disturbances inflicted upon them by early settlers and present resource management practices. It is likely that the clearing of woodlands for agriculture, and the long history of farming in this area, has caused significant soil erosion over the years.

Soils of the Lititz Run Watershed
The soil types found in the Lititz Run Watershed are: (BdB, BdC) Bedington silt loam, (BeB, BeD) Bedington channery silt loam, (CkA) Clarksburg silt loam, (DbA) Duffield silt loam, (HaA, HaB, HaC) Hagerstown silt loam, (HbC) Hagerstown silty clay loam, (Hc) Hagerstown-Urban land complex, (Ln) Lindside silt loam, (Nc) Newark silt loam.

Soil types found in the watershed that are considered Prime Agricultural Soils, as defined by the USDA, are Bedington (BdB), Clarksburg (CkA), Duffield (DbA), Hagerstown (HaA, HaB), and Lindside (Ln).

Clarksburg silt loam, Lindside silt loam and Newark silt loam are all potential hydric soils when located in drainageways, depressions and / or bottom lands.

Lititz Run Watershed
Geology Map

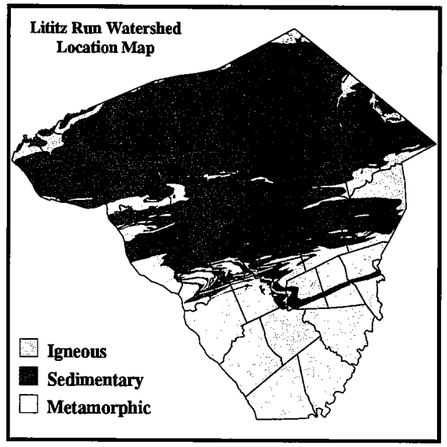


LEGEND

- Limestone
- Dolomite
- Sandstone
- Geology Boundaries

GEOLOGIC FORMATIONS

Cbs Buffalo Springs Limestone-Dolomite
Cm Millbach Limestone
Cr Richland Dolomite
Csb Snitz Creek-Buffalo Dolomite
Czc Zooks Corner Dolomite
Oco Cocalico Sandstone
Oe Epler Limestone
Oo Ontelaunee Dolomite
Os Stonehenge Limestone



LANCASTER COUNTY
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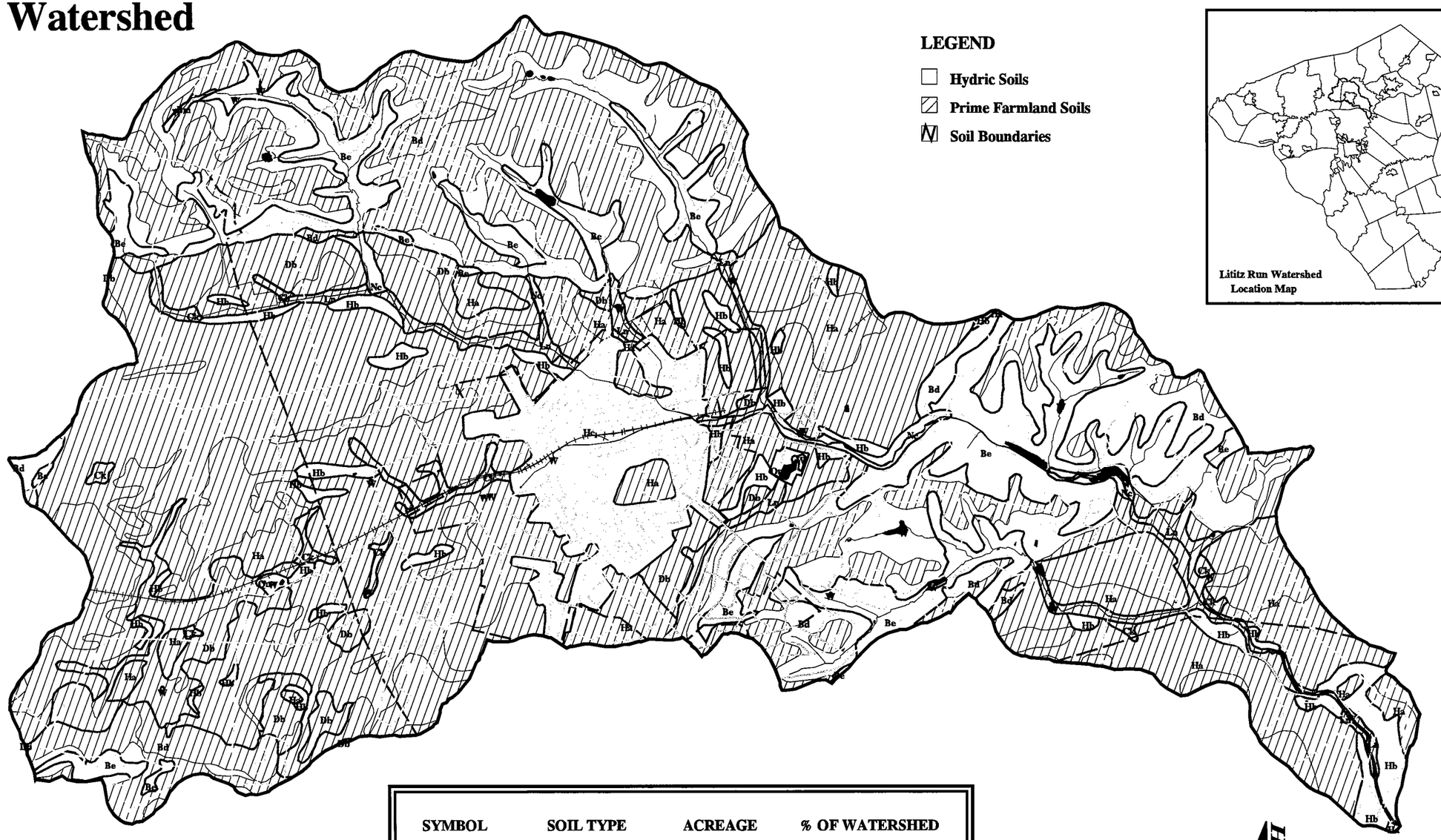
NORTH

3000 0 Feet 3000 6000

1 Inch = 3000 Feet

Lititz Run Watershed
Soils Map



SYMBOL	SOIL TYPE	ACREAGE	% OF WATERSHED
Bd, Be	*Bedington*	*4364*	*40%*
Bm	*Blairton*	*6*	*1%*
Ck	*Clarkburg*	*109*	*1%*
Db	*Duffield*	*748*	*3%*
Ha, Hb, Hc	*Hagerstown*	*5516*	*50%*
Ln	*Lindside*	*266*	*2%*
Nc	*Newark*	*74*	*1%*
Qu	*Pits, Quarries*	*19*	*1%*
W	*Water*	*28*	*1%*
TOTAL		**11,133**	**100%**

NOTE: 7,662 Acres of Study Area is Prime Farmland as designated by the US Department of Agriculture.

LANCASTER COUNTY
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WATER RESOURCES

Water Quality of the Nation

There has been significant improvement in the quality of U.S. water resources since 1972, due mainly to reductions in pollution from industrial and municipal point sources brought about by the Clean Water Act. However, water quality problems remain, and many of these are the result of nonpoint source pollution (USDA 1997).

Nonpoint sources include urban runoff, agricultural soil erosion and runoff of chemicals from agricultural fields, leaching of agricultural chemicals into groundwater, and atmospheric deposition of contaminants from air pollution. EPA's 1995 Water Quality Inventory reports that over one-third of surveyed U.S. rivers, lakes and estuaries do not fully support a healthy aquatic community or human activities all year round. According to the Inventory, agriculture is the leading source of impairment for the Nation's rivers, affecting 60% of the impaired river miles. Agriculture was also judged to be the leading source of impairment of wetland water quality. While the status of groundwater quality in the U.S. is not well known, of 38 States reporting overall groundwater quality, 29 judged their groundwater quality to be good or excellent. When degradation of groundwater quality does occur, it is typically a localized problem and agriculture is often a source. Of the 49 States reporting sources of groundwater contamination, agriculture was cited as a source in 44 States (USDA 1997).

Agricultural production involves many activities and practices that can adversely affect the quality of surface and groundwater. Sediment from eroding land can negatively affect surface water, while nutrients from fertilizers, manure, and pesticides can contaminate both surface water and groundwater (USDA 1997).

Tilling the soil and / or leaving it without vegetation cover for some period of time results in accelerated soil erosion. Sediment harms waterbodies when present in excessive amounts by clouding the water and coating the leaves of aquatic plants, both of which deprive them of sunlight needed for growth. The deposition of sediment reduces the useful life of reservoirs, clogs ditches and irrigation canals, blocks navigation channels, resulting in increased dredging costs. By raising stream beds and burying streamside wetlands, sediment can increase the likelihood and severity of floods. Suspended sediment can increase the cost of water treatment for municipal and industrial water users. According to the EPA, siltation is one of the leading pollution problems in U.S. rivers and streams (USDA 1997).

The application of fertilizers and / or manure to agricultural land increases the chance that nutrients will run off into surface waters or leach into groundwater. The two primary agricultural nutrients that play a role in water quality are nitrogen and phosphorus. Nitrogen, primarily found in the soil as nitrate is soluble and easily transported by surface runoff or by leachate. Phosphorus, primarily in the form of phosphate, is only moderately soluble and, relative to nitrate, is not very mobile in soils or groundwater. An excessive amount of nitrogen or phosphorus in surface waters can cause algae to grow at an accelerated rate. An abundance of algae results in cloudy water, which prevents aquatic plants from receiving sunlight for photosynthesis. When the algae die, they are decomposed by bacteria, depleting the oxygen dissolved in the water. This is the process of eutrophication which can result in clogged pipelines, fish kills, and reduced recreational opportunities. According to EPA, nutrient pollution is the leading cause of water quality impairment in lakes and estuaries and the third leading cause in rivers (USDA 1997).

Above a certain concentration, nitrate is also a concern for drinking water. Based on the human health effects of nitrate and nitrite, EPA has established a maximum contaminant level (MCL) of 10 mg/L for nitrate, and 1 mg/L for nitrite in public drinking systems. Nitrates or nitrites above the MCL can be a factor in causing methemoglobinemia ("blue-baby syndrome"), which prevents the transport of oxygen in the bloodstream of infants, and may be a cancer risk to humans due to nitrosamine formation. In its 1988-90 national survey of drinking water wells, EPA found nitrate in more than half of the 94,600 community water system wells and almost 60 percent of the 10.5 million rural domestic wells, making nitrate the most frequently detected chemical in well water (USDA 1997).

Surface Water Quality

About one-quarter of the land area of Lancaster County is covered by high quality or exceptional value watersheds (Lancaster County Planning Commission 1996). The Lititz Run Watershed has many characteristics that keep it from attaining a high-value rating. Only 5% of the watershed is forested, with the vast majority of the watershed in agricultural production. Due to this type of land use, water pollution from sedimentation and nutrient loading is common.

Some studies have reported that as much as 70% of all water pollution comes from nonpoint source pollutants (Lancaster County Planning Commission 1996). Streambank and cropland erosion together accounted for an estimated 92-93% of all soil losses in 1995 (Don Robinson 1995). The USDA (1984) estimates that streambank erosion accounts for approximately 18% of all soil lost to local streams in Lancaster County, with the remaining loss being from croplands. The authors of this publication believe that streambank erosion accounts for a much higher percentage of the overall soil loss.

In Lancaster County, 17% of the farms produce excess manure when compared to the need for nitrogen for crops, while 42% produced excess manure when compared to the need for phosphorous for crops. Yet if manure were redistributed Countywide based on nitrogen needs, there would be no net excess of nitrogen in manure. However, there would still be an excess of phosphorous in manure (Lancaster County Conservation District 1989).

Cattle in the stream, destabilizing the streambanks and contaminating the water with their waste. (Photo: Grant Heilman, Grant Heilman Photography)

Streambank protection offers added benefits in the way of herd health protection and fish and wildlife habitat improvements. A count of fish before and after streambank fencing as part of the Pequea-Mill Creek project revealed more than a doubling of desirable fish species (Lancaster County Planning Commission 1996).

Acid rain also represents a problem for local surface water quality. Airborne nitrogen and sulfur, created by cars, trucks, power plants, and industries, cause acid rain and excess nutrients in County streams and groundwater. It is estimated that approximately one-third of nitrogen pollution may come from airborne pollutants. Pennsylvania has one of the highest levels of acid rain in the country, with Lancaster County classified as a marginal non-attainment area for compliance with national ambient air quality standards for ozone. Ozone is a pollutant which is formed in the air by chemical reactions primarily involving volatile organic compounds, nitrogen oxides and carbon monoxide (Lancaster County Conservation District 1989).

Water quality problems caused by urban-suburban runoff are extremely difficult to control after development has occurred. Storm water management regulations which apply to new development can greatly reduce storm water flows, thereby reducing water quality problems created by urban and suburban runoff. All 60 Lancaster County municipalities have storm water management regulations in place, either utilizing their own adopted standards or falling under the jurisdiction of the County's regulations (Lancaster County Conservation District 1989).

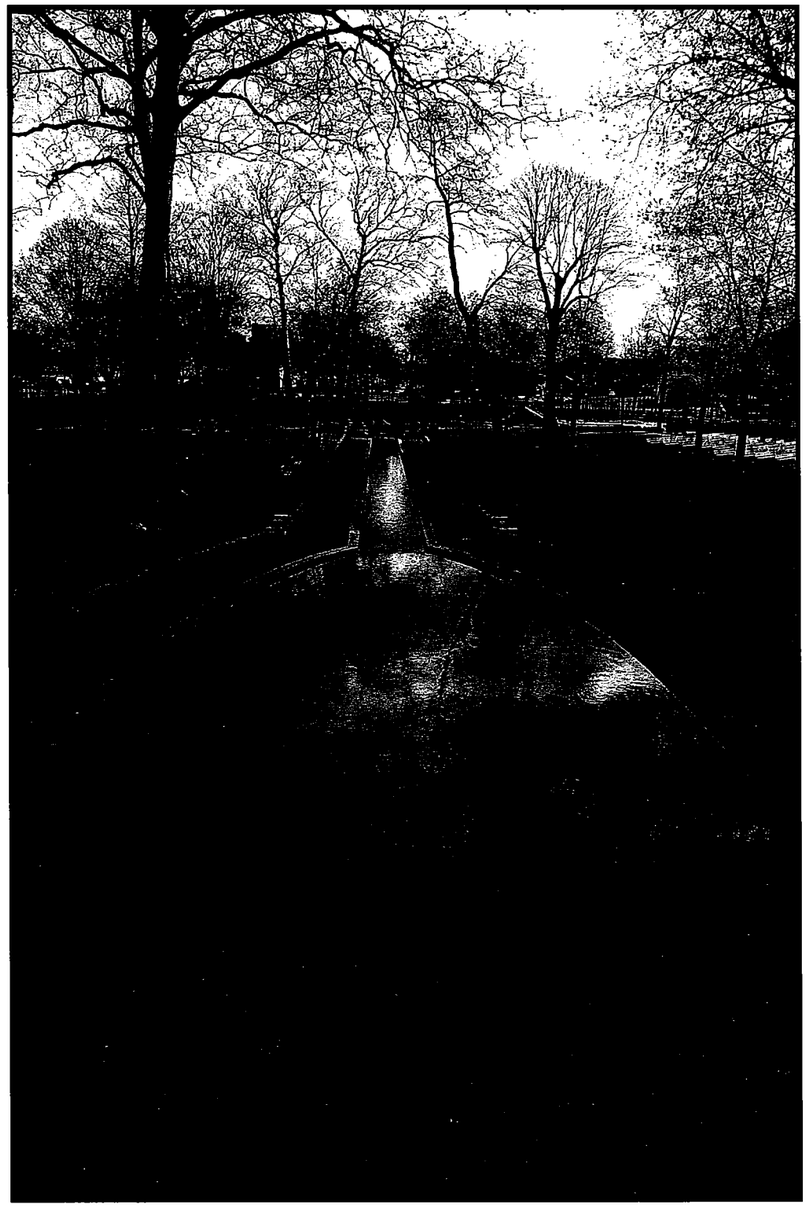
Wetlands do more to safeguard both water quality and yield than does any other land use on an acre-for-acre basis. Wetlands act as natural water storage areas during floods and storms by retaining excessive waters and gradually releasing them into the ground or nearby surface waterways. Wetlands purify water by filtering, assimilating and recycling pollutants. (Lancaster County Planning Commission 1996). Surface water areas, including streams, floodplains, lakes and reservoirs, also act as water storage areas during floods and storms, and replenish underlying groundwater aquifers.

Lititz Run Watershed

Limestone streams, such as Lititz Run, are made up of the flow from springs, which yield constant-temperature, mineral-rich waters. Because of the spring-fed source for much of the water, there is normally little fluctuation in temperature from winter to summer. The human influenced environment has modified this condition, with the removal of the forest, and the establishment of farm and mill ponds and extensive areas of concrete, asphalt and buildings. Lititz Run currently suffers from "thermal" pollution, a warming of the water temperature, which reduces the quality of aquatic life and negatively affects the entire food chain.

The Lititz Run channel has a total length of 6.2 miles in which the stream falls 236 feet. The Lititz Run is unique because the stream's source is within an urban area, whereas the source of most area streams are upland agricultural areas. Lititz Run's source is a stone headwall in Lititz Spring Park in the Borough of Lititz. The first mile of Lititz Run, is very urban in nature with most of the banks stabilized by concrete, and stone. Where there is maintained lawn areas adjacent to the stream, erosion is often a problem due to the intensity of storm events. Streambanks that are forested are often more stable.

The Lititz Run Watershed drains an 11,114 acre basin. There are a total of 9 stream channels comprising a total stream length of 20.2 miles. Lititz Run and the Santo Domingo are all subject to periodic flooding. Based on historic data, Lititz Run is the major source of flooding within Lititz Borough and Warwick Township. Most of the recent floods are the result of spring rains and snow melt.



The source of the Lititz Run is the stone grotto headwall in Lititz Spring Park. (Photo: Runk / Schoenberger, Grant Heilman Photography)

Groundwater Quality in the Watershed

It is easy to recognize that as population increases, there will be an increased need for water. What is often forgotten is that population increases along with changes in land use can have a detrimental effect on the quality and quantity of water. Suburban sprawl, with its increase in impervious surfaces (buildings, parking lots, roads, etc.), reduces the ability of area aquifers to replenish themselves to meet the growing demand for water. Water quality of surface and groundwater can be negatively affected by increased erosion and sedimentation, contamination due to runoff from roadways and parking lots, and nutrient pollution (Lancaster County Planning Commission 1996).

Water availability is necessary to ensure future economic potential for increased populations and other possible industries. The quantity and quality of public and private water systems can be safeguarded and enhanced through responsible watershed management planning (Lancaster County Conservation District 1989).

Water quality data suggests that agricultural pollutants such as manure, chemicals, and petroleum are contributing to the water quality degradation of the Lititz Run Watershed (Warwick Township 1993). In the 1992 US Census of Agriculture it was reported that 80% of Lancaster County farms used commercial fertilizers, down from 82% in 1987. The sale of nitrogen and phosphorous fertilizers have increased 31% and 21%, respectively, between 1984 and 1994 (Breitsman 1995). During this same time period, the land area planted in crops decreased by 7%. The increase in the sale of fertilizers may be partly attributable to increased urban lawn care, golf courses and out-of-area use.

With the widespread availability of manure and fertilizers, application rates may often be higher than necessary or recommended (Lancaster County Planning Commission 1996).

Pesticides are used by homeowners, businesses, institutions, and farmers. Pesticides can, even in small concentrations, be a public health concern when they enter area groundwater and streams (Lancaster County Conservation District 1989).

Major transportation routes, such as routes 501 and 772, and urban industrial areas pose the threat of hazardous substance spills to the Lititz Run Watershed. Given the rapid travel times of some carbonate aquifers, this can represent a significant problem for the future. The majority of hazardous substance spills in the county involve manure or petroleum products.

Acid rain can act on carbonate geology, accelerating the creation of sinkholes or solution channels, which can transmit contaminants to the groundwater (Lancaster County Conservation District 1989). The Lititz Borough Waterworks reported nitrate levels above the Maximum Contaminate Level (MCL) in 1989, and nearly 40% of Lancaster County households are served by on-lot water supplies, many of which exceed the MCL for nitrates (Lancaster County Planning Commission 1996).

The Costs of Water Pollution

Because property rights to the environment are not clearly defined, there is no market price associated with using water resources as a receptor for eroding soil, excess nutrients, pesticide residues, etc. Consequently, farmers and other landowners are not compelled to factor the offsite costs of erosion or chemical runoff and leaching into their production decisions. These costs are "external" to their operation. Economists refer to these effects as "externalities". In addition, individuals are often unaware of the offsite effects their decisions cause.

To reduce nonpoint source pollution, a more comprehensive scale of analysis and management is required. Nonpoint source strategies recognize that small sources of pollution are widely dispersed on the landscape and the cumulative impacts of these pollutants on water quality and habitat are great. A watershed approach to protecting water quality has proved most effective because it recognizes the interconnectedness of subbasins.

Lititz Borough Waterworks report nitrate and total dissolved solids in excess of the maximum contaminant level (MCL). In the early 90's, the Borough installed Anion Exchange Units for nitrate removal at a cost of just under $2 million. The operation of the anion exchange units require the use of about one ton of salt per day. The salinity caused by this treatment requires adding zinc ortho-phosphate to the water to keep pipes from rusting. This treatment of potable water places increased demands on the wastewater treatment plant which needs to handle increased amounts of sodium, nitrate and water. The most recent significant addition to the wastewater treatment facility, in 1981, cost $15 million, and it is projected that another addition will be needed within the next 5 years. John Strayer, plant manager of the Lititz Borough Waterworks, says " I always tell groups visiting the facility that the best way to treat water, is to never pollute it in the first place."

An example of Point Source Pollution. Effluent from the wastewater treatment plant entering Lititz Run. (Photo: Runk / Schoenberger, Grant Heilman Photography)

VEGETATION AND WILDLIFE

Natural diversity is the web of life, plants, animals, fungi and microorganisms, that work together to maintain the vital ecological functions that sustain all life on Earth. Scientists estimate that the current rate of extinction of plant and animal species around the world is as much as 10,000 times that of the rate of extinction due to natural climate variability and natural disasters. Since the industrial revolution, natural ecosystems have been significantly altered through clearing of land for timber and agriculture, mineral extraction, and housing commerce, and roads. Of Pennsylvania's documented 3,500 or more native species of vascular plant and animals, 156 are known to have disappeared from the state since the arrival of European settlers, and another 351 are endangered or threatened. Information does not exist to tell us how many species of invertebrate animals, fungi, non-vascular plants, and microorganisms have been lost (21st Century Environment Commission 1998).

The loss and degradation of natural habitat from urbanization and fragmentation or landscapes, introduction of exotic species, and air and water pollution are the greatest threat to Pennsylvania's remaining natural diversity. Future growth will inevitably continue to put pressure on the state's natural diversity, and thus on its environmental health. Without a concerted effort to maintain and enhance natural diversity, populations of many native species will continue to decline and several will face extinction (21st Century Environment Commission 1998).

Historic Vegetation of the Region

When European Colonists first arrived, it is estimated that 95% of the Chesapeake Bay watershed was forested. By the mid 1800's, over half of the forest land had been converted to other uses. Forests have recovered somewhat from their historic lows, with about 60% of the Chesapeake Bay watershed being forested today (Chesapeake Bay Program 1995).

The Tulip-Oak forest type now forms the majority of the woodland in Lancaster County (The Nature Conservancy 1990). The Tulip poplar is considered to be an early-successional forest species because its seedlings are not tolerant of shading. It is a species that thrives during early stages of forest development. As the forest ages and the canopy closes, seedlings fail to survive, and early successional species give way to late successional species whose seedlings are shade tolerant (The Nature Conservancy 1990). The regeneration of our forests is threatened by an overabundance of white-tailed deer, unsustainable forest management practices, poor air quality (including ground level ozone and acid rain), and the sprawl of new development (Pennsylvania 21st Century Environment Commission 1998)

According to the U.S. Department of Agriculture's Forest Service Inventory, the state of Pennsylvania is now 58 percent forested. However, there are great variations from one county to another. Lancaster County has little forest cover. The exceptional productivity of its agricultural land has caused little or no farmland to have been abandoned and revert back to forest (Schein and Miller 1995).

Today, the vegetation of the Lititz Run Watershed bears little resemblance to the forests that existed before the arrival of European settlers. In Lancaster County, only about 17% of the land area is in forest (Lancaster County Planning Commission 1996), and forest cover for the Lititz Run Watershed is even less. The Lititz Run Watershed contains only 606 acres of forested land, which represents only 5% of the land area. In addition to forested land, there is only a small 106 acre area in shrub / brush land; this type of land cover is usually formed from either abandoned farmland or regenerating woodland.

The riparian and aquatic habitat provided by the Lititz Run and Santo Domingo are considered poor to marginal. The lack of forested riparian zones is one of the main reasons for the poor habitat values of these important open space corridors. The Lititz Run and Santo Domingo and adjacent terrestrial habitat provide very little habitat for nesting, rearing, resting, feeding, and cover for wildlife. Floodplains are often dominated by monocultures of species, such as reed canary grass, which forms a thick mat of vegetation that has choked out other species, providing poor food value, marginal habitat, and low biodiversity.

A Great Blue Heron (*Ardea herodias*) in a wetland. (Photo: Arthur C. Smith III, Grant Heilman Photography)

Historic Changes in Wildlife

The effect of hunting on Pennsylvania's wildlife has been significant. Hunting exterminated the wolf and beaver in eastern North America in the seventeenth and eighteenth centuries. Although people may have substituted for predators in controlling the prey populations, the role of such species as beavers in damming creeks and cutting trees have been left unfilled. The dislocations caused by the loss of these animals likely still affect forest structure and watershed functions (Russell 1997).

As an area is converted from a natural to a man-made state, the delicate balance of the local ecosystem is often disrupted. This imbalance degrades or strains the environment's ability to support varied forms of plant and animal species. In turn, local species become threatened or endangered. The key to protecting wildlife diversity is the protection of local natural habitats. The protection of habitats can also serve other equally important functions, like the control of erosion, the recharge of groundwater, the attenuation of pollutants, and providing the community passive recreational opportunities (Warwick Township 1993).

Pennsylvania Natural Diversity Index
The Pennsylvania Natural Diversity Index (PNDI) is the State agency charged with keeping current on rare, endangered, or otherwise significant natural features. This inventory uses some 800 sources of information to map, describe, and disseminate facts about important natural features.

The PNDI has found no unique habitats in the Lititz Run Watershed, but there are several forested areas within the watershed that provide good habitat for a wide diversity of wildlife. In particular, the Millport Conservancy land located between Rothsville Road and Millport Road is a unique area within the watershed. The Millport Conservancy land is an extremely scenic area consisting of wooded hillsides, riparian vegetation and aquatic bird habitat.

The Nature Conservancy's 1990 countywide natural areas inventory also identified the Millport area as a site of local significance. The site offers the potential for wildlife habitat, and low impact recreation. The mill pond is used by shorebirds, waterfowl, and other waterbirds. At the same time, the Millport pond, a large, shallow water body, has been identified as significantly contributing to the thermal pollution of the Lititz Run. The Lititz Run Watershed Masterplan calls for draining the pond, reestablishing a natural stream channel through the area, and the creation of a diverse floodplain wetland (LandStudies 1996a).

Black-crowned Night Heron
One of the significant species found in the Lititz Run Watershed is the Black-crowned Night Heron (*Nycticorax nycticorax*). In the lower reaches of the Lititz Run, there is an active rookery of the Black-crowned Night Heron, which is considered a "species at risk" by the Pennsylvania Biological Survey. The rookery in the Lititz Run Watershed is a significant colony. There is only one colony larger in the state of Pennsylvania (Brauning 1998).

The range of the Black-crowned Night Heron is from the northwestern U.S. east to Nova Scotia, and south to South America during the breeding season. It winters as far north as Utah and Oregon in the west and to the lower Ohio Valley, southern New England, and the Gulf Coast. In Pennsylvania, this heron is found throughout the state during migration but breed primarily in the eastern part of the state. It is sometimes seen in winter until open water freezes.

The Black-Crowned Night Heron (*Nycticorax nycticorax*) rookery in the Lititz Run Watershed is the second largest in the state of Pennsylvania. (Photo: Greg Wilson)

An immature Black-Crowned Night Heron eating a fish. (Photo: Arthur C. Smith III, Grant Heilman Photography)

The habitat for the Black-crowned Night Heron is coastal estuarine areas and they use low to moderate gradient rivers, lake shallows, marshes, forested wetland, and riparian habitats. They also make use of upland forests, grasslands and coastal sand dunes. Nesting occurs in trees near marshes or open water, in swamps, marshes, orchards and other upland habitats. The Black-crowned Night Heron is an opportunistic feeder preying mostly on fish, amphibians, and invertebrates in shallow water, but also on small mammals and young birds on land. The clutch size range is 3 to 5 eggs incubated by both sexes from 24 to 26 days. The young first fly at about 6 weeks. The adult breeds at 2 or 3 years of age in colonies. Breeding occurs in the eastern third of the State of Pennsylvania.

Wildlife and Habitat of the Lititz Run Watershed
The lack of wildlife in the Lititz Run Watershed is linked directly to the poor wildlife habitat found there. With the exception of the Millport Conservancy land, there is very little habitat for nesting, rearing, resting, or feeding, in the watershed. The quality of in-stream habitat can be assessed by an examination of the stream's macroinvertebrates. The macroinvertebrate populations within the Lititz Run Watershed are typical of an agriculturally degraded stream. Macroinvertebrates are present in low numbers and there is a lack of species diversity, which negatively affects the productivity of the entire food chain.

Urban Wildlife - - Ducks
Lititz Spring Park, the source of the Lititz Run, supports a large number of permanent resident ducks. These ducks do not migrate south for the winter because they have a continuous food source, being fed by local residents. These ducks have developed a dependence on humans for food and can no longer be considered "wild."

LAND USE

The uniqueness of this region with its rich scenic, natural and historical resources, has continued to attract people as a place to visit, live and work. Increased development pressure brought on by increasing population is contributing to the loss of the scenic and natural features that initially attracted people to the area. If the Lititz Run Watershed is to maintain or improve its natural resources and rural character, wise planning is required.

Historic Land Use

The history of development and settlement patterns add depth to our knowledge by telling us something of the age of the pattern, which affects the amount of influence the pattern exerts on current ecosystem structure and processes (Russell 1997). Fence lines and woodlots within a property most likely demarks a change in soil or other feature that influences the natural resource potential of the site, explaining why woodlots are located where they are, why some land was grazed and not planted, and why some farms were abandoned earlier than others (Russell 1997).

Boundary disputes resulted in uncertain titles to land. Absentee landownership also led to illegal clearing and timber cutting where the demand for land was low and there was a high cost to getting a clear title (Wacker 1975). Some eighteenth-century visitors observed that because of the uncertainty of titles only lawyers could get rich (Rogers 1765; Hamilton 1907). All of this contributed to haphazard settlement patterns and poor stewardship of the land (Russell 1997).

Actual settlement patterns under this confused regulatory non-system were quite varied. Proprietors encouraged settlers to establish villages by advertising with detailed plans of settlements consisting of carefully arranged house and farm plots, with no vacant land left between them. The town of Lititz is a good example.

Outside the aggregations of surveyed lots in town, the arrangement of farms was much more casual (Russell 1997). Farmers often cleared and fenced fertile, level land with or without legal title, leaving no woodlots on the better soils. Later surveys found these lots to be highly irregular and to exclude poorer, steep areas, which were used for common grazing and as sources of wood (Wacker 1975). It was after the Revolutionary War that states ceded unsettled western territory to the new federal government. The federal Ordinance of 1785 imposed a rational, rectilinear surveying system on this land in keeping with the philosophy of the Enlightenment. Because settlement occurred earlier in the Lititz Run Watershed, a more random development pattern is clearly evident.

Eastern Pennsylvania contained some of the most productive land in eastern North America, but the rivers were not usable without major navigational improvements. Very early in the state's history there were powerful incentives to make rivers navigable by building canals alongside them, or (more rarely) overland. Because canal-building was often impossible or too expensive, an extensive system of all-weather roads were constructed. Eastern Pennsylvania took to road building very early in the state's history, and from the beginning the routes of eastern Pennsylvania often converged in places far from navigable water. It is no accident that Lancaster and York, the main inland market centers of the Pennsylvania Piedmont region, were among the first American cities to grow up and thrive without being located on the seacoast or a major river, and the first to depend on roads - not rivers - for commercial transportation (Marsh and Lewis 1995).

The Pennsylvania Town

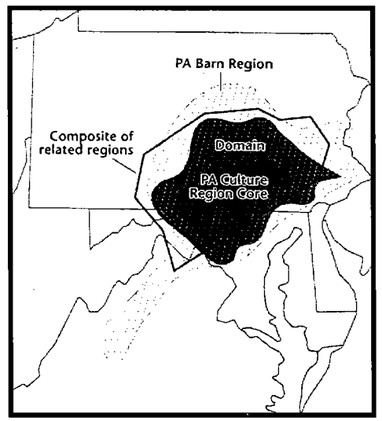
Even the most casual tourist cannot help noticing how regionally distinctive the traditional settlement landscape of the Pennsylvania Cultural Area happens to be (Noble 1984). While the countryside with its picturesque farmhouses and barns has received the lion's share of attention from both scholars and laypeople, it is in the towns and cities that we find the most convincing case for the particularity of the regional culture. Several physical characteristics set the Pennsylvania town apart from agglomerated settlements in all other sections of the United States (Zelinsky 1977). Pennsylvania towns generally resemble those that appeared in Great Britain and other North Sea countries in the late seventeenth and early eighteenth centuries, and are a product of contemporary Northwest European fashion (Zelinsky 1995).

One quite visible item that makes our commonwealth so remarkable is the 'Pennsylvania Town,' especially those found in the Pennsylvania Cultural Region. These towns have many unique characteristics such as:

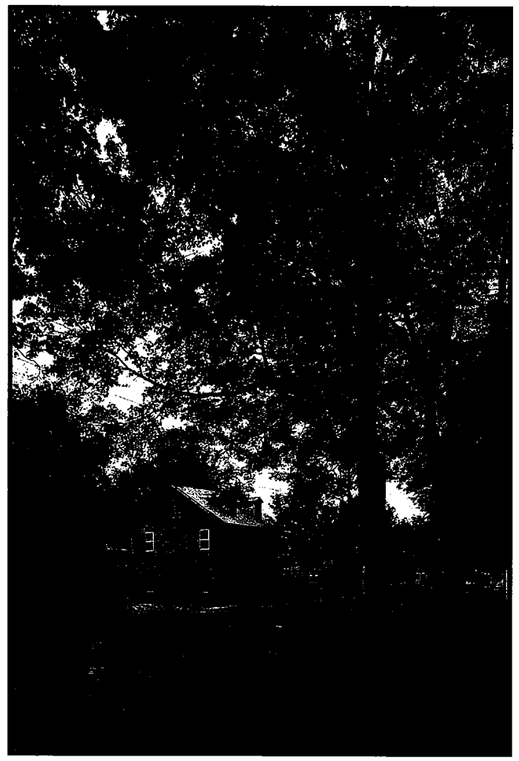
The Pennsylvania Town is exceptionally compact, with little, if any space between adjacent structures or between building and street or sidewalk. The town has a random spatial intermixing of functions - - dwellings, shops, offices, and public facilities - - to a degree rare elsewhere in America. Brick is the preferred building material in the 'Pennsylvania Town', with stone and stucco as other popular materials and there is an abundance of shade trees planted in the curbing or on narrow sidewalks.

The town's street geometry is peculiarly Pennsylvanian with two readily visible features: a central diamond and a well-developed system of alleys that are busily trafficked and often lined with businesses and residences; and there is a distinctive street naming system which is derived from the one used for Philadelphia; this system has one parallel set of thoroughfares named after trees and the intersecting set bearing sequential numbers.

There is also found a great deal of architectural variety and even idiosyncrasy among the 'cheek-by-jowl' buildings that is extraordinary by American standards (Zelinsky 1995).



Map of Middle Atlantic States showing the Pennsylvania Culture Region Core in dark. (Zelinsky 1995)



Lititz possesses all the characteristics of the 'Pennsylvania Town' including: predominate use of brick, the mix of uses (commercial and residential), street trees and town square. (Photo: Larry Lefever, Grant Heilman Photography)

Economics

Lancaster County's economy has traditionally centered around agricultural production and related industry. Over the last several decades, the economy has diversified to include strong manufacturing, construction, service, retail and tourism components. A strong work ethic, proximity to major markets and a high quality of life, have and continue to lure business to this area. Consequently, Lancaster County enjoys a healthy economy which has shown a remarkable resilience to cyclical economic downswings (Lancaster County Planning Commission 1996).

Agriculture continues to be a primary contributor to Lancaster County's economy. Lancaster County is the most profitable farm market in the State, and one of the top farm markets in the country, reflecting both a predominance of productive agricultural soils and a strong historic farming tradition. Tourism and the manufacture of food and kindred products are two notable spin-off industries directly related to agricultural production. The strong agricultural presence has provided the County with a major comparative advantage over other places in attracting and keeping such industries (Lancaster County Planning Commission 1996).

Lancaster County also enjoys a strong manufacturing sector. The proportion of the County's work force employed in this sector is significantly higher than that for the State as a whole, indicating the specialization of the County in manufacturing. While the State has suffered a 39% net loss in manufacturing jobs since 1990, the number of manufacturing jobs in Lancaster County has remained constant, placing the County in a relative advantageous position (Lancaster County Planning Commission 1996).

Most recent growth in employment within the County has been in the service sector, which parallels state and national trends and is expected to continue. Ecotourism (tourists attracted by natural and historic sites and activities) is a growing industry in our region. Drawing on the appeal of area agriculture, the Plain Sect communities and numerous outlet malls, the value of tourism to the County is measured in sales among various service industries and retail trade (Lancaster County Planning Commission 1996). Tourism in Lancaster County generated approximately $500 million in direct sales in 1994.

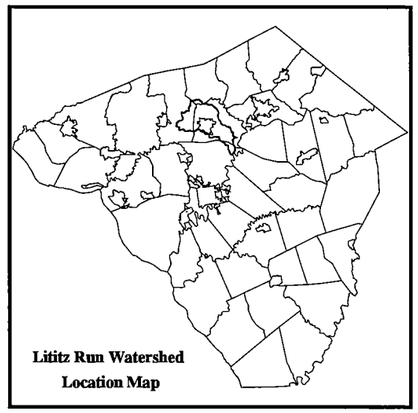
The Lititz Area enjoys the same economic advantages as the rest of the county. The town of Lititz is a vibrant community with a solid industrial and manufacturing sectors adding diversity to the traditional agricultural economic base of the surrounding rural areas. The town of Lititz also has many shops that cater to the tourist industry.

Current Trends in Land Use

The population growth of the suburban areas of Lancaster County have, for the most part, greatly out paced growth of the urban area during the period of 1950 to the present. This population growth reflected a national trend of suburbanization. For example, from 1950 to 1980, the population of Warwick Township, considered a suburban area of Lancaster City, grew by 151%, while the Borough of Lititz only grew by 36%. Manheim Township experienced the largest growth in the area with a population increase of 180% during this same time period.

Between 1970 and 1990, the proportion of County land in urban uses more than doubled, from 44 to 105 square miles, while population growth increased by only 32% (Lancaster County Planning Commission 1996). This trend is indicative of the highly land-consumptive nature of recent growth in Lancaster County and elsewhere. Land for residential uses nearly doubled in area between 1978 and 1990. Agricultural land use, at the same time suffered a loss of nearly 25,000 acres, averaging over 2,000 acres per year loss of agricultural land. Because of the rate of lost farmland, the American Farmland Trust has ranked Lancaster, and other counties in the region, as the nation's second most threatened agricultural area. The World Monument Fund of New York recently placed Lancaster County on its list of the 100 most imperiled and irreplaceable treasures of the world; the county was listed because of its tradition of religious tolerance and large Amish community (Intercourse News 1997).

Lititz Run Watershed
Land Use Map



LEGEND

LAND USE	Acres	LAND USE	Acres	LAND USE	Acres
Low Density Residential	290	Industrial/Commercial	57	Recreation Conservation	85
Medium Residential	1653	Agriculture	6815	Institutional	194
High Residential	320	Woodland	686	Miscellaneous	78
Commercial	145	Open Land	485	Open Water	46
Industrial	219	Transportation Utilities	50	Mixed Development	10

TOTAL AREA = 11,133 ACRES

LANCASTER COUNTY
GEOGRAPHIC INFORMATION SYSTEM
PLANNING COMMISSION

NORTH

3000 0 Feet 3000 6000

1 Inch = 3000 Feet

III. WATERSHED PLAN

Introduction
In the development of the Watershed Plan there is a need to think holistically, remembering the linkage among the health of our environment, our economy and our society, and that we are striving for excellence in all three (Pennsylvania 21st Century Environment Commission 1998). Because of the growth occurring within the Lititz Run Watershed, many of the most pressing needs can be summarized as issues of sustainability.

Sustainable development is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". There exists a large amount of literature on sustainability, or more accurately, on the lack of sustainability, especially in American culture. The lack of sustainability in our culture has been blamed on various causes including capitalism, colonialism, religion, development, the population explosion, and science and technology (Van Der Ryn and Cowan 1996).

Sustainability is not a single movement or approach. On one hand, sustainability is the province of global policymakers and environmental experts attending conferences such as the Earth Summit. On the other hand, sustainability is the domain of grassroots environmental and social groups, committed to changing their own communities (Van Der Ryn and Cowan 1996). These community based organizations are interested in finding alternatives to the practices that got us in trouble in the first place. To address issues of sustainability we will need to reconsider everything that we currently take for granted, such as agriculture, energy use, design of the built environment, transportation, economics, resource use and our central values (Orr 1992). There is a need for the public to understand the basic concepts of sustainability, and for the public to evaluate its lifestyle and understand the impacts that our daily decisions have on the local and global environment.

Sustainable Communities
Many communities have discovered that traditional approaches to planning and development are creating rather than solving societal and environmental problems. Where traditional approaches can lead to congestion, sprawl, pollution, resource over-consumption, sustainable communities seek to offer real, lasting solutions that will strengthen their and our future. Sustainable communities use resources efficiently, create efficient infrastructures, protect and enhance quality of life, and create new businesses to strengthen their economics (Center of Excellence for Sustainable Development).

Communities that are considered the most sustainable in the world have most often evolved from rather well-established human cultures persisting over hundreds of years. Amish farming communities, for example, would cease to be sustainable if the Amish culture of soil conservation, land stewardship, resourcefulness, frugality, and strict codes of social behavior faltered (Thayer 1993). American ("English") culture has evolved in just the opposite direction. We are a nation of quickly changing value systems of consumerism, frequent relocation, lifestyle fads, resource wastage, fossil fuel addiction, and anthropocentrism (Thayer 1993). If we are to design sustainable communities, we will need to educate each other and deliberately design or foster the stable social structures that guide human activity in those landscapes. Without sustainable values, communities designed to be sustainable will be misused, become unsustainable, and fail (Thayer 1993). The first necessary step toward living sustainably, is to resolve to remain in one's region, learn the local ecology, make it home, and make it work (Snyder 1991).

A Reason For Hope
The Lititz Run Watershed community has some advantages in planning for a sustainable future. We have excellent role models in the Amish culture, and the citizenry as a whole, exhibits a "rootedness" that is unique in the United States. This rootedness is demonstrated by the fact that a smaller percentage of persons born in the state of Pennsylvania ever migrate elsewhere (Zelinsky 1995).

The Lititz Run Watershed community has also built up a considerable amount of momentum in recent years in improving the environment and planning for the future. The Borough of Lititz and Warwick Township have undertaken inter-municipal strategic planning to comprehensively address and coordinate the issues faced by these two municipalities.

Local citizens have become actively involved in planning and environmental restoration projects throughout the watershed. Miles of streambank have been stabilized by members of the Donegal Chapter of Trout Unlimited and several bioengineering, or 'soft' engineering projects have been installed, including streambank stabilization at Farmer's First Bank in downtown Lititz. Public and municipal volunteer labor assisted in all of these projects, especially with the planting of 14,000 wetland plants at the newly completed Santo Domingo water quality facility. While there have been some impressive work and improvements over the last few years, there is still much to do.


Watershed Education Board


Streambank Stabilization by Trout Unlimited


Farmer's First Bank Streambank Stabilization


Community Planting Day (Photo: Lori Zimmerman)

RECOMMENDATIONS

These recommendations are categorized as either Agricultural, Urban / Suburban Areas, and Open Space and address environmental, social, and economic issues within the Lititz Run watershed. The recommendations can be encouraged by municipalities, or incorporated into new zoning recommendations. This list of recommendations is a starting point. It is a list of the changes that, if addressed, will help keep the Lititz Run Watershed a quality place to live, work and raise a family, for now and for future generations.

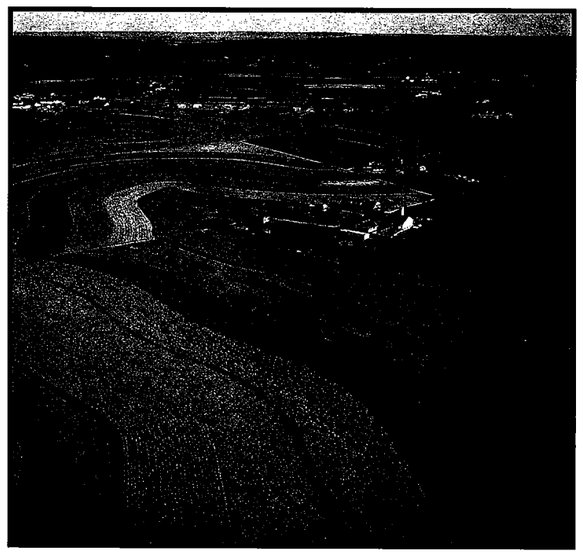
Implementation of these recommendations can be addressed by the strategic planning initiative between the Borough of Lititz and Warwick Township. Techniques for implementation may include ordinances, transfer of development rights, transfer of open space and recreation requirements, water quality credit trading, mitigation credits, regulatory negotiations, regional planning initiatives, and grant procurement.

Recommendations - - Agriculture

1. Preserve working farms.

2. Consider prime and statewide important farmland soils a valuable natural resource and give priority to their preservation and continued use for agricultural production.

3. Continue to implement conservation tillage and agricultural land stewardship technique alternatives (i.e. no-till planting, cover cropping, grassed waterways, contour plowing, terracing, integrated pest management, etc.)



Contour Plowing (right), conservation tillage and leaving crop residues on the field (above) are effective methods of reducing soil loss from agricultural fields. (Photos: Grant Heilman, Grant heilman Photography)

4. Continue to implement nutrient management planning.

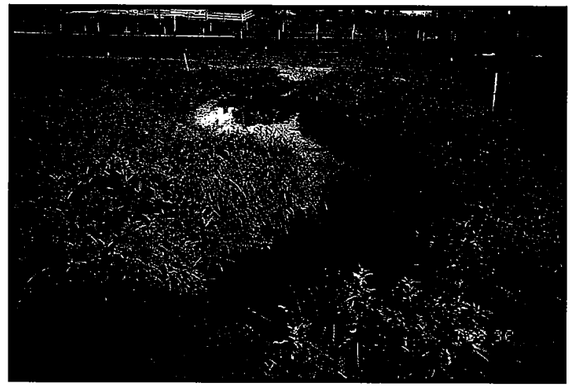
5. Continue to implement barnyard management techniques that improve water quality.

6. Continue to implement streambank fencing in conjunction with the planting of forested riparian buffer.

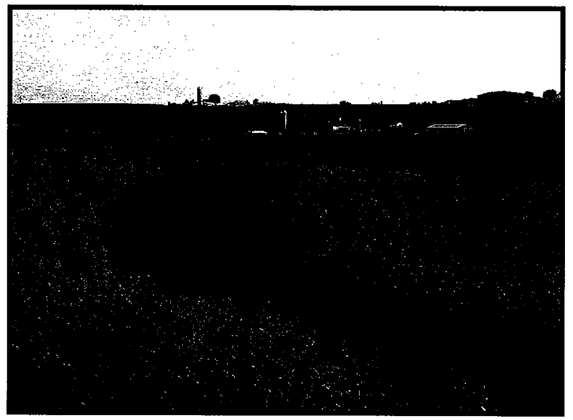
7. Protect and create wildlife habitat.

8. Explore incentives for farmers who apply these conservation methods (grants, tax incentives, etc.

Solar pumps (above) and spring development watering systems can eliminate the need for livestock to access the stream. Concrete stream crossings (right) increase the health and safety of livestock while reducing streambank erosion. (Photo: Frank Lucas, Pequea-Mill Creek Project)



Stream fencing keeps livestock and their waste out of the stream and allows regrowth of streambank vegetation. (Photo: Frank Lucas, Pequea-Mill Creek Project)



Grass waterways, shown here between fields of corn, will help filter out sediment during storm events. (Photo: Larry Lefever, Grant Heilman Photography)

Recommendations - - Urban and Suburban Areas

1. Develop a model for balancing economic and ecological objectives.

2. Maintain a vibrant downtown.

3. Encourage neo-traditional design elements that mimic the unique qualities of the 'Pennsylvania Town' in areas adjacent to historic towns and villages.

4. Encourage conservation planning techniques which condense development and preserve open space.

5. Allow variances in local weed ordinance for landowners implementing ecological restoration in accordance with proper management practices.

6. Continue to encourage local schools to promote hands on education through watershed based curriculums.

7. Educate the public on the financial and environmental costs associated with maintaining large areas of turf and lawn for "aesthetic" non-functional purposes.

8. Encourage multi-purpose stormwater management facilities which mimic the site's pre-development drainage pattern and includes water quality improvement and wildlife habitat considerations.

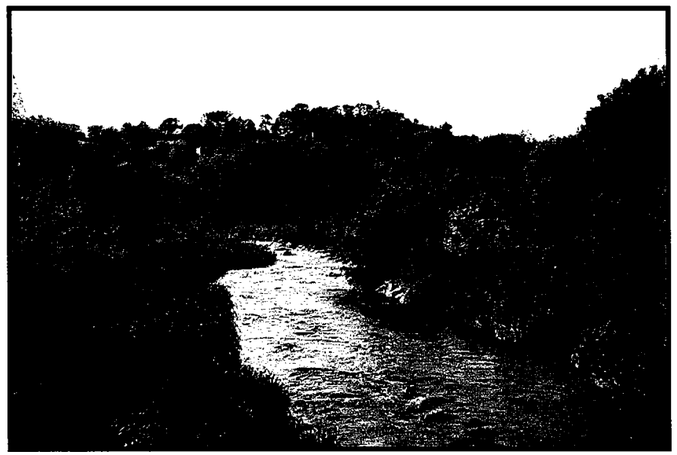
9. Continue multi-municipal planning to develop regional plans with a strong emphasis on the local watershed.

10. Promote a streamlined approval process for projects that support conservation development techniques within approved planned development areas.

11. Protect and restore stream corridors by promoting the establishment of forested riparian buffers throughout the watershed.

12. Continue to restore the stream, its streambanks, and adjacent floodplains using techniques that maintain channel stability, improve water quality, and promote biodiversity.

Stormwater facilities can be designed to support a diverse assortment of plant species that will be a benefit to local wildlife. (Photo: LandStudies, Inc.)



Riparian buffers consisting of grasses, shrubs and trees stabilize streambanks, filter nutrients, shade the stream, and provide a food source for aquatic insects. (Photo: LandStudies, Inc.)

Created wetlands can provide important wildlife habitat and restore hydrologic function such as aquifer recharge. (Photo: LandStudies, Inc.)

Recommendations - - Urban and Suburban
Continued

13. Reduce lawn areas and promote low maintenance meadows and native landscaping in passive recreation areas.

14. Promote non-vehicular transportation by establishing linkages to the planned rails-to-trails effort. Continue to look for opportunities to connect all areas of the watershed.

15. Discourage residents from feeding ducks within Lititz Spring Park and along stream. Change the focus from ducks to trout to reduce damage to park, water quality degradation, and health and sanitary problems. Suction dredge the organic sediment within the rock lined raceway and stock with trout. Replace duck food with trout food.

16. Continue reforestation efforts within the urban, suburban, and rural areas.

17. Continue to restore wetlands throughout the watershed for various purposes such as agricultural runoff treatment, parking lot / roadway runoff treatment, wildlife habitat, floodplain re-establishment, and as part of wetland mitigation banking projects.

18. Establish protective zoning or conservation easements for important local wildlife habitat areas, such as the Black-crowned Knight Heron rookery.

19. Establish and implement wellhead protection guidelines. Educate the public about the vulnerability of their water supply. Provide convenient disposal sites for motor oil and hazardous household chemicals.

20. Educate the public about alternatives to common hazardous and toxic products.

21. Fully implement Urban Growth Boundaries, through appropriate zoning and infrastructure planning, to direct growth to appropriate areas and away from important natural resources.

22. Encourage or require the preservation of open space for passive use such as wildlife habitat, natural areas, linkages and aquifer recharge areas.

Wetlands function as filters and can be designed to treat runoff from roads and parking lots. (Photo: LandStudies, Inc.)

If we are to maintain or improve the quality of the environment within the watershed, functioning ecologic systems will need to be designed into the built environment. (Photo: Jim MacKenzie)

Recommendations - -Open Space

1. Develop an open space and greenway plan at the watershed scale. Continue to encourage the establishment of open space linkages among the various municipalities.

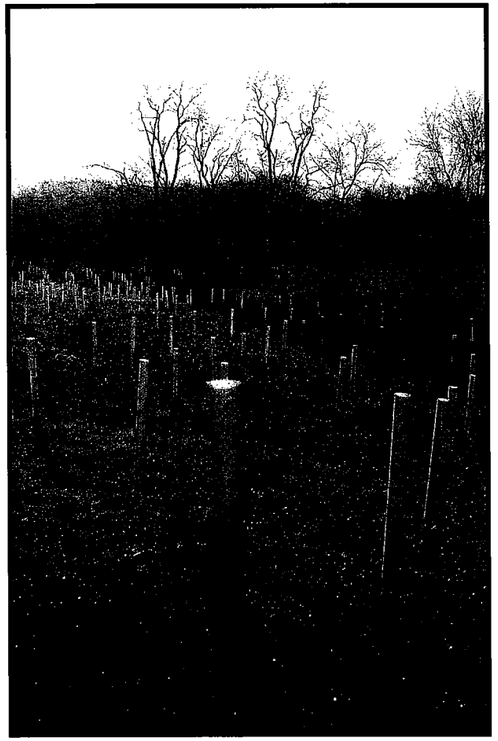
2. Promote the integration of low maintenance natural areas as a component of all active recreation areas.

3. Incorporate passive recreation areas and areas for nature / wildlife observation in any proposed open space system.

4. Continue installing educational signage throughout the open space system of the watershed. Signs should explain interesting facts about the plants, animals, and ecology of these areas.

5. Inventory and map natural resource restoration opportunities within watershed.

6. Establish maintenance and management guidelines for all open space natural areas.



There are many reforestation opportunities within the Lititz Run Watershed including planting of street and parking lot trees, hedgerows, and forested riparian buffers. Tree shelters (left) protect young trees from being browsed by animals and from severe weather. (Photo: LandStudies, Inc.)

The Action Plan

The recommendations made above are numerous and many involve complex land planning, engineering and societal issues. An individual may feel overwhelmed by this list and question what one person can do to make a difference. While the task of striving for a sustainable future for our community may seem daunting, the worst mistake would be to take no action.

Without residents of the Lititz Run Watershed working for positive change, the recommendations made by this report, or any other, will achieve nothing. The time to get involved is now! Here is a partial list of current projects that need your support.

- Lititz Borough and Warwick Township are working on a Comprehensive Strategic Plan and are soliciting public input. This plan will create a vision for what the community will look like in the future.

- Warwick Township is currently planning a non-motorized trail system for the abandoned rail line east of Lititz. This is an exciting step in what may grow into a watershed wide greenway system.

- The Donegal Chapter of Trout Unlimited is involved in "hands-on" restoration projects throughout the watershed.

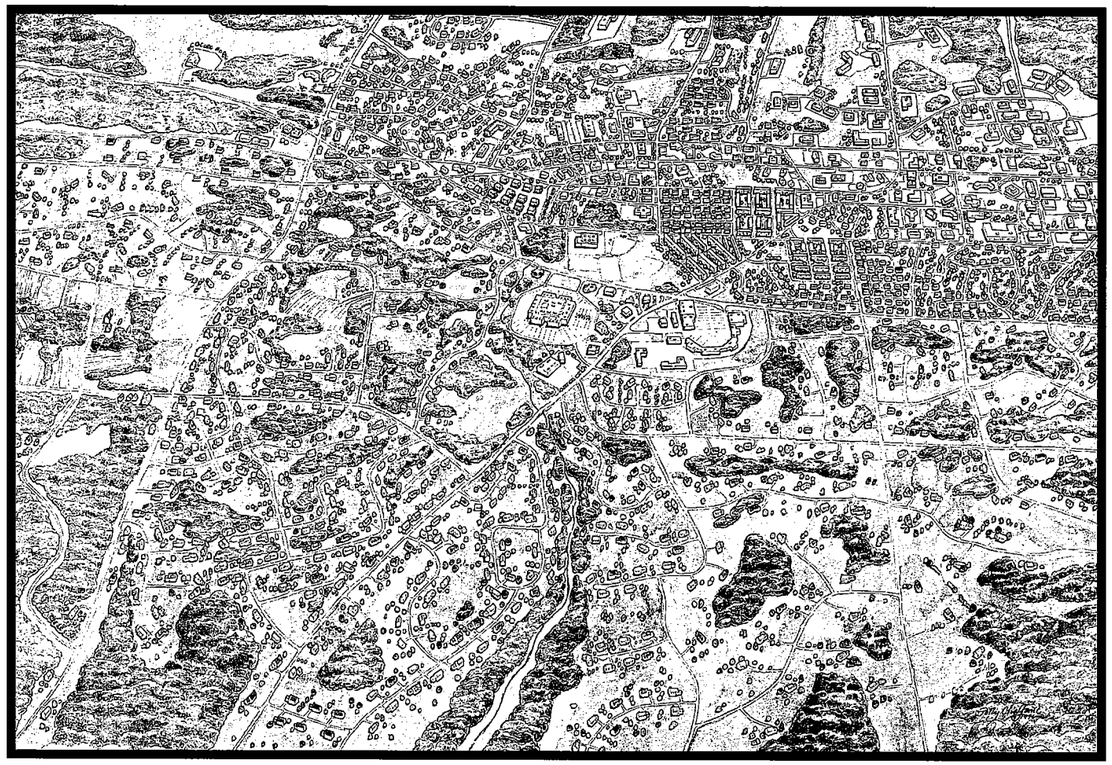
- Lititz Borough is working on a Wellhead Protection project that will monitor and propose planning alternatives to protect the municipal water supply.

- The Lititz Run Watershed Alliance is working on numerous projects addressing agricultural best management practices, wetland creation, riparian corridor restoration and education / public outreach. To get involved contact the Lititz Run Watershed Alliance at 626-8900.

What Do You Want the Lititz Run Watershed To Look Like in the Future?

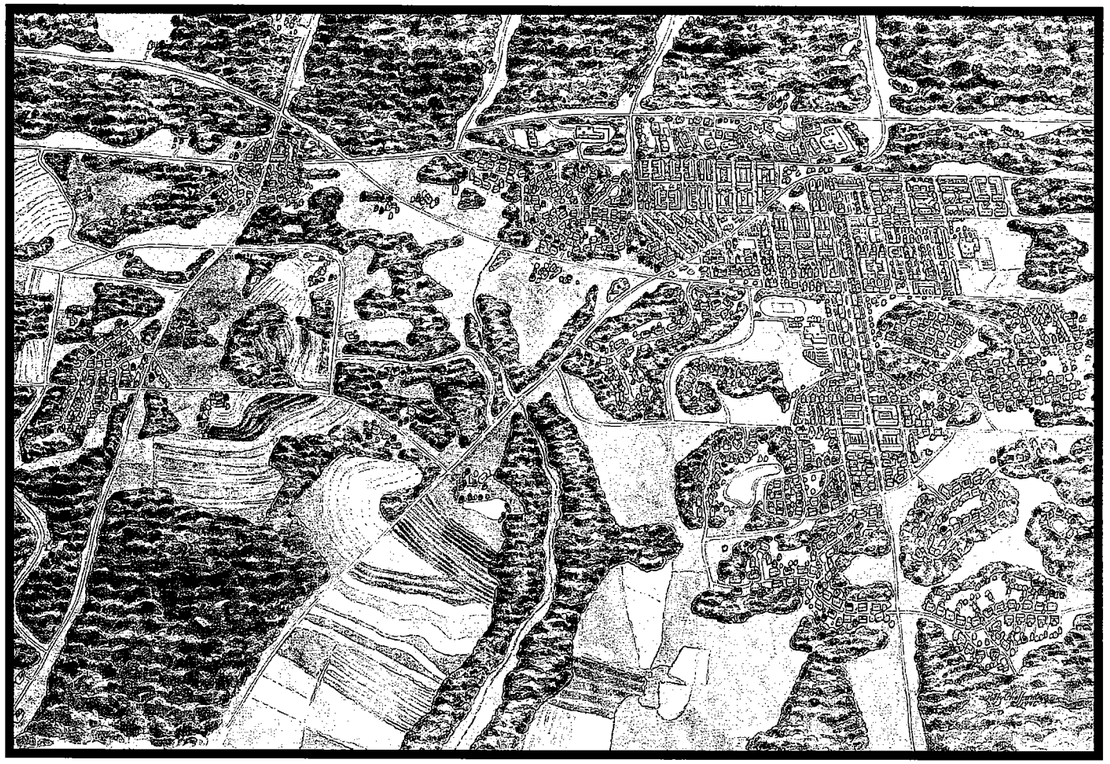
The Current Trend

This image depicts how the watershed may look if the current trend of suburban sprawl continues. Suburban sprawl is characterized by low-density development that wastes valuable farmland and other important natural resources. Typical suburban development is also heavily reliant on the automobile.



The Vision

This image represents how the watershed could look if we worked together to define a new development pattern that allows for development while maintaining working farms, preserving rural character and improving the health of the environment. The two images show the same amount of development. The difference is that this alternative condenses development which preserves farmland and open space. Condensed development gives residents better access to schools, shopping, employment, and public transportation.



Illustrations from: Landscapes, Managing Changes in Chester County 1996-2020, Comprehensive Plan Policy Element, 1996
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