LAND USE

Land use, in its most fundamental sense, is the classification of how land is used. Categories including residential, commercial, industrial, and community facilities; recreation; and open space all attempt to define settlement patterns — how land is developed or not developed (please see Maps 28, 29, 30).

Land-use analysis attempts to show the physiographic relationships between the natural environment and the developed environment, including resource limitations indicated by hydrologic and topographic features, and developable land factors indicated by soils, areas with aquifer recharge potential, and landscape vistas. Other variables are also included in the analysis of land use, such as ownership patterns and economic land values.

Land-Use Characteristics, Trends, and Sources of Impact

As illustrated in Maps 28 and 29 showing Piedmont Basin land use in 1982 and in 1992, respectively, the Anderson Land-Use Classification System, used by DNREC's Geographical Information System (GIS), separates land uses into these categories: Urban Built-Up, Agriculture, Brushland, Rangeland, Forestland, Wetlands, Water, and Barren Land. For the purposes of this report, Urban Built-Up includes residential, commercial, and industrial areas, as well as transportation, utilities, mixed urban, and other undifferentiated urban, institutional, and recreational areas. Agricultural land is a separate category. Forestland, Brushland, Rangeland, and Barren Land is combined under the Forest/Open Land category. Wetlands and Water also have been combined since relative to other categories of land use, this category changed little over the study period. These categories were compared to one another in the tables found in this section.

The trends section was generated by a rough comparison of time-series changes in land-use and land-cover data taken from 1982 and 1992 photography. These projects used similar variations of the Anderson Land-Use Classification System. The 1982 photography was interpreted and mapped in 1982 according to 7.5-minute U.S. Geological Survey quadrangles at a 10-acre minimum mapping unit, which means that the predominating use in each 10-acre or larger tract was used to label the individual polygons. The 1992 photography was interpreted and mapped at the quarter-quadrangle level using a 4-acre minimum mapping unit.

Therefore, the 1992 information is much more useful for showing smaller individual features such as settlement patterns and is not directly comparable to the 1982 data. For example, the total acreages for the watersheds are not exactly the same for the two data sets. However, since the differences are small numbers with respect to the whole watersheds, the acreages and percentages are shown for comparisons. In addition, the acres changed between 1982 and 1992 are relative numbers, but the errors are a small fraction of the total watersheds. Finally, the data for both years could be further refined to determine and correct the cause of discrepancies and classification errors in the original photo interpretation.

White Clay Creek Watershed

Urban Built-Up

As shown in Table 70, this category of land use shows a marked increase, from 38% in 1982 to 54% in 1992. In this watershed, the Pike Creek and Hockessin areas are experiencing heavy growth pressures. These areas in conjunction with the Pencader Hundred region will probably continue to lead the Piedmont Basin in growth in the near future.

There are active industrial sites located adjacent to the White Clay Creek and inactive industrial sites in Newark that present opportunities for providing high-quality employment opportunities without disrupting any critical habitats. Several abandoned industrial sites downstream of the Curtis Paper Mill could be redeveloped using the Brownfields and Blue Collar Jobs programs.

A major highway improvement that could stimulate growth is being built at the Route 273 and Ogletown Interchange. The interchange could connect to the new U.S. 301 if the 1995 to 2001 Delaware Transportation Capital Improvement Plans are fully implemented. Improvements to Route 7, Polly Drummond Hill Road, the Route 7 Christiana Crossing intersection, Route 58 extension, Pike Creek Road, Stoney Batter Road, and Valley Road are planned and could further stimulate growth.

There has been some study by Newark and the Delaware Department of Transportation of a future highway bypass around Newark that could cut through developed and undeveloped areas to the south and to the west of the city. This project would be located in the Christina River watershed, but development pressures would also be felt in the White Clay Creek watershed. Recently, funds were designated to improve signalization in the City of Newark to manage congestion.

Rail transportation for industry, passenger service, and bulk shipment is provided by the Consolidated Rail Corporation and the Amtrak Northeast Corridor. Several abandoned industrial sites including the NVF facility by Curtis Mill and the Continental/Budd/NVF plant enjoy rail access. Passenger service along the Amtrak line is possible in Newark, and a regional commuter station has been proposed in the Bread and Cheese Island area. Rail transportation produces fewer air impacts, has fewer hazardous material

accidents per ton mile, and is more energy efficient. However, a regional commuter station at Bread and Cheese Island would have to be carefully planned to avoid impacts to wetlands and wildlife habitat.

Agriculture

This land use declined from 27% as measured in the 1982 mapping to 12% in 1992. Due to land prices, the economic attractiveness of development, tax laws that favor selling assets of estates, the breakdown of local agribusiness, and other pressures, the loss of agriculture in this area will likely continue, but at a slower rate because University of Delaware agricultural lands are located here. It is unlikely that the university will develop its agricultural land in this watershed. However, the potential loss of the remaining privately owned farmland is high. Such development could impact habitat quality and increase the potential for non-point source pollution and flooding.

Forest/Open Land

This category registered 33% in 1982 and 31% in 1992. The decreased acreage in this category is probably due to development activity. Some forested areas are too sloped for farm machinery or development, and some large forested tracts have been preserved through acquisition efforts. Since there are so few active farming operations, it is unlikely that significant forestland was cleared to provide additional cropland. There is a large connected tract of forest north of Newark and along the northern sections of Middle Run. Other connected forests and open land along Pike Creek and Mill Creek are important to the quality of those waterways.

Wetlands/Water

The small 424-acre gain in wetlands, which was 2% of the total watershed in 1982 and 3% in 1992, is probably due to changes in the minimum mapping unit from 10 acres in the 1982 project to 4 acres in 1992. There was also a gain in Churchman's Marsh, where lands were classified as brushland in the 1982 project and as wetlands in 1992. The gain in water in 1992 is probably due to differences in the Churchman's Marsh area. The 1992 map, which recognized the White Clay and Red Clay junction and greater surface water in the Churchman's Marsh area, is probably indicative of the conditions that existed in 1982.

Red Clay Creek Watershed

Urban Built-Up

As expected from increases in population and development activity, this category rose from 40% in 1982 to 58% in 1992. See Table 71. This classification includes land in commercial, services, institutional, industrial, transportation, utilities, communication, and recreational categories. Most of the new growth occurred in the upper areas of the watershed around Hockessin and Yorklyn.

There are active industrial sites adjacent to Red Clay Creek that have upgraded their operations, but historic contamination and some pollutants from Pennsylvania have curtailed recreational uses of the stream. Major improvements are under construction on Route 48 (Lancaster Pike) and planned for Hercules Road (SHR 282). These improvements could stimulate new development and may lead to greater air pollution and other impacts.

Recreational rail transportation is provided by the volunteer-operated Wilmington and Western Railroad. This line uses restored historic steam engines and passenger cars to operate a railroad along Red Clay Creek. The recreational use of the stream helps educate visitors about the waterway's values and beauty.

Agriculture

Agricultural land use declined from 27% in 1982 to 12% in 1992. Due to the economic attractiveness of development, tax laws that favor selling off the assets of estates, the breakdown of local agribusiness, and other pressures, the loss of agriculture in the area is likely to continue. Most of

Table 70
WHITE CLAY CREEK WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-Up	11,286	38%	15,898	54%	4,612
Agriculture	7,842	27%	3,490	12%	-4,352
Forest/Open Land	9,852	33%	9,245	31%	-607
Wetlands/Water	492	2%	916	3%	424
Total	**29,472**	**100%**	**29,549**	**100%**	

the remaining land in agriculture is in large estates. Some of these are protected through conservation agreements with Delaware Nature Society.

Forest/Open Land

Forest and open land declined slightly during the period, from 32% in 1982, to 28% in 1992. As indicated by the maps, some forested and open land south of Hoopes Reservoir was converted to residential development. Connected forested and open land is around the reservoir and on the riparian steep slopes north and west of the reservoir.

Wetlands/Water

The total acreage of wetlands and water stayed nearly constant during this period, composing just 1% of the watershed in 1982, and 2% of the watershed in 1992. More wetlands appeared to have been recognized by the 1992 maps in the lower section of Red Clay Creek before it leaves the watershed due to the greater resolution of the 1992 data. In the 1992 map, Hoopes Reservoir appears larger, perhaps due to the greater resolution of the 1992 data.

Brandywine Creek Watershed

Urban Built-Up

This category of land use rose from 43% of the total basin in 1982 to 60% in 1992. See Table 72. As indicated by the maps, most of this new growth occurred in the northern Delaware sections of the watershed.

There are inactive industrial sites in Wilmington located along Brandywine Creek, including the Bancroft Mills, and underutilized industrial sites along the lower Brandywine that have redevelopment potential. Through cleanup and adaptive reuse, these sites can provide economic growth with smaller environmental costs, compared to developing in pristine areas where little or no infrastructure exists. In addition, according to the Governor's Task Force on the Future of the Brandywine and Christina Rivers, there are riparian tracts between Josephine Gardens and the industrial park adjacent to 12th Street that are junkyards which could be acquired for parkland or housing. They present opportunities for providing high-quality recreational amenities and employment without disrupting any critical habitats.

Urban growth is stimulated by easy access to Interstate 95, which connects Delaware to the bustling mega-

Table 71
RED CLAY CREEK WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-up	5,413	40%	7,882	58%	2,469
Agriculture	3,623	27%	1,610	12%	-2,013
Forest/Open Land	4,257	32%	3,721	28%	-536
Wetlands/Water	165	1%	293	2%	128
Total	**13,458**	**100%**	**13,506**	**100%**	

Table 72
BRANDYWINE CREEK WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-up	6,249	43%	8,759	60%	2,510
Agriculture	3,684	25%	1,953	13%	-1,731
Forest/Open Land	4,625	32%	3,680	25%	-945
Wetlands/Water	115	< 1%	314	2%	-199
Total	**14,673**	**> 100%**	**14,706**	**98%**	

lopolis that includes New York, Philadelphia, Baltimore, and Washington, DC. Major arteries include Concord Pike, Route 13, Kirkwood Highway, Route 141, and Kennett Pike, which connect the watershed with Philadelphia, Dover and other points south, Newark, and Kennett Square. Highway access to major population centers stimulates growth and causes air-quality and other concerns.

Other planned highway changes are designed to accommodate existing growth such as improvements to Route 141 at the Rockland Road intersection. The upgrading of Route 141 to four lanes is continuing to improve traffic flow to Route 202 (Concord Pike) from Newport and Route 13. The planned building of an additional twin-lane span across the Brandywine adjacent to the Tyler McConnell Bridge will further improve capacity and stimulate growth.

Rail transportation is provided in the area between steel mills in Pennsylvania and the Port of Wilmington by the Octoraro Railroad. Amtrak operates the Wilmington Shops facility in the lower Brandywine. Rail transportation stimulates economic growth and produces fewer environmental impacts compared to highway transportation. Historic contamination exists along many rail facilities.

Agriculture

In 1982, agricultural uses constituted 25% of this watershed. In 1992, only 13% of the land was used primarily for agriculture. As indicated by the maps, this loss probably was due to increased development into residential uses. Much of the remaining agricultural land in this watershed remains in large private estates.

Forest/Open Land

Acreage in this category decreased from 32% in 1982, to 25% in 1992. As indicated by the maps, this decline could be attributed to a transition to urban uses. Most of the remaining forest and open land in the watershed is connected and occurs along Brandywine Creek and some of its tributaries.

Wetlands/Water

As shown by the maps, this category was less than 1% of the total watershed in 1982, and 2% in 1992. The difference in wetlands from 115 acres in 1982 to 46 acres in 1992 was probably due to differences in land classifications between the two projects. As indicated on the maps in 1982, an area around the Wilmington Shops – Amtrak Maintenance Facility was classified as wetlands. In 1992, this same area is unclassified, and more riparian wetlands along the Brandywine Creek are recognized. With respect to water, the most apparent difference in the maps is the inclusion of the main stem of Brandywine Creek in the 1992 map.

Shellpot Creek Watershed

Urban Built-Up

Residential uses increased from 77% in 1982, to 84% in the 1992 data. See Table 73. As indicated by the maps, the gain was due to the development of agricultural land and lands classified as wetlands and water. Major highways that serve this area and are important stimulators of growth include Interstate 95, Interstate 495, Business Route 13, and Route 13. Important arteries include Marsh Road, Foulk Road, and portions of Harvey Road. Rail transportation crosses the area for the Conrail and Amtrak lines.

Agriculture

Agriculture declined from 3% in 1982, to 1% in 1992. The maps indicate that the loss was due to development.

Forest/Open Land

Forested and open land remained relatively constant at 12% in 1982 and in 1992. The remaining forest and open

Table 73
SHELLPOT WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-up	6,955	77%	7,742	84%	787
Agriculture	252	3%	97	1%	-155
Forest/Open Land	1,089	12%	1,100	12%	11
Wetlands/Water	774	9%	254	3%	-520
Total	**9,070**	**101%**	**9,193**	**100%**	

land appears to occur along riparian areas that may be unsuitable for development due to the presence of slopes, floodplains, and wetlands.

Wetlands/Water

Wetlands declined from 9% in 1982, to 3% in 1992. This loss appears to be due to changes in classification of the 1982 wetlands around the Wilmington Shops – Amtrak Maintenance facility to an unclassified use in 1992, the changes in classification of the wetlands along the Fox Point State Park due to higher tides in 1992, and the change in the classification of the Cherry Island Landfill from wetlands in 1982 to barren land in 1992. The Amtrak facility appears to be in the Brandywine and Shellpot watersheds.

Water was not classified in the 1982 map. In 1992, water accounted for 2% of the watershed. The gains occurred at the Wilmington Waste Water Treatment Plant and a body of water at Bellevue State Park.

Naamans Creek Watershed

Urban Built-Up

The data indicate a rise of 297 acres of developed areas, from 83% of the watershed in 1982 to 87% in 1992. See Table 74. As the maps show, small changes in the watershed of new land conversions to urban uses have occurred.

Agricultural

Agricultural land declined from 3% in 1982 to 1% in 1992. A relatively large area south of the Marcus Hook oil refinery was classified as agricultural in 1982. However, in 1992, this was shown as residential.

Forest/Open Land

As indicated by the maps and the data, forested lands remained nearly constant at 13% to 12% from 1982 to 1992. During this period, only 39 more acres were classified as forest. Nearly all the remaining forestland occurs in a connected parcel on the border of Arden along Naamans Creek.

Wetlands/Water

This category was less than 1% for the period. In 1982, there were 8 acres in this classification; in 1992, there were 35 acres. The differences probably reflect the use of a smaller minimum mapping unit in 1992.

Christina River Watershed

Urban Built-Up

As expected from changes in population and development activity, this category of land use has grown. The data indicate residential uses rose from 48% to 59% during the 1982 – 1992 period. See Table 75. While the difference between the two data sets is not as high a percentage change as in the other Piedmont Basin watersheds, this watershed has the highest number of acres of new urban uses. Much of the growth has occurred in the Pencader/Glasgow region. A good deal of what we see under construction today has occurred since the 1992 photography was prepared and shows that this watershed, along with the Hockessin and Pike Creek areas, will lead the Piedmont Basin in growth.

The Christina River has been an industrial river since colonial times. While cleanup has produced benefits, facilities in Newport and along the urban waterfront including the Port of Wilmington still impact the lower Christina River watershed. Industrial discharges and site runoff produce water-quality impacts from point and nonpoint sources. Redevelopment and revitalization of this area can produce economic and environmental benefits. Incentives applied here can benefit conservation efforts elsewhere since accommodating growth here will make use of existing infrastructure, be conducted in parallel with cleanup, and relieve development pressure on more viable habitat in less developed areas.

Water transportation is provided at public access points along the river for small recreational boats at Route 7, Newport, and the Seventh Street Peninsula in Wilmington. At various times, commercial traffic used the river. The town of Christiana was a seaport in colonial times.

Table 74
NAAMANS CREEK WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-up	5,345	83%	5,642	87%	297
Agriculture	215	3%	63	1%	-152
Forest/Open Land	859	13%	761	12%	-98
Wetlands/Water	8	< 1%	35	< 1%	27
Total	**6,427**	**> 99%**	**6,501**	**> 100%**	

However, the Christina River is much shallower now due to silt from erosion and runoff. Major improvements are planned and are in various stages of development along the Wilmington urban waterfront, which was a major industrial area and shipbuilding facility in World War I and II. The improvements are being coordinated by the Wilmington Waterfront Development Corporation.

The Port of Wilmington, owned and operated by the state of Delaware, provides ocean access for the region. Development is encouraged at the port to serve the state's economic needs. The port may need to be expanded in the future in order for it to remain competitive with other ports in the region.

This watershed also contains the New Castle County Airport, which is the only commercial air facility in the state capable of handling cargo and passengers on supersonic transports and jumbo jets. There is also a Delaware National Guard base at the airport.

Agriculture

This use declined from 16% in 1982 to 8% in 1992. Due to the economic attractiveness of development, tax laws that favor selling off the assets of estates, the breakdown of agribusiness, and other pressures, the loss of agriculture in the area is likely to continue.

Forest/Open Land

The data indicate that forest and open land uses were 32% in 1982 and 25% in 1992, with a loss over the period of 2,866 acres less in 1992. As of this writing, greater losses than that could be expected due to ongoing development pressures and agricultural conversion of forestland into cropland to replace lost agricultural lands. Major connected forested areas appear to be along the riparian corridor in floodplain areas, in wetlands west of Glasgow, and on and around Iron Hill and Chestnut Hill.

The maps indicate barren land associated with development activity in Glasgow Industrial Park, Fox Run, and other shopping centers along Route 40. There are also several large tracts of land being developed around the routes 40 and 273 intersection and the Cherry Island Landfill. As other lands, including agricultural areas, are displaced for development, they may become barren because they are not cropped but left in a holding pattern between productive uses.

Wetlands/Water

The 911-acre gain in wetlands and water, from 5% in 1982 to 7% in 1992, is probably due to poor wetland and water-layer coverage in the 1982 map, which used a 10-acre minimum mapping unit, as compared to the 1992 map, which used a 4-acre minimum mapping unit. Many wetlands are rather small areas of land and will not show up well at the 10-acre mapping unit. Known losses of wetlands have occurred since 1982, including a classification change in 1992 from wetland to barren land for the Cherry Island Landfill, progression of wetland areas into forest, and losses due to development. In 1982, the 10-acre minimum mapping unit appeared to interfere with recognition of the Christina River and its smaller tributaries as water. Also in 1982, the main stem of the river is not classified at all. Finally, it appears that the tide was higher in the 1992 map. These factors could explain the differences in the maps.

Positive Initiatives

There are many positive land-use initiatives under way in the Piedmont Basin. For example, the county has several land-use regulations such as wetland protection policies, floodplain protection programs, steep slopes protection, open space requirements, water resource protection overlay districts, designation of critical natural areas, and requirements for transportation analysis in rezoning and development that are applied throughout the county. In addition, cluster development regulations can be applied to develop sites and conserve significant areas of sensitive lands. Finally, the comprehensive land-use plan for the county is undergoing an update. The update will incorporate

Table 75
CHRISTINA WATERSHED LAND USE/LAND COVER COMPARISON

CLASSIFICATION	1982 ACRES	PERCENT OF WATERSHED	1992 ACRES	PERCENT OF WATERSHED	ACRES CHANGED
Urban Built-up	20,530	48%	25,468	59%	4,938
Agriculture	6,727	16%	3,322	8%	-3,405
Forest/Open Land	13,497	32%	10,631	25%	-2,866
Wetlands/Water	1,968	5%	2,879	7%	911
Total	**42,722**	**101%**	**43,004**	**99%**	

the 10 goals of "Shaping Delaware's Future." The completed and approved plan will be used as the basis for future county environmental protection programs.

White Clay Creek Watershed

The City of Newark recently annexed a tract to its north that resulted in the conservation of sensitive lands by designating them as parkland in the orderly provision of infrastructure and services. The annexation plan was used to identify lands with no development potential, lands with development limitations, and lands with desirable development potential. Comprehensive annexation plans and joint governance districts around municipalities in cooperation with the county and state can provide for the protection of sensitive resources and cost-effective provision of infrastructure and government services.

Upstream of Newark, a large portion of the Delaware land bordering White Clay Creek is protected. These forested areas provide water-quality and quantity benefits. Major water supplies for Newark and United Water are provided by this watershed. Other direct-surface water supplies for industrial use include the Curtis Paper Mill and closed industrial sites downstream from it, owned by the NVF Company.

The White Clay Creek watershed has been designated as a "Study River" for possible inclusion in the "Wild and Scenic Rivers System." If the creek meets the criteria for inclusion, a possible outcome of the upcoming National Park Service's draft management plan could be White Clay Creek's nomination as a "Wild and Scenic River."

Red Clay Creek Watershed

The Delaware Nature Society is very active in this watershed in acquiring voluntary conservation easements.

Brandywine Creek Watershed

The Brandywine Conservancy and WoodIawn Trustees are two land conservation organizations that are active and have significant holdings in the Brandywine Valley. The Wilmington Waterfront Development Corporation is actively working to redevelop Wilmington's sections of the Brandywine to correct past environmental oversights and bring economic development to the city.

Upstream of Wilmington, a large portion of the Delaware land bordering Brandywine Creek is protected. These forested and open areas provide water-quality and quantity benefits for a large fraction of northern New Castle County's population. Brandywine Creek will require future land-conservation efforts to reduce threats to its quality and the area's welfare.

Christina River Watershed

The Wilmington Waterfront Development Corporation is interested in designating a Wilmington Wildlife Refuge and redevelopment and remediation of brownfields associated with the underutilized industrial and urban waterfront. This can result in a cleaner waterfront that accepts development pressures in a concentrated area as compared to scattered development in more sensitive areas at greater economic and environmental costs.