Anderson Township

STORMWATER MANAGEMENT

COMPREHENSIVE PLANNING WORKSHOP
School of Planning
College of Design, Architecture, Art, and Planning

University of Cincinnati

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Introduction

During the Spring Quarter 2008, the Graduate Comprehensive Planning Workshop in the School of Planning, University of Cincinnati, focused on three areas of concern for Township planning, the update to the Anderson Township 2005 Trails Plan; review and evaluation of the Township's 'H' Riverfront Zoning District; and storm water management for existing and future development. The Anderson Township Trustees requested the School of Planning to study these three projects and to prepare recommendations that can be incorporated into the update of the Township's 2005 Comprehensive Plan.

This document focuses on the issue of stormwater management within the Township. It presents an evaluation of existing conditions related to stormwater, identifies existing stormwater issues, and provides recommendations to the Township for their consideration in resolving existing issues and preventing the creation of new ones.

Background

Currently, only 22%of the land within Anderson Township is available for new development. The impervious surfaces and soil compaction associated with the development of the remaining 78% of the Township generate excess stormwater runoff beyond that which would occur under natural conditions. To compound matters, much of the development in Anderson occurred prior to 1996, the year that stormwater management facilities became a requirement for all new major developments. In developments built prior to 1996, precipitation falling on pavements and rooftops flows into storm sewer which outlets directly into the Townships creeks and streams, with no controls for quantity, flow rate, or quality. Anderson Township's rolling hills, steep terrain, and level floodplains compound these runoff issues, the former contributing to the high velocity with which runoff rushes through the natural system, eroding banks and damaging property, and the latter resulting in areas of ponding and flooding.

Structure

Beyond this introduction, Section II: Analysis Components and Their Application to the Township examines in more detail the factors which contribute to excess stormwater runoff and details the components of the analysis which will later be used to analyze the Township's watersheds.

Section III: Analysis of Subwatersheds takes the tools presented in Section II and applies them to each of Anderson Township's ten subwatersheds. The existing stormwater issues in each subwatershed, as noted by the Township or as observed in the field by team members, are discussed here, and potential future issues are projected based on the analysis of the build-out of the subwatershed.

Section IV: Recommendations details the recommendations for addressing stormwater management that our team has compiled for the Township's consideration. The recommendations are categorized under the following four general strategies: professional engineering analysis, watershed protection management, regulating a healthy watershed, and retrofitting and demonstration programs. These strategies generally take a new approach to stormwater management beyond what is standard convention in Hamilton County, but an approach which has found success elsewhere in the region and in the country.

The concluding remarks can be found in Section V, and the references are located in Section VI.

As a community bordered by two rivers -- the Little Miami and the Ohio -- and fragmented by a network of creeks and streams, Anderson Township cannot avoid the issue of water, nor should it. This report will serve as a first step towards developing a more sustainable relationship between the development and stormwater runoff, reinforcing the notion that the waters of Anderson Township are a resource rather than liability.

Anderson Township Subwatersheds

The subwatershed is the unit of analysis for this stormwater management study. Anderson Township is comprised of several subwatersheds, the delineation of which is indicated in Figure 1. The hydrologic geography of the Township is divided along a ridge located roughly near Beechmont Avenue. Runoff from the northern and western subwatersheds, Dry Run, Clough, Newtown, Duck Creek, Indian Hill-Terrace Park and California, flows to the north and west eventually emptying into the Little Miami River. Runoff from the southern subwatersheds, Eight Mile, Five Mile, Four Mile, and Three Mile, flows southward and empties directly into the Ohio River.

Obviously, however, stormwater runoff follows no jurisdictional boundaries. As Figure 2 indicates, watersheds for several of the creeks extend beyond the limits of Anderson Township. On the east side of Anderson, small portions of the subwatersheds for Dry Run and Eight Mile Creek extend into Union and Pierce Townships in Clermvont County, which means that these two watersheds are impacted by development which occurs outside of Anderson's jurisdictional control. A similar situation occurs on the west side of the Township where runoff from the City of Cincinnati flows to Three Mile Creek which is located partially within Anderson Township and eventually wraps back into the City of Cincinnati. Anderson Township also receives water from Mt. Washington, which, as the name suggests, sits at a higher elevation than the surrounding area, sending runoff into Anderson Township in all directions. The reciprocal, too, occurs in several areas. Newtown is greatly impacted by runoff from Anderson Township in the Newtown Subwatershed. Additionally, a small portion of the Eight Mile watershed actually drains to Nine Mile Creek in Clermont County, and the impacts of runoff from the California subwatershed are more acutely felt within the City of Cincinnati where the watershed eventually drains to the Little Miami River. Although Anderson Township should be conscious of the cross-jurisdictional watershed issues, because Anderson has direct control only over land within its boundaries, this study will focus on the issues and potential solutions that Anderson can directly administer.

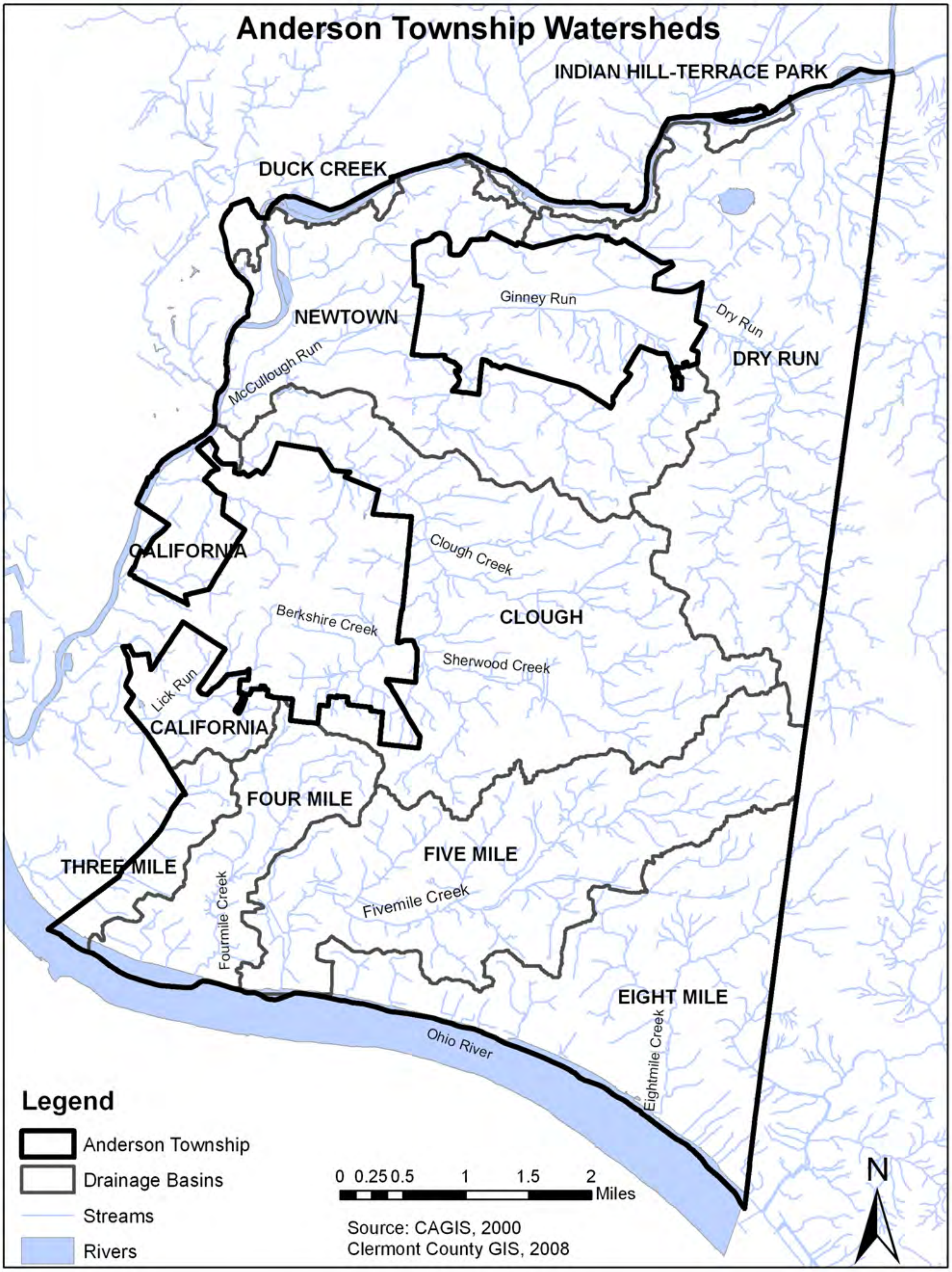


FIGURE 1. ANDERSON TOWNSHIP SUBWATERSHEDS.

Analysis Components and Their Application to the Township

Land Use

The conversion of natural and rural land to urban land increases the volume and velocity of stormwater runoff in a watershed, by in large through an increase in impervious surface. In an urban watershed impervious surfaces cover a considerable area which reduce infiltration and decrease travel time, thus significantly increasing peak discharges and runoff. Impervious surfaces include roads, sidewalks, parking lots, and buildings, and are accompanied by paved gutters, storm sewers, and other elements of artificial drainage – all of which change and replace the natural flow paths in the watershed (NRCS 1986). Further effects of urbanization include alterations in slope and soil, which also compound stormwater runoff issues such as erosion and landslides.

Anderson Township, with 1,370 people per square mile, is considered an urban area as defined by the U.S. Census[1]. Land use was analyzed to determine the classification of each subwatershed in terms of the level of development. As illustrated in Table 1, most of the watersheds are classified as fully- to highly-developed. Parcels identified as vacant, undeveloped land, or agriculture were subtracted from the total area to determine the amount of land that has been developed in a given subwatershed.

The percentage of developed land was calculated by dividing developed land by the total area. Classification of subwatersheds in terms of percent of developed land are low 0-40%, medium 41-60%, high 61-80%, and fully developed 81-100%.

In terms of development, 50 percent of the township is dedicated to residences, 64 percent of which are low density and 34 percent medium density. High density and multi-family are just three percent. Parks, recreation, open space, and township greenspace are the next most frequent land use at 17 percent, followed by agriculture at nine percent. Commercial, office, industrial, and institutional uses together comprise just ten percent. Figure 3 illustrates the land uses by watershed. Buildings occupy 1.4 square miles or 4.4 percent of the township. However, the main sources of impervious surface are driveways, parking, streets, and sidewalks, of which there are 1366 miles within the 32 square mile area.

TABLE 1. ANDERSON TOWNSHIP WATERSHED DEVELOPMENT CLASSIFICATION

Watershed	Total Area per square feet	Developed Area per square feet	Percentage Developed	Classification
California	41163351.99	26466251.61	64%	High
Clough	169219507.9	153275437.5	91%	Fully Developed
Dry Run	189677645.8	141372087.4	75%	High
Duck Creek	31470212.28	13275351.39	42%	Medium
Eight Mile	124048411.3	92704188.3	75%	High
Four Mile	53810794.12	48091853.89	89%	Fully Developed
Five Mile	139924655.7	127773642.5	91%	Fully Developed
Indian Hill Terrace Park	19621071.22	18977924.08	97%	Fully Developed
New Town	148250928.4	84728616.42	57%	Medium
Three Mile	20787261.45	18557624.67	89%	Fully Developed

Source: Anderson Township 2005 GIS data.

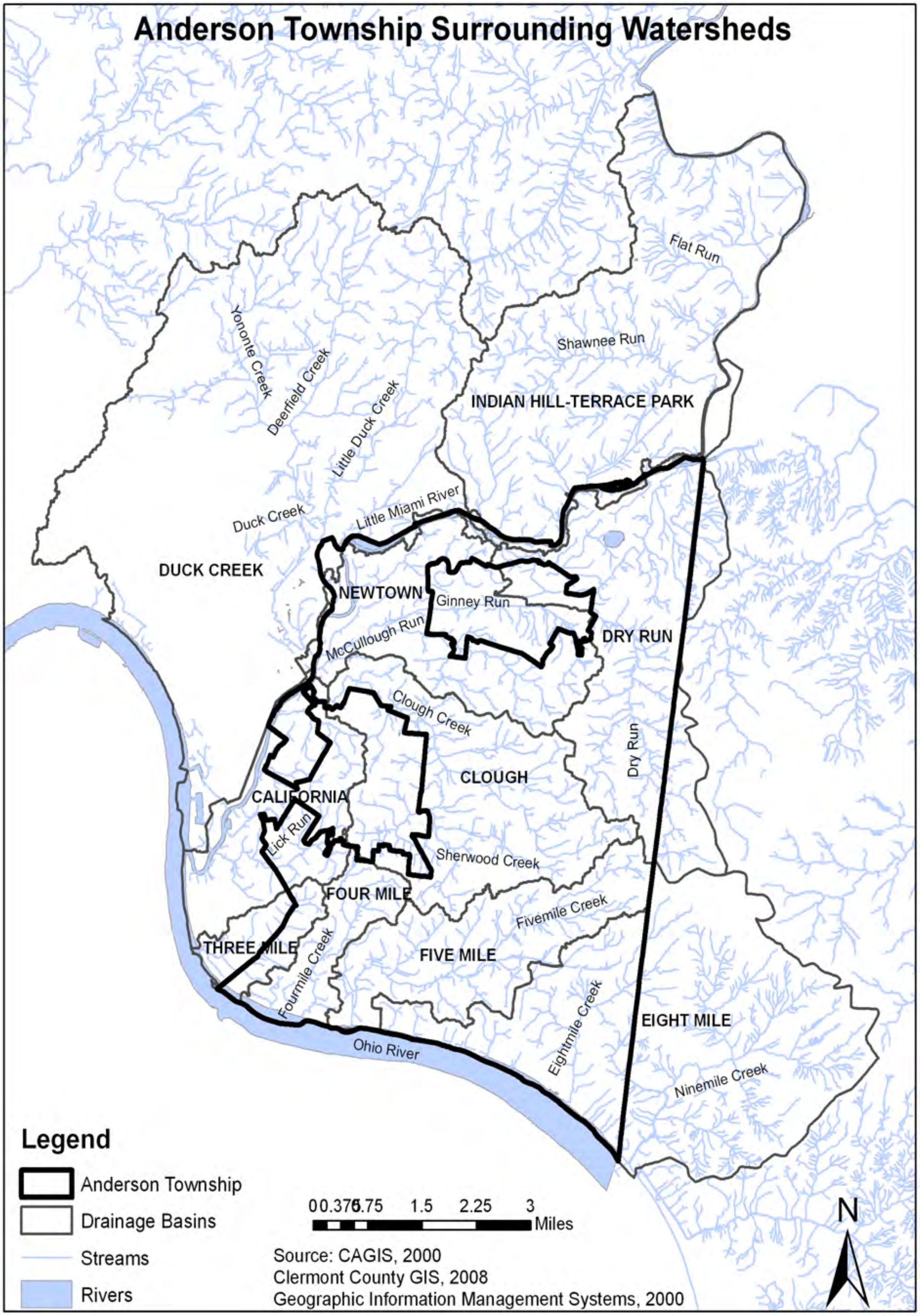


FIGURE 2. WATERSHEDS BEYOND ANDERSON TOWNSHIP LIMITS.

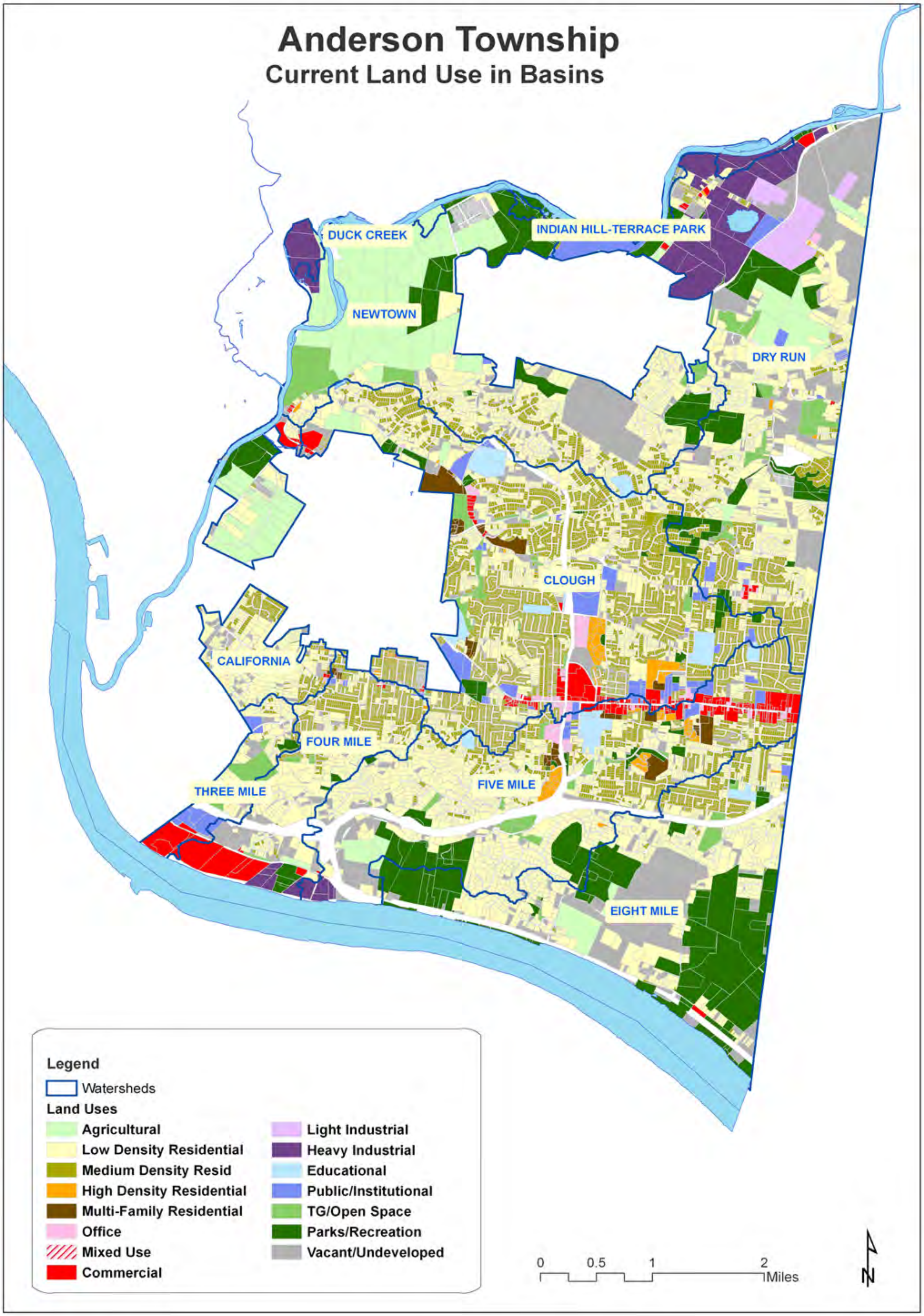


FIGURE 3. ANDERSON TOWNSHIP LAND USE BY WATERSHED. SOURCE: ANDERSON TOWNSHIP 2005 GIS DATA.

Land Cover

For the purpose of runoff calculations, land cover is a more generalized and pragmatic classification method. It represents the dominant visually-observed cover in an area. Each category includes an estimation of associated imperviousness and surface interception and retention ability. Eight categories were used in the analysis:

1. None – Water features such as ponds, lakes, wetlands, rivers
2. Open Land – Meadows, grazing fields
3. Woodland
4. Cleared Land – No Vegetation
5. Agricultural/Crops
6. Urban low density / rural - Single family, farm houses and out buildings
7. Urban high density - Commercial, industrial, apartment complexes
8. Pavement – Large parking lots, streets

The land cover classification was determined using an aerial photo and Geographic Information Systems. The following figure shows the land cover categorization for the entire township and figure 5 illustrates land cover by watershed.

There are several benefits to analyzing land cover as opposed to land use for stormwater runoff calculations. The land cover analysis also provides a finer distinction between agricultural and cleared land. It also identifies concentrations of paved areas. Another contribution to runoff is the associated soil group, which will be discussed in the next section.

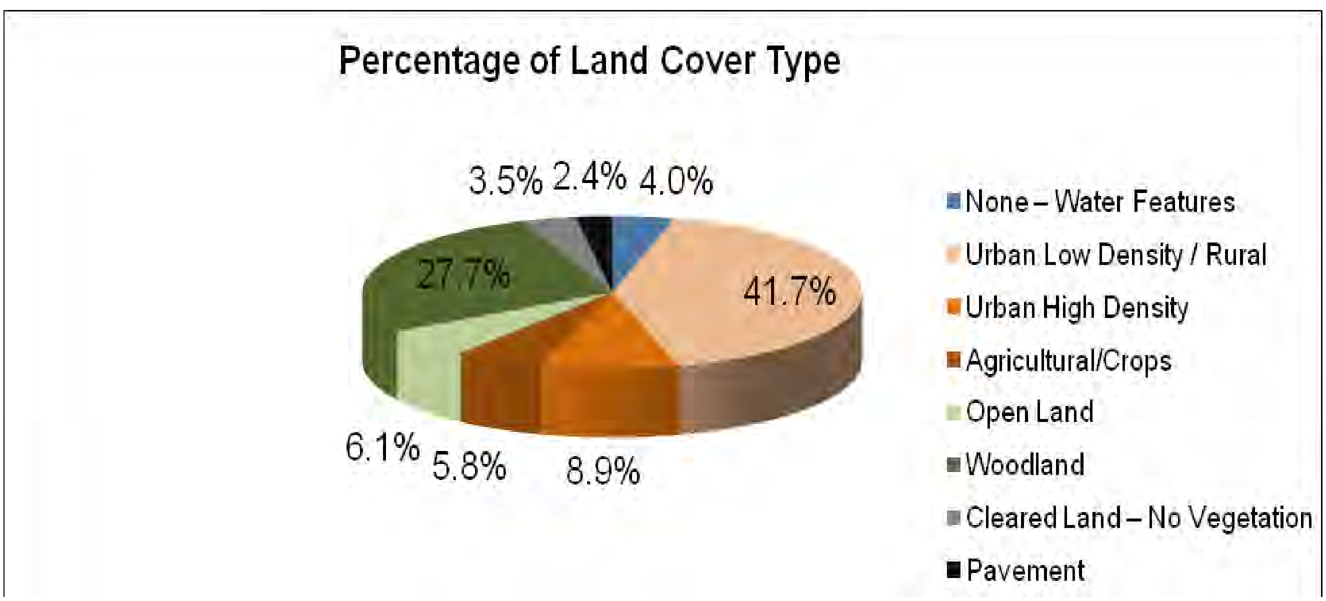


FIGURE 4. ANDERSON TOWNSHIP LAND COVERS. SOURCE: CAGIS 2006.

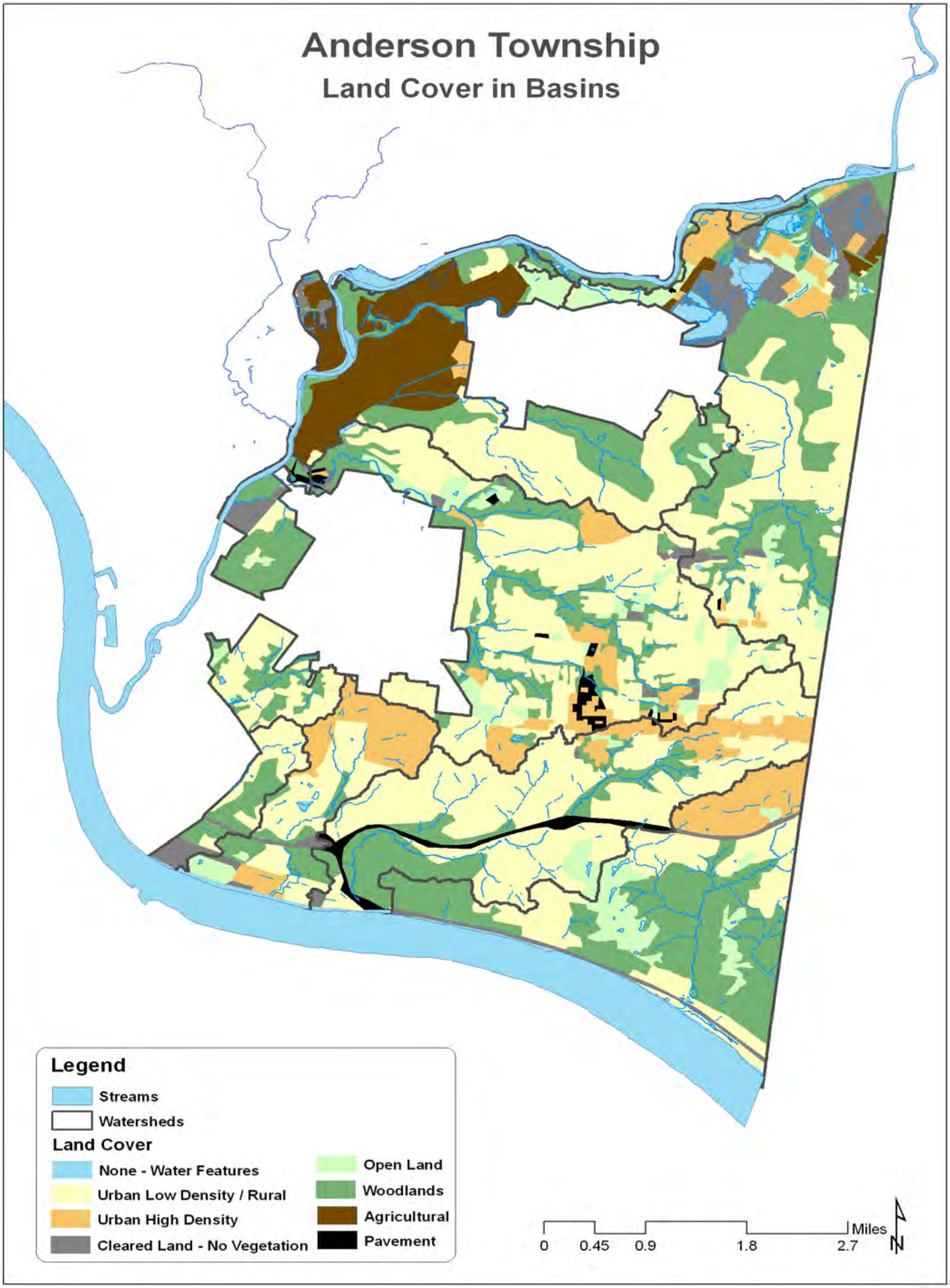


FIGURE 5. ANDERSON TOWNSHIP LAND COVER BY WATERSHED.

Soil

Since most urban areas are only partially covered by impervious surface, soil type is the other major determinant in runoff calculations. Water infiltrates soils at different rates depending on subsurface permeability as well as surface intake rates. Soils are classified into four hydrologic soil groups (HSG) - A, B, C, and D - according to their minimum infiltration rate. The HSG also indicates the transmission rate—the rate at which the water moves within the soil.[2]

Changes in land cover through urbanization have a greater effect on runoff in watersheds with soils with high infiltration rates (sands and gravels) than in watersheds dominated by silts and clays, which generally already have low infiltration rates. With urbanization, native soil profiles may also be altered as fill material from other areas are introduced, which can significantly change its infiltration characteristics.[ii] These soils are generally called Urban Land Complex and are classified as HSG C.

The four groups are defined as follows:

Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well- to excessively-drained sand or gravel and have a high rate of water transmission (greater than 0.30 in/hr).

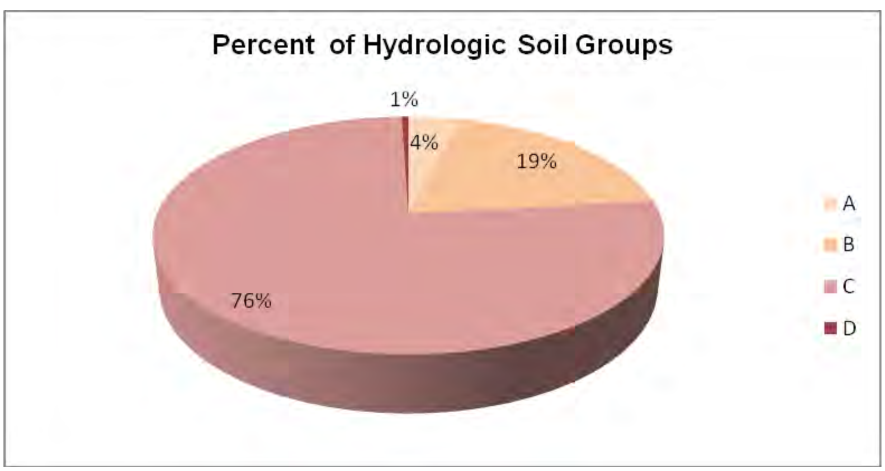
Group B soils have moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15- 0.30 in/hr).

Group C soils have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (0.05-0.15 in/hr).

Group D soils have high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanently high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr).[ii]

Group C dominates Anderson Township with the exception the watersheds Duck Creek, Indian Hills – Terrace Park and the northern parts of Dry Run, California, and Newtown, as well as the southern edge of the township along the Ohio River. These areas have primarily B soils. Some Group A soils can be founds along streams and rivers, and a small amount of Group D soil is concentrated south of Beechmont and west of Five Mile Road. The following figure illustrates the HSG distribution in Anderson Township.

FIGURE 6. ANDERSON TOWNSHIP SOIL GROUPS. SOURCE: CAGIS 2006.



Stormwater Runoff Calculation

The total volume of stormwater runoff generated by each watershed was estimated for both the existing land cover and the future build-out utilizing what is commonly known as the SCS curve number method of the Natural Resources Conservation Service.[ii] As part of this method, curve number (CN) values are assigned to each combination of land cover and HSG throughout each watershed, illustrated in Table X. An average CN value for each watershed was then determined using a weighted average based on the area associated with each CN value.

As mentioned in the Land Cover section, 79 percent of the township is occupied by water features, woodland, open land, and urban low densities/rural; however, due to the high incidence of HSG C, these areas still have a high CN, and thus higher runoff rates.

According to the Bulletin 71 of the Rainfall Frequency Atlas of the Midwest, the average rainfall for a 10-year, 24-hour storm in Hamilton County is 4.76 inches. Utilizing the SCS curve number method, the runoff in inches associated with a range of CN values was calculated, as shown in Table X below. To determine the runoff corresponding to the calculated average CN values, we interpolated between the runoff values in this table.

Finally, once the runoff depth for each watershed was established, the runoff volume for each watershed was estimated by multiplying the runoff depth by the area of the watershed contributing to runoff (only existing lakes, ponds, etc. were excluded). For the future build-out, projected land use changes provided by Anderson Township were translated into land cover types and the average CN value was adjusted accordingly for each watershed. Table 4 and 5 show the runoff volume calculations and the comparison between estimated runoff volumes generated from existing conditions and the build-out scenario.

TABLE 2. LAND COVER/HSG CN VALUES

Curve Runoff Numbers	**Hydrologic Soil Group**			
Land Cover Type	**A**	**B**	**C**	**D**
None	na	na	na	na
Woodland	25	55	70	77
Open Land	39	61	74	80
Urban Low Densities / Rural	57	72	81	86
Cleared Land	72	82	87	89
Agriculture/Crops	72	81	88	91
Urban High Density (85% Impervious)	89	92	94	95
Pavement	98	98	98	98

TABLE 3. RUNOFF/CN RELATIONSHIP

Rainfall (in)* = 4.76	**Curve Number (CN)**								
	60	65	70	75	80	85	90	95	98
Runoff (in)	1.16	1.50	1.86	2.26	2.68	3.15	3.65	4.18	4.52

*Rainfall depth from Table 1, Bulletin 71 of Rainfall Frequency Atlas for Midwest. 10-year, 24-hr storm in Hamilton County.

		Existing			
Watershed	**Area (acres)**	**CN**	**Runoff (in)**	**Total Watershed Runoff Volume (ac-ft)**	**Total Watershed Runoff Volume (cy)**
Indian Hill- Terrace Park	213	63.3	1.38	16.00	25,813
Duck Creek	211	68.8	1.77	26.00	41,947
California	987	74.8	2.24	177	285,560
Newtown	2,943	75.6	2.31	557	898,627
8 Mile	2,906	75.9	2.34	538	867,973
Dry Run	3,886	76.6	2.39	773	1,247,107
3 Mile	433	77.9	2.50	86.00	138,747
Clough	3,976	78	2.51	832	1,342,293
4 Mile	1,246	82.4	2.91	273.00	440,440
5 Mile	3,184	83.9	3.05	803.00	1,295,507

TABLE 4. RUNOFF CALCULATIONS FOR EXISTING CONDITIONS

	Future				
Watershed	**CN**	**Runoff (in)**	**Total Watershed Runoff Volume (ac-ft)**	**Total Watershed Runoff Volume (cy)**	**% Increase in Runoff from Existing**
Indian Hill- Terrace Park	**No Significant Increase**				
Duck Creek	**No Increase**				
California	77.5	2.47	195	314,600	10.2%
Newtown	76.7	2.4	590	951,867	5.9%
8 Mile	78.5	2.55	587	947,027	9.1%
Dry Run	78.7	2.57	835	1,347,133	8.0%
3 Mile	**No Significant Increase**				
Clough	**No Significant Increase**				
4 Mile	**No Significant Increase**				
5 Mile	**No Significant Increase**				

TABLE 5. RUNOFF CALCULATIONS FOR FUTURE BUILD OUT

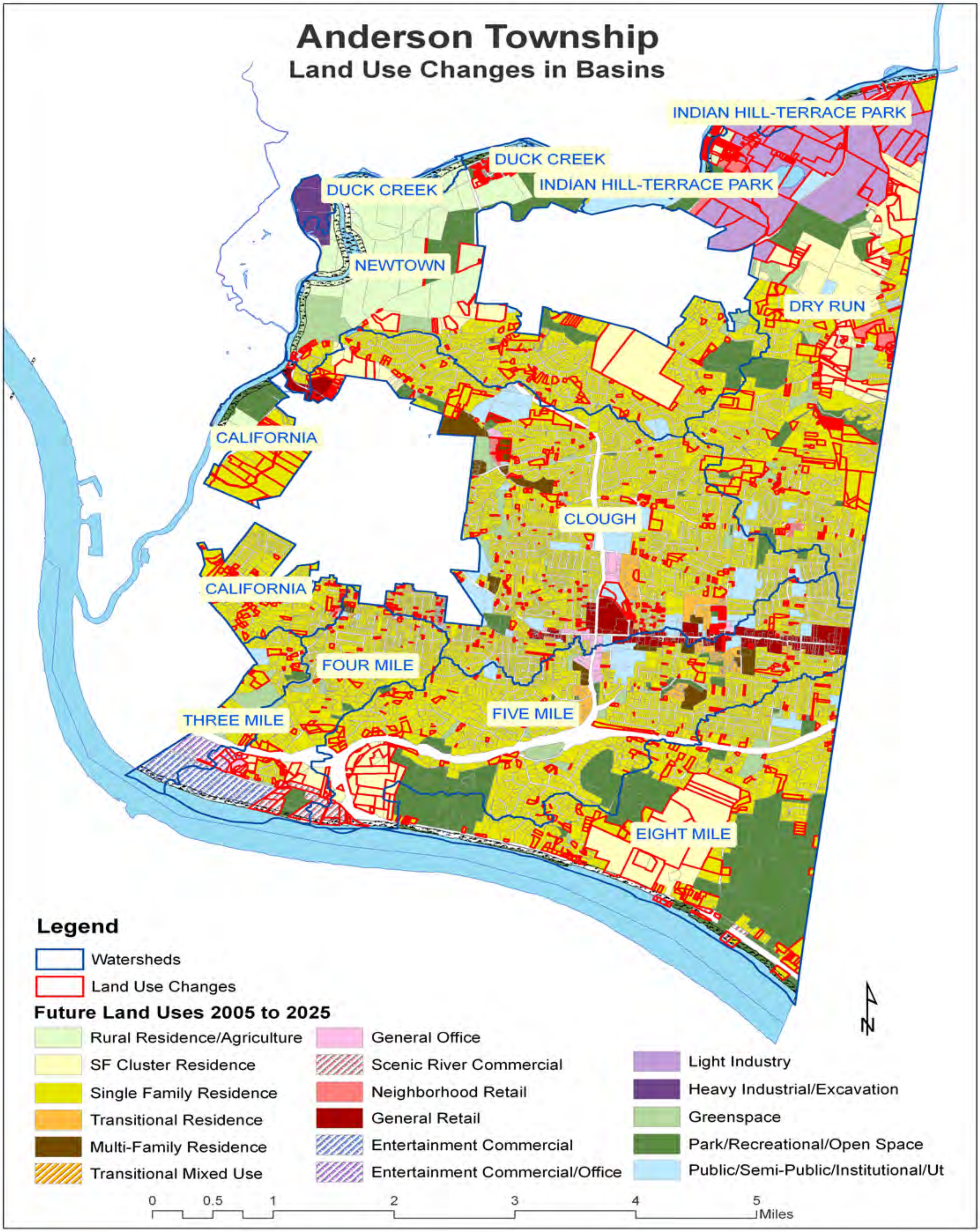


FIGURE 7. ANDERSON TOWNSHIP LAND USE CHANGES IN SUBWATERSHEDS. SOURCE: CAGIS 2006.

Build Out

According to the Future Land Use Plan of Anderson Township, 6.5 square miles or roughly 25 percent of the township will be changed by 2025. Much of this change is occurring in the northern and southern portion of the township in currently agricultural or underutilized commercial and industrial areas, and often involves transforming low intensity to higher intensity uses. From the build out, a 33 percent increase in stormwater runoff is projected, distributed between the Newtown, Dry Run, California, and Eight Mile watersheds. This results from an expected increase in impervious surface due to changes in land cover.

Natural and Engineered Drainage

Anderson Township, bounded by the Little Miami River to the north and west and by the Ohio River to the south, has an extensive stream network draining into the two rivers. There is also substantial slope (thirty percent) in the northern and southern portions of the township, which increases the velocity of stream flows. Through urbanization, peak discharge is increased both in volume and in runoff rate, which when combined with steep slope, further increases stream flow velocity.

The natural drainage system (Figure 8) is augmented by a separated storm sewer system concentrated throughout the residential areas in the middle section of the township and a small number of combined storm sewer systems at the edge of Mount Washington. Because stormwater detention was not a requirement until 1996, only a small number of detention subwatersheds are scattered throughout the Township. These detention subwatersheds are associated with subdivisions constructed since 1996, and new commercial and industrial development (or redevelopment) which has occurred in recent years. Detention subwatersheds are designed to slow peak discharge to pre-development rates and prevent flooding of properties downstream. Unfortunately, as mentioned earlier, only a small percentage of the Township's runoff is slowed by detention prior to emptying into the natural drainage ways.

Analysis of Subwatersheds

General Approach to Stormwater Issue Analysis

The increase in volume and velocity of stormwater, particularly through increased imperviousness, overburdens the capacity of the existing storm sewer system leading to erosion, flooding and standing water as well as water quality issues which have not yet been examined for these watersheds. Throughout the township, examples of all of these issues have been identified (see Figure 8a) and considered on a watershed level. Using the process described in the Stormwater Runoff Calculation section the issues were regarded in relation to land cover, soils, and average runoff. Other factors such as natural and engineered drainage, and current and future land use were observed to find potential contributors to the problems.

Newtown and Duck Creek Subwatersheds

General Characteristics

The Newtown subwatershed is comprised of much of the Village of Newton and approximately 2,950 acres of Anderson Township which surround the village to the north, west and south. As can be seen in Figure 2, the drainage ways of the subwatershed are three major streams with several smaller tributaries all of which flow to the Little Miami River, either to the north through the Duck Creek subwatershed or to the east where the river wraps through the Newtown subwatershed. At the southeastern corner of the subwatershed, the Little Dry Run Creek courses northward along the eastern edge of the subwatershed and into Newtown where it turns westward along SR 32 and eventually joins another tributary before emptying into the Little Miami River. In terms of topography, much of the southern half of the Newtown subwatershed has slopes greater than 30%, while the northern portion of the subwatershed is flat, as much of it lies in the floodplain of the Little Miami River. These differences in topography also correspond, unsurprisingly, to the soil characteristics of the subwatershed; the soil in the northern half of the Newtown subwatershed is generally classified as Hydrologic Soil Group B, while the soil in the southern half of the subwatershed is generally classified as Hydrologic Soil Group C. Located to the north of the Newtown subwatershed is the Duck Creek subwatershed, a small, 211-acre watershed primarily within the floodplain of the Little Miami River. As indicated by Table 4 in the previous section, the existing stormwater runoff volumes generated by the Newtown and Duck

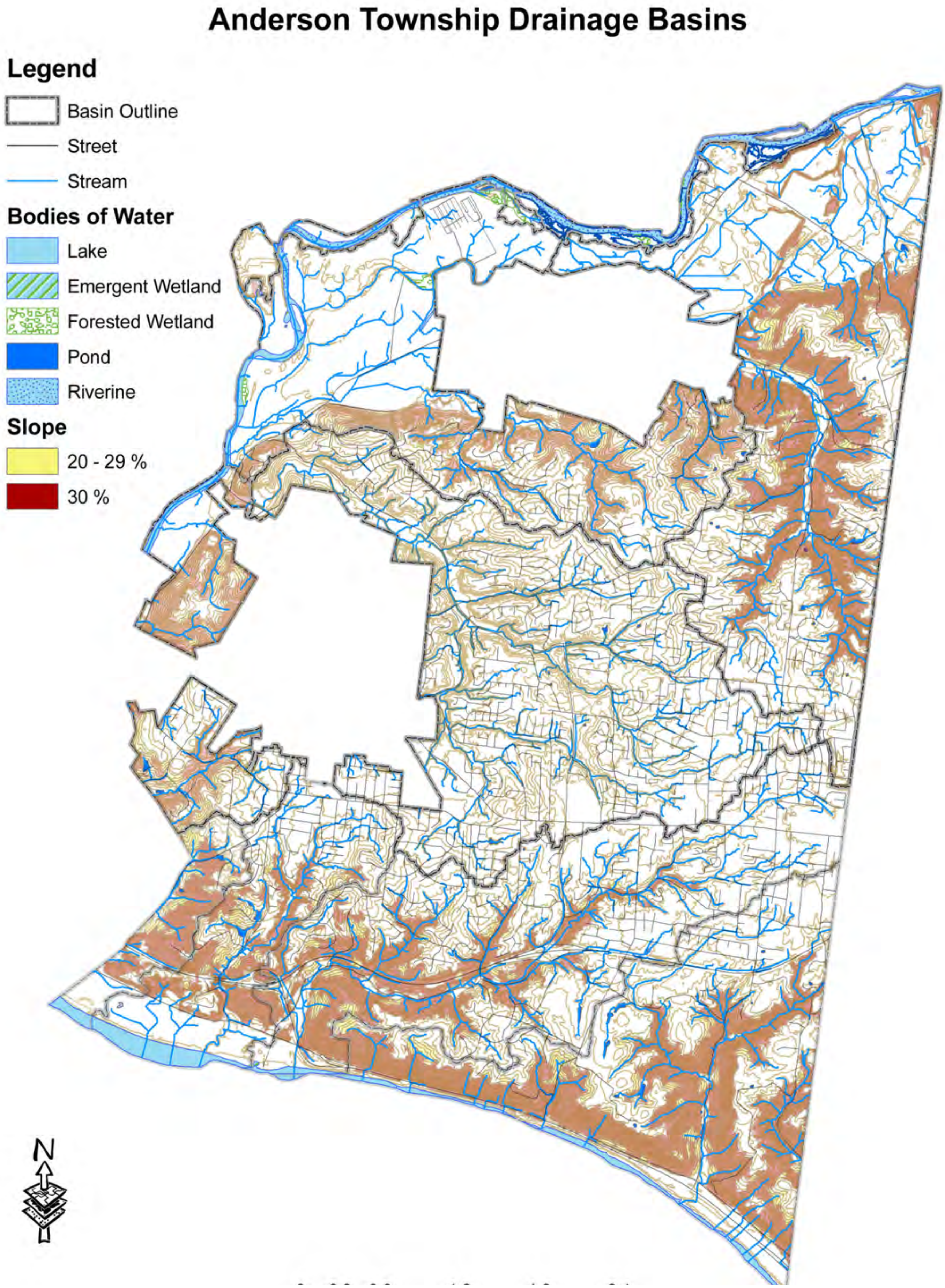


FIGURE 8. ANDERSON TOWNSHIP NATURAL DRAINAGE SYSTEM. SOURCE: CAGIS 2006.

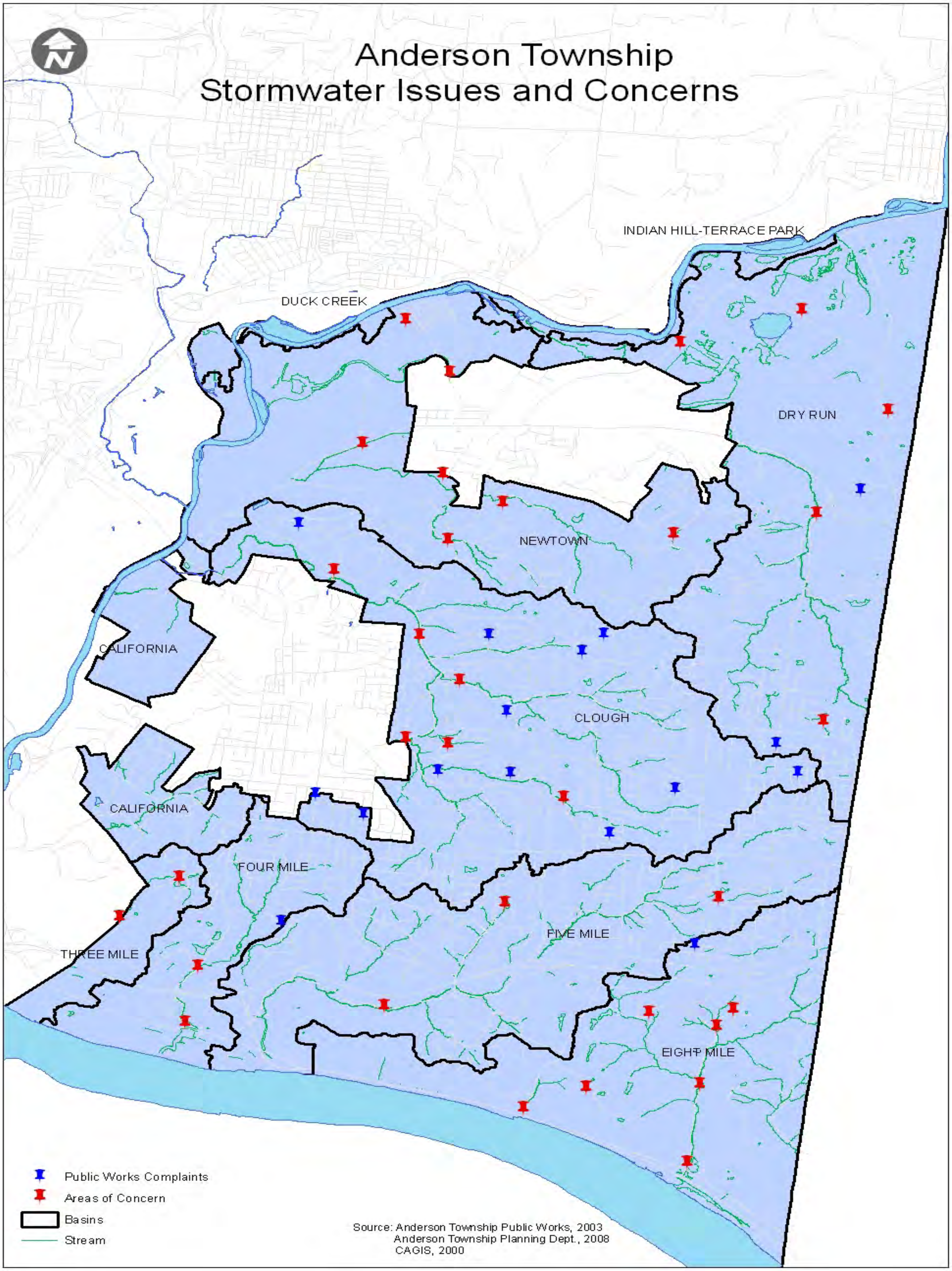


FIGURE 8A: STORMWATER ISSUES IN ANDERSON TOWNSHIP.

Creek subwatersheds are estimated to be approximately 900,000 cy and 42,000 cy, respectively.

Newtown and Duck Creek are the two least developed subwatersheds in the township at 57% and 42% respectively. In the case of Newtown, the southern half of the subwatershed contains almost all of the developed land whereas the northern half and most of the Duck Creek subwatershed are made up primarily of agricultural lands and contain very few built structures. Land cover in the Newtown subwatershed, as indicated in Figure 11, is predominantly comprised of agricultural (35%), urban low density (32%), and woodland (24%). Similarly, Duck Creek is covered by woodland (38%), agriculture (24%), and cleared but undeveloped land (16%).

Existing Stormwater-Related Issues

Two major areas within the Newtown subwatershed were identified by Township staff as containing issues relating to erosion. In our field surveys (see Figure 12), team members were able to observe the problem first hand. On the eastern side of the subwatershed along the section of Little Dry Run Road north of Williams Creek Road, the creek of the same name meanders under the roadway, and areas of severe erosion along its banks can be observed. Since this creek runs into the neighboring village, it is likely that property owners there are experiencing similar problems with erosion.

Erosion is also an issue at the convergence of two waterways which make up McCullough Run. At the intersection of Lawyer and Newtown Roads, the merged creek crosses underneath the road through a culvert no larger than five feet in diameter. The capacity of this system is not known; however, the culvert is more than half full during a light rain, and there are signs of erosion along the banks of the creek in this area.

The area of largest concern within the Newtown subwatershed is at the intersection of Ragland Road and Turpin Lane. Both roads near this area are continuously flooded. As the Township is aware, the creek actually passes over Ragland Road in one section (See Figures 9 and 10). Along Turpin Lane, significant standing water can be seen on roadway and on the adjacent properties. This low-lying section farms part of the floodplain which extends across RT 32. There is the possibility that the road is acting as a levee preventing water from draining back to the river. Property owners in this area are likely impacted by this hazard, which potentially prevents access to their homes and businesses, particularly during times of heavy rain. Further development upstream is sure to exacerbate the problems.

Analysis of Existing Stormwater-Related Issues

As mentioned previously, much of the erosion and significant runoff volumes are typical problems experienced in Anderson Township as a result of development upstream, here mainly of single family subdivisions, which occurred prior to stormwater detention requirements. This development type is compounded with the significant slopes in the area which naturally serve to prevent infiltration and increase runoff velocity. Recommendations for reducing further erosion will be made in Phase II of this project.

In dealing with the flooding issues at Ragland and Turpin Lane, the Township has indicated that a proposed detention subwatershed will be constructed in a green space north of Merlin Court when Hamilton County has acquired the funds necessary to follow through with the project. This detention subwatershed would certainly mitigate the flooding problems in the Ragland Road/ Turpin Lane area. However, further study by an engineer will be necessary to address issues of standing water on and adjacent to Turpin Lane which occurs even during periods with no significant rainfall.

Future Build-out

Changes in the use of the land currently owned by the Hermitage Club are likely to increase runoff down McCullough Run to the flooding area on Ragland Rd. Other parcels highlighted in Figure 13 have been identified for changes from less-developed (such as

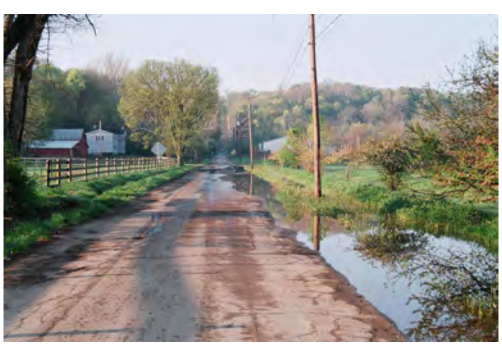


FIGURE 9 AND FIGURE 10: PERMANENT FLOODING IS A PROBLEM ALONG RAGLAND ROAD AND TURPIN LANE IN THE NEWTOWN SUBWATERSHED.

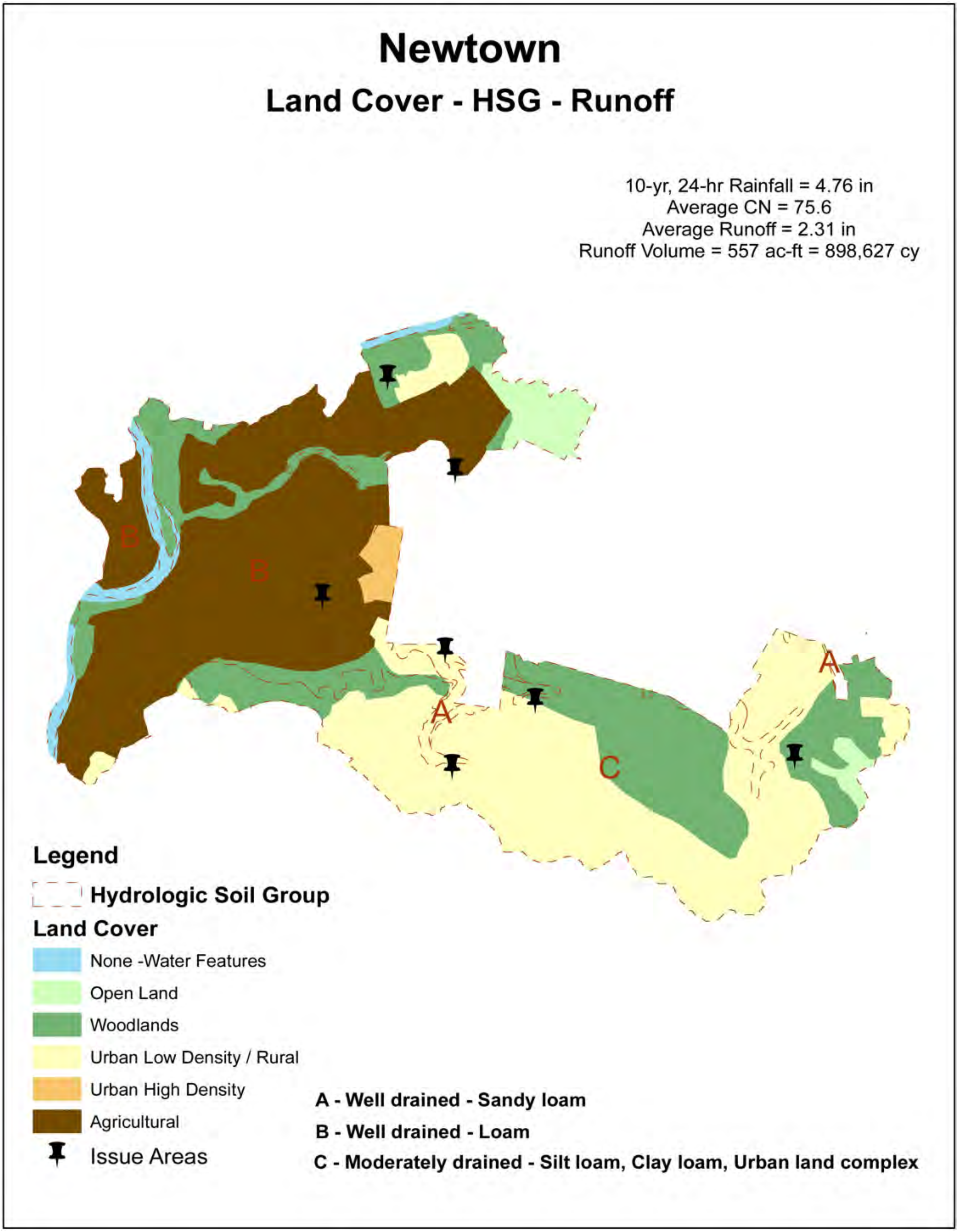


FIGURE 11: LAND COVER IN NEWTOWN SUBWATERSHED. SOURCE: CAGIS 2006.

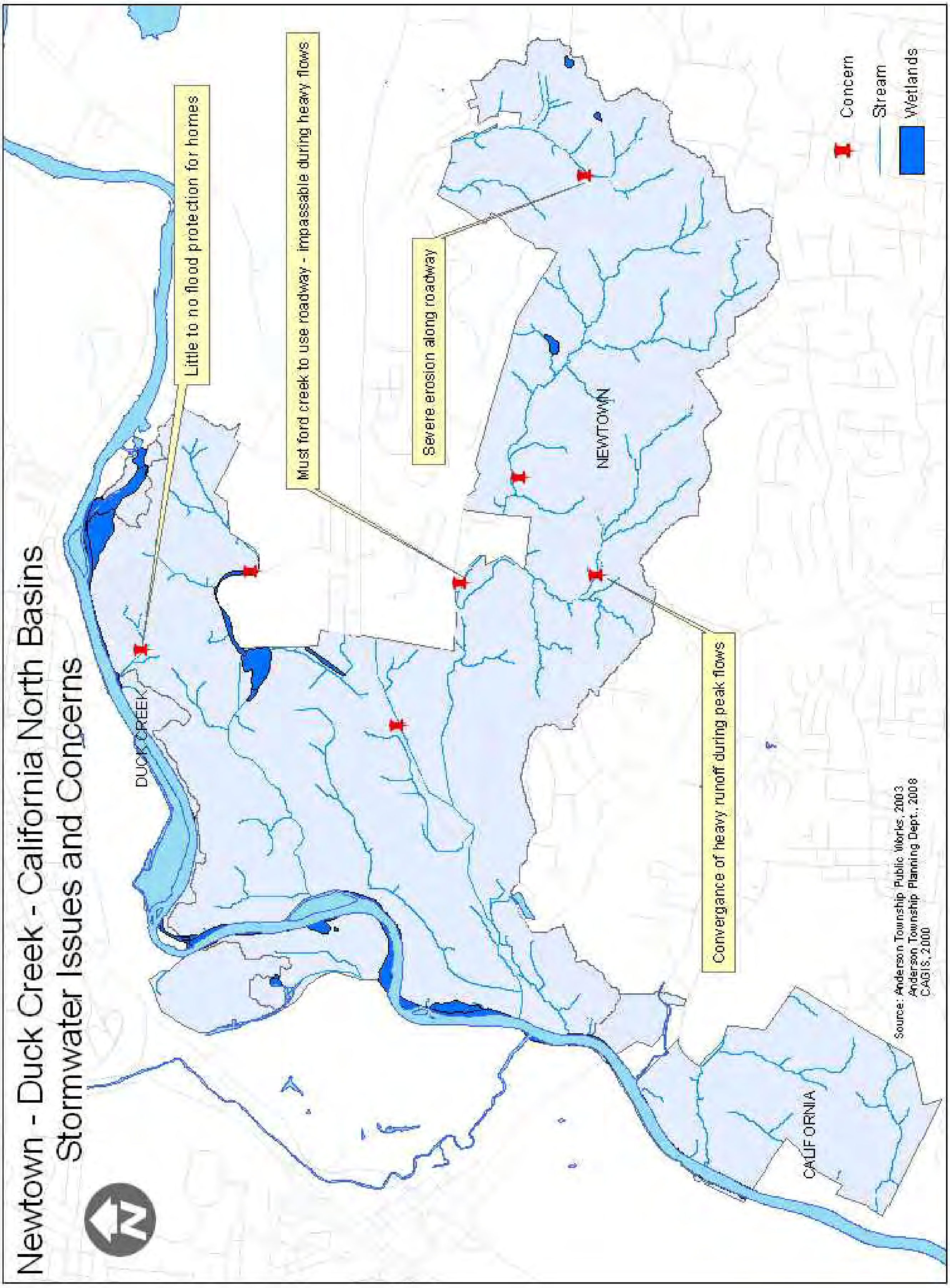


FIGURE 12: STORMWATER ISSUES IN NEWTOWN, DUCK CREEK, AND CALIFORNIA NORTH SUBWATERSHEDS.

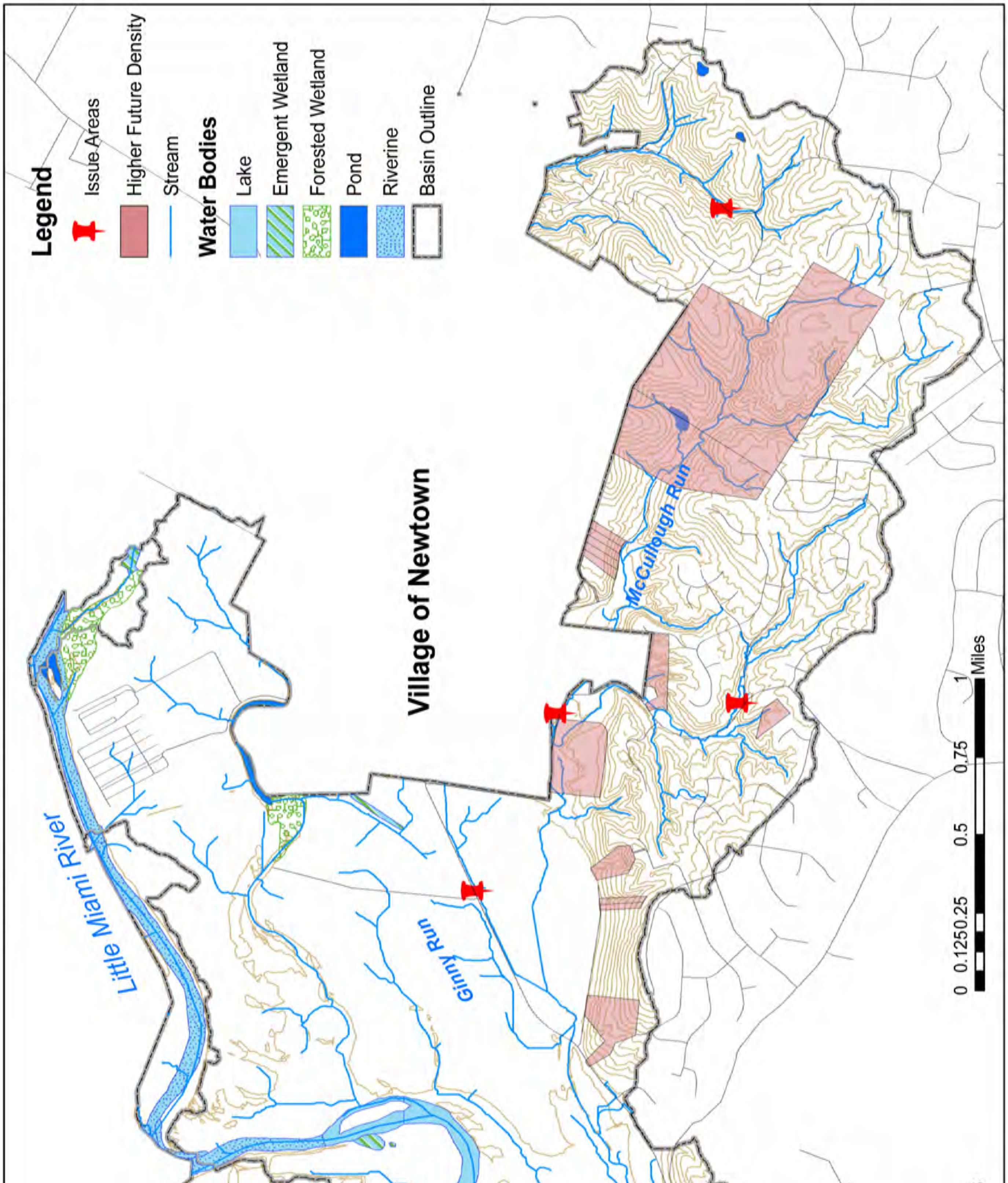


FIGURE 13: FUTURE ISSUES IN NEWTOWN AND DUCK CREEK SUBWATERSHEDS.

Agriculture/ Rural) uses to Single Family Cluster. The runoff from the land under these new uses is expected to increase. Runoff for the entire Subwatershed is calculated to increase by nearly 6 % from the existing to the future land use.

Indian Hill-Terrace Park Subwatershed

General Characteristics

The Indian Hill-Terrace Park Subwatershed is the northernmost subwatershed of Anderson Township and runs along the Little Miami River. The land cover of this 213-acre subwatershed is predominately woodlands at 46% and ponds, lakes and wetland at 38%, with a small portion that is classified as urban high density at 12%. The Indian Hill-Terrace Park Subwatershed is predominately flat and located in the floodplain of the Little Miami River. It has a small portion of 30% or greater slopes located on the southeast border of the subwatershed adjacent to the Dry Run subwatershed. The majority of Indian Hill-Terrace Park's land use is classified as heavy industrial and parks/recreation with another large portion being public/institutional where a mega church is currently under construction. There have been no major issues or concerns with Indian Hill-Terrace Park Subwatershed from public works or from area residents. Although a large church is currently under construction, the stormwater runoff from that site will outlet directly to the Little Miami River and will not impact any additional properties. The Indian Hill-Terrace Park watershed subwatershed is comprised of 213 acres with a total estimated existing runoff volume of 26,000 cy with no significant increase for future build out.

Dry Run Subwatershed

General Characteristics

The Dry Run Subwatershed is bound by the Indian Hill-Terrace Park Subwatershed to the north, Clermont County to the east and the Village of Newtown to the west. At 3,886 acres, the Dry Run subwatershed is one of the largest watersheds within Anderson Township. Dry Run Creek begins near Clough Pike and runs northward through the length of the subwatershed until it outlets at the Little Miami River. One portion of Dry Run Creek passes through the City of Newtown, and some runoff enters Anderson Township from Clermont County to the east, contributing to the total runoff volume. As can be seen in Figure 17, Dry Run's land cover is comprised of low urban development land at 36%, woodland at 31%, and cleared land at 12%. Much of the area along Dry Run Creek has slopes of 30% or more. The 3,886 acres of Dry Run subwatershed has a total watershed runoff volume of 1,200,000 cy and could have a potential 8% increase in runoff from existing land use conditions to future land use conditions. The hydrological soil group for Dry Run has predominately B classification in the northern half and predominately C classification in the southern half with ribbons of A classification running throughout the subwatershed.

Existing Stormwater-Related Issues

An area of concern noted by the township is located on Roundbottom Road, just east of Edwards Road, where there have been reports of flooding and evacuation of residents. This is a low-lying, relatively flat area with heavy industrial use located to the southeast. There may be run-off from the heavy industrial sites heading downhill and running into the low lying areas and possibly flooding the residential houses while flowing to the river. There is a detention subwatershed located to the southeast of the problem area. The soil type located in this problem area is classified as A which indicates a good area to build upon with high infiltration rates. Yet, there are no inlets in the surrounding area to potentially help drain the water. We preliminarily recommend that the Township hire an engineer to determine if this issue can be addressed through the addition of infrastructure.

The team observed a potential issue not mentioned by the Township on Broadwell Road, northwest of the railroad tracks, where a detention pond appeared to be overflowing its banks following only a slight rain. Because this was not an issue noted by the township, we would like Township input regarding this issue to determine whether a problem exists. The detention pond appears to serve the light and heavy industries in the area. We surmise that either the detention pond was designed to have overflow, or the detention pond may have been undersized.

Along Mount Carmel Road, between Broadwell Road and Newtown Road, there is serious erosion along Dry Run stream that runs in close proximity to the road. This erosion is likely the result of runoff from the large lot residential development upstream, the slow infiltration rate of the soil, and steep winding terrain of the area.

Currently, as noted by Township staff, a private driveway bridge over Dry Run on Eight Mile Road is being reconstructed, as shown in Figure 15. Stormwater runoff volume and velocity likely undermined the foundation of the bridge requiring the

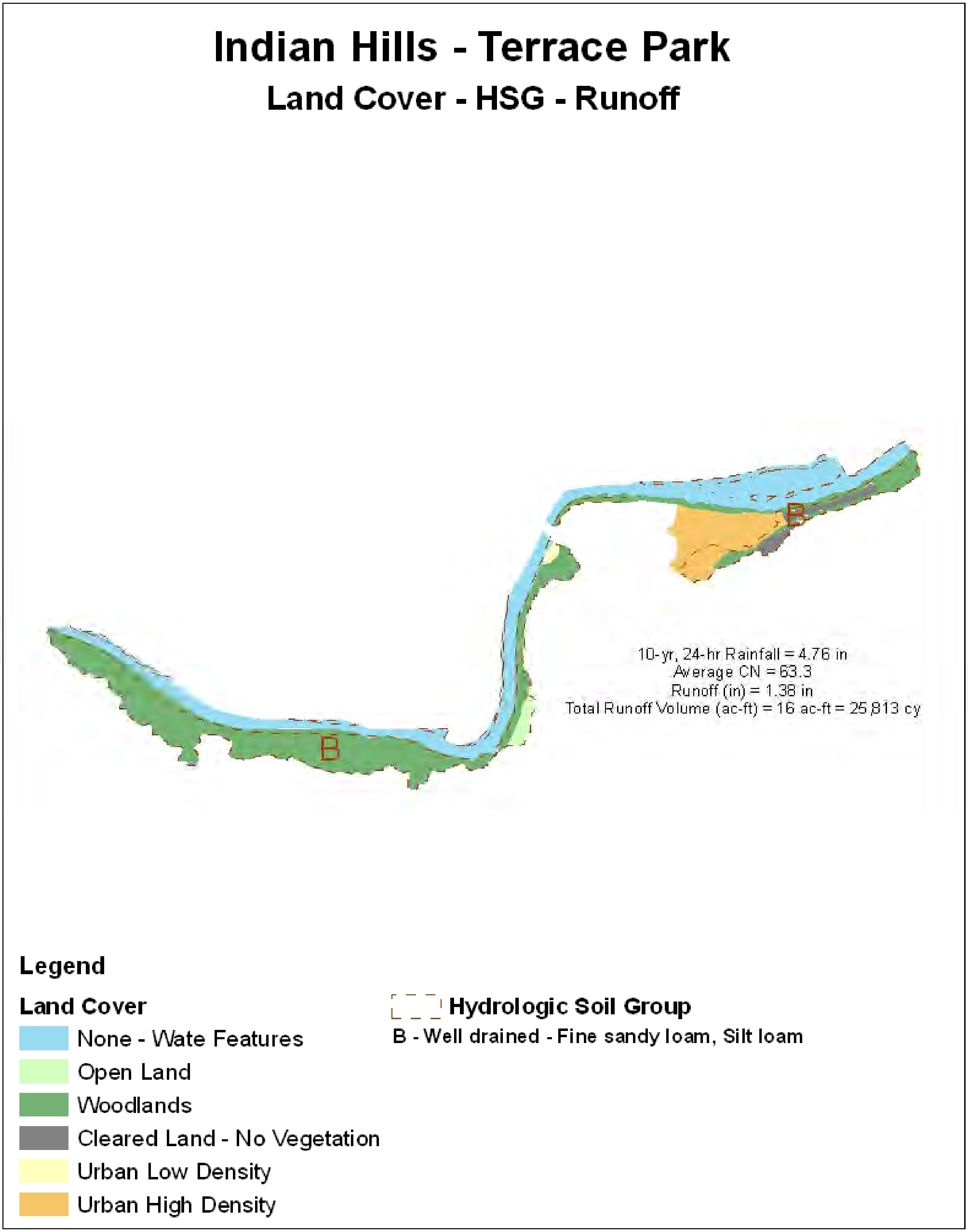


FIGURE 14: LAND COVER IN INDIAN HILLS-TERRACE PARK SUBWATERSHED. SOURCE: CAGIS 2006.

FIGURE 15: RECONSTRUCTION OF A PRIVATE DRIVEWAY BRIDGE IN THE DRY RUN SUBWATERSHED.

FIGURE 16: EROSION IN THE DRY RUN SUBWATERSHED.

replacement. Also, in this area, significant erosion was observed which had undermined the toe of the channel slope, causing soil and trees from the bank above to slip into the creek. See Figure 16. These erosion issues in Dry Run are very likely the result of the significant amount of development located upstream from the problem areas, most of which was constructed prior to detention regulations. As mentioned previously, this is a common problem throughout the Township.

The last issue that should be addressed in Dry Run Subwatershed is standing water at 1917 Eight Mile Road which came from the public works issue data. There are a number of inlets located in close proximity to this issue, so this may not be the concern. The standing water may be caused by a low area in the topography causing water to stand.

Future Build-out and Storm-Related Issues

Significant future industrial development is to occur in the northern half of Dry Run at the corner of Broadwell Road and Mount Carmel. Approximately 200,000 acres are slated to be developed as residential at the corner of Mount Carmel Road and Newtown Road, according to Anderson Township's future land use plan. This future development may exacerbate erosion and flooding problems downstream.

Five Mile Subwatershed

General Characteristics

The Five Mile Subwatershed is located in the southern half of Anderson Township and contains nearly 3,200 acres of land. Every tributary within the subwatershed converges with or feeds into the Five Mile Creek, which outlets into the Ohio River. The Subwatershed has the highest Average Curve Number in Anderson Township (83.9), which reflects a very high amount of direct peak flow runoff that is not infiltrated into the soils during a storm event (See the stormwater runoff calculations in Figure 21).

A large percent of Five Mile Subwatershed contains slopes of 30 percent or greater. This becomes a more significant feature as the creek parallels Interstate 275 and progresses closer to the Ohio River. The predominant soil type is Hydrological Type C, a mix of silt and clay loam. The Five Mile Subwatershed has approximately five percent of total land cover devoted to significant levels of impervious pavement, second highest in Anderson Township. This is primarily because of the Interstate, its interchanges, and parts of U.S. Route 52 traversing through the subwatershed. Nearly 60 percent of the land is devoted to residential uses. The residential land is fairly low density except for areas in proximity to I-275.

Existing Stormwater-Related Issues

The existence of these large paved areas leads to one of the major stormwater runoff issues observed within Five Mile. As I-275 passes north of Five Mile Road and the creek, stormwater

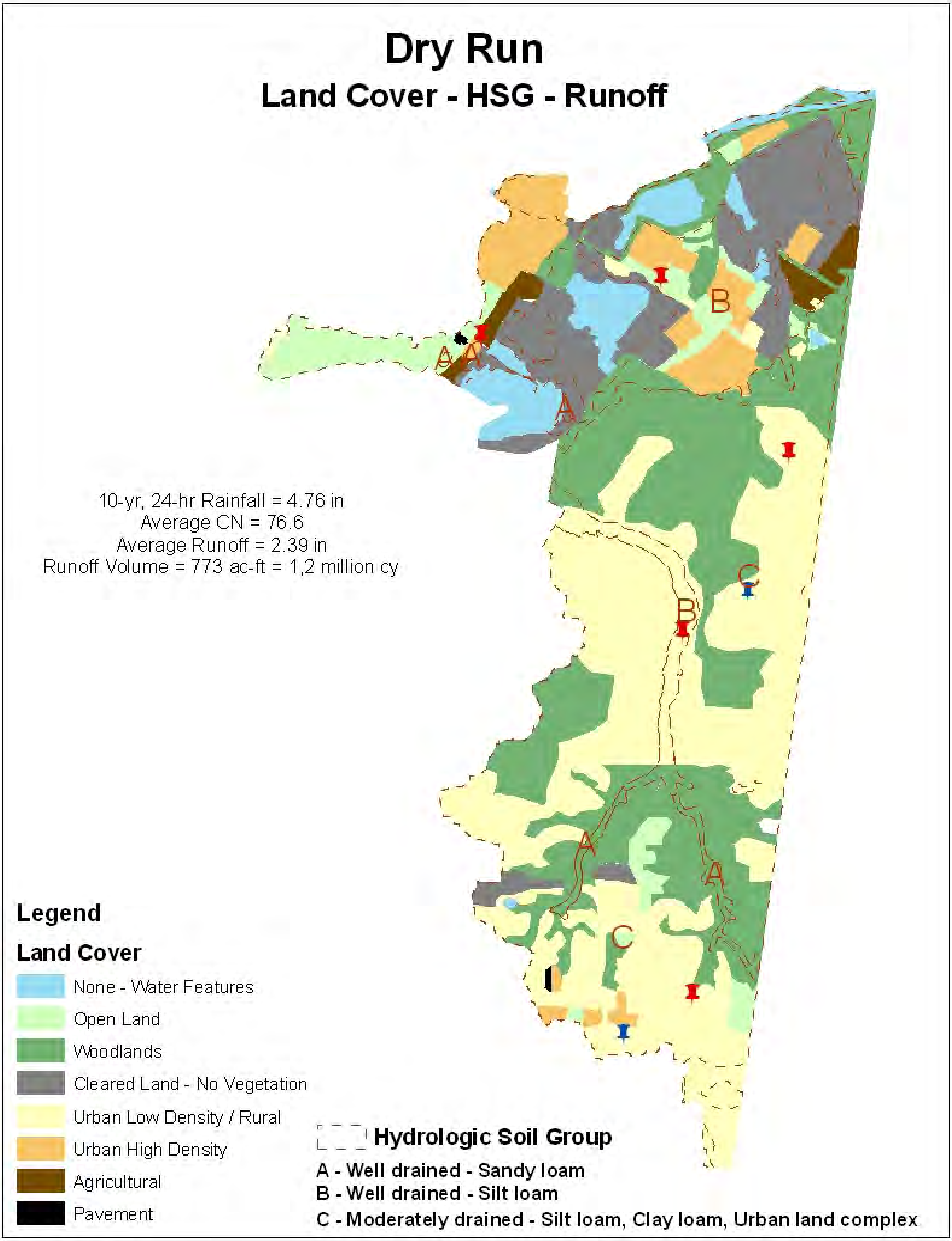


FIGURE 17: LAND COVER AND STORMWATER ISSUES IN INDIAN HILLS- TERRACE PARK AND DRY RUN SUBWATERSHEDS. SOURCE: CAGIS 2006.

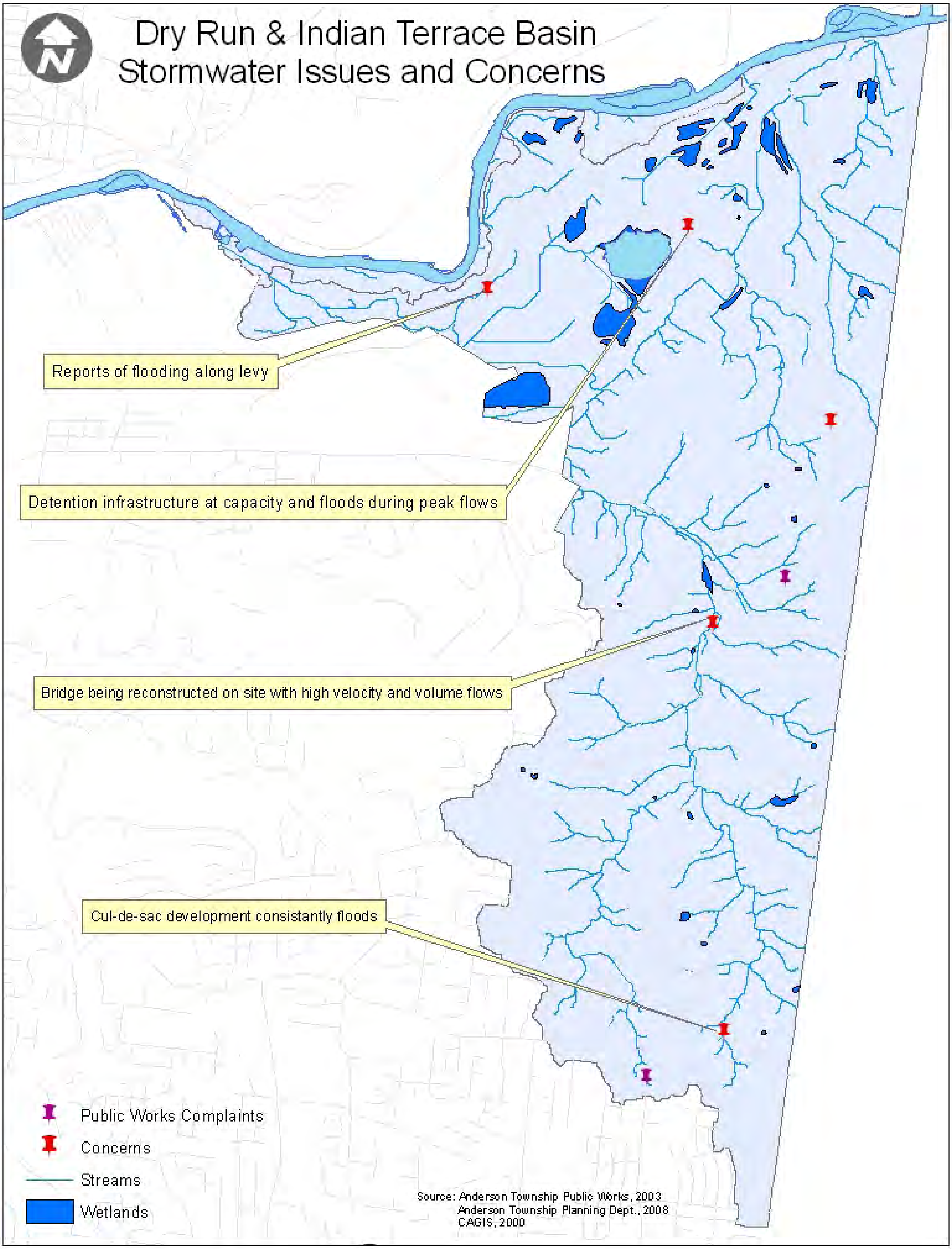


FIGURE 18: STORMWATER ISSUES IN DRY RUN AND INDIAN TERRANCE SUBWATERSHEDS.

FIGURE 19 AND FIGURE 20: EROSION WITHIN THE FIVE MILE SUBWATERSHED.

is diverted from the highway to Five Mile Creek which ruhns parallel to Five Mile Road. At many points along Five Mile Road the creek has significantly eroded much of its banks and continues to undercut the soils (See Figures 19 and 20).

The Township staff called attention to another issue in the Five Mile Subwatershed. Flooding of residential properties on Jakaro Drive off of Eight Mile Road is likely caused by significant runoff from a car dealership on Beechmont Avenue, upstream from Jakaro. It is our understanding from the Township that this issue has been addressed by the public and private sectors by the diversion of some stormwater runoff from the car dealership to Clermont County and the creation of an overflow channel to increase capacity near residences.[3]

Although the Five Mile Subwatershed is 91 percent developed, further development is likely. In fact, the Future Land Use Plan indicates that approximately 127 acres of land are expected to change from vacant and agricultural to single family cluster residential in close proximity to the confluence of Five Mile Creek and the Ohio. However, because this development is so near to the Ohio River and will require the construction of on-site stormwater detention subwatersheds, the additional runoff produced by this development is unlikely to produce significant further impacts. Additionally, slightly over 57 acres of land is expected to change from vacant/undeveloped land to single family residential throughout the northern half of Five Mile Subwatershed.

Because 64 percent of the land cover in the Five Mile Subwatershed is 'urban low density/rural – low and medium residential uses' - any significant stormwater runoff mitigation would involve retrofitting best management practices on private property. Forty one detention subwatersheds are scattered within the Five Mile Subwatershed. A significant number are used to capture commercial and office building runoff along Beechmont Ave. Nearly seven percent of land is commercial and high-density residential clustered around the northern section of Five Mile. As these properties begin to be redeveloped, there is opportunity to add new on-site detention subwatersheds, thereby further reducing runoff into the headwaters of Five Mile Creek.

Eight Mile Subwatershed

General Characteristics

Eight Mile Subwatershed is located in the southeast section of Anderson Township adjacent to the Ohio River and Clermont County to the east. The primary conveyance zone for the 2853 acres of Eight Mile Subwatershed is the Eight Mile Creek, in addition to a few distinct smaller streams which all outlet separately to the Ohio River, as indicated in Figure 29. Additionally, runoff is contributed from Clermont County.

A significant percent of the Eight Mile Subwatershed contains slopes of 30 percent or greater. This significant coverage of steep slopes along the riparian zone greatly increases the velocity of storm water runoff as well as decreases the ability of soils and vegetative cover to absorb and infiltrate the stormwater runoff[4]. The majority of the Eight Mile Subwatershed is soil type C, though portions of the subwatershed, particularly the area within the floodplain of the Ohio River are soil type B.

Of primary concern is the volume and velocity of runoff during large storm events. Although nearly 54 percent of Eight Mile Subwatershed is comprised of open land and woodlands, a significant concentration of urban high-density and urban low-density/rural land cover – primarily residential uses of varying densities - exists at the headwaters of Eight Mile Creek.

Existing Stormwater-Related Issues

One major issue to which the township called attention within Eight Mile is at a critical point along Eight Mile Road, south of Hopper Road, where a smaller stream intersects with Eight Mile Creek. Severe erosion resulted in a bridge blow-out, as can be seen in Figure 27. This illustrates the power that these streams have during significant storm events.

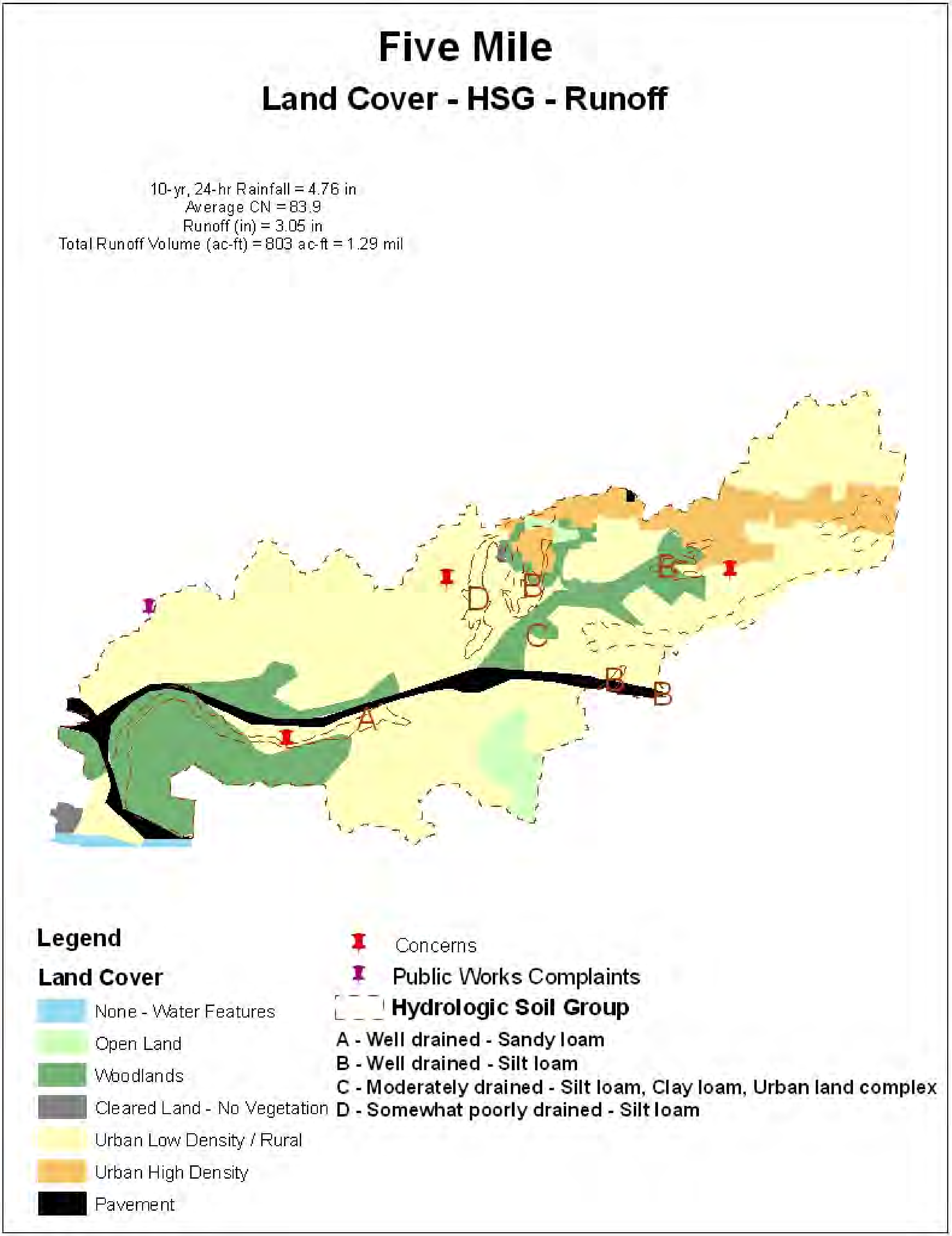


FIGURE 21: LAND COVER IN FIVE MILE SUBWATERSHED. SOURCE: CAGIS 2006.

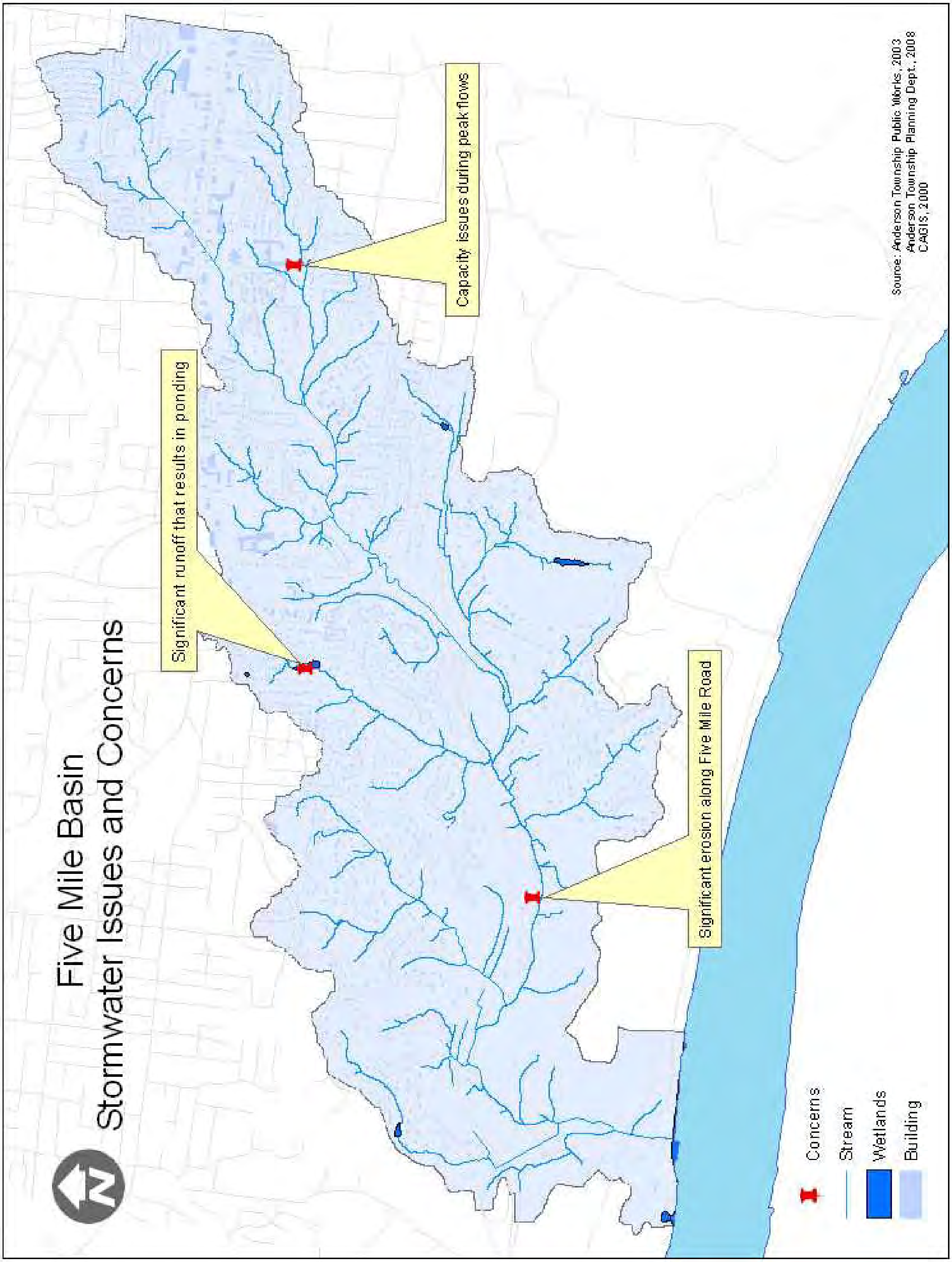


FIGURE 22: STORMWATER ISSUES IN FIVE MILE SUBWATERSHED.

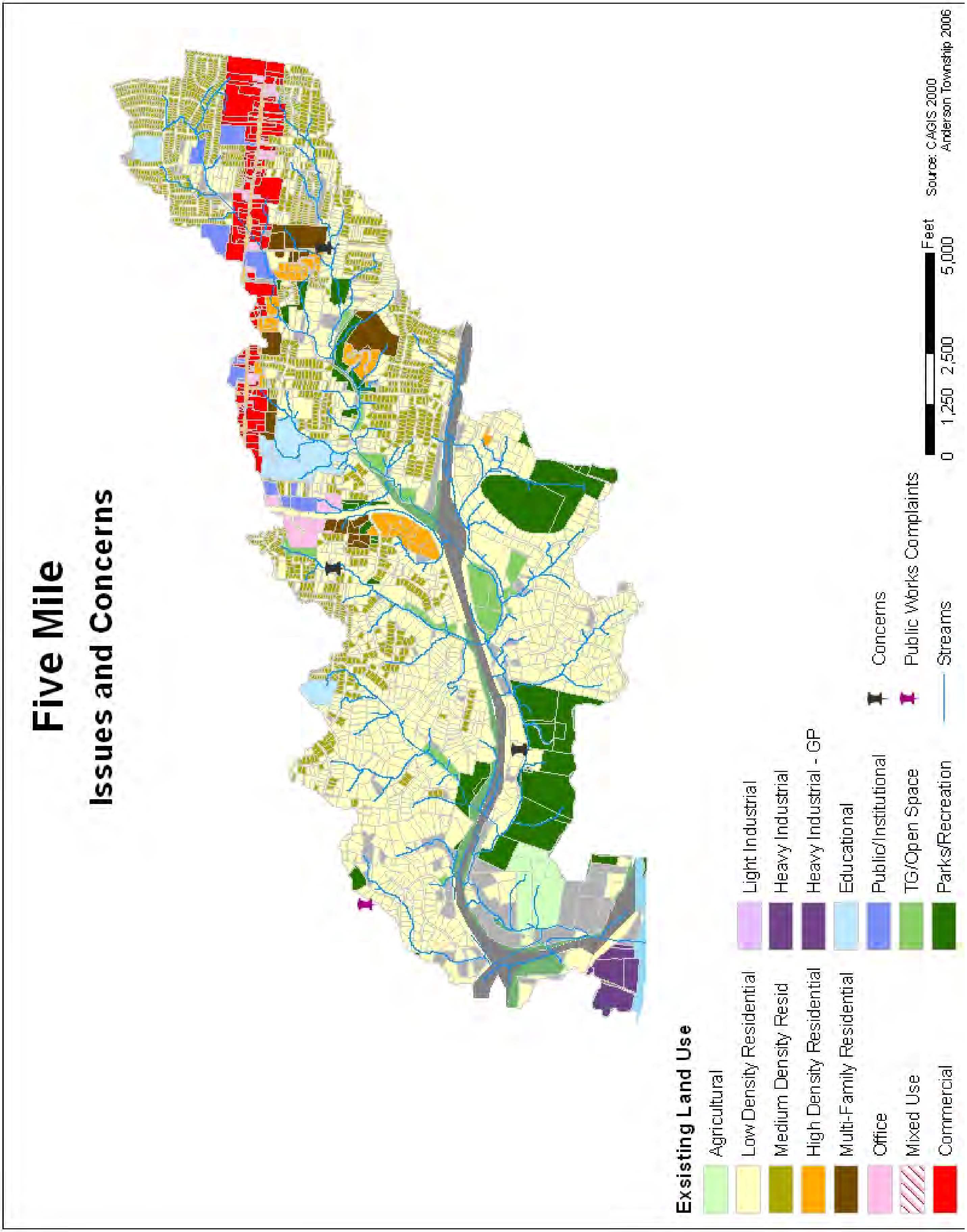


FIGURE 23: STORMWATER ISSUES

Just north of that location near the confluence of several streams is another significant area of concern. The streams run underneath Hopper and Eight Mile Roads and have severely eroded much of the soils nearby (See Figure 25) The erosion of the riparian zones has begun to contribute to roadway degradation along Eight Mile Road. Anderson Township has noted that the entire course of Eight Mile Creek is a primary area of concern and routinely has problems that arise from volume and velocity of runoff during storm events. These issues and concerns along Eight Mile are repeated along all of the roadways that run along the bottom of a valley parallel to a significant stream including Asbury, Eight Mile, Hopper, and Nordyke Roads.

FIGURE 24: CONSTRUCTION AT THE SITE OF A BRIDGE BLOW-OUT IN EIGHT MILE SUBWATERSHED.

FIGURE 25: EROSION IN EIGHT MILE SUBWATERSHED.

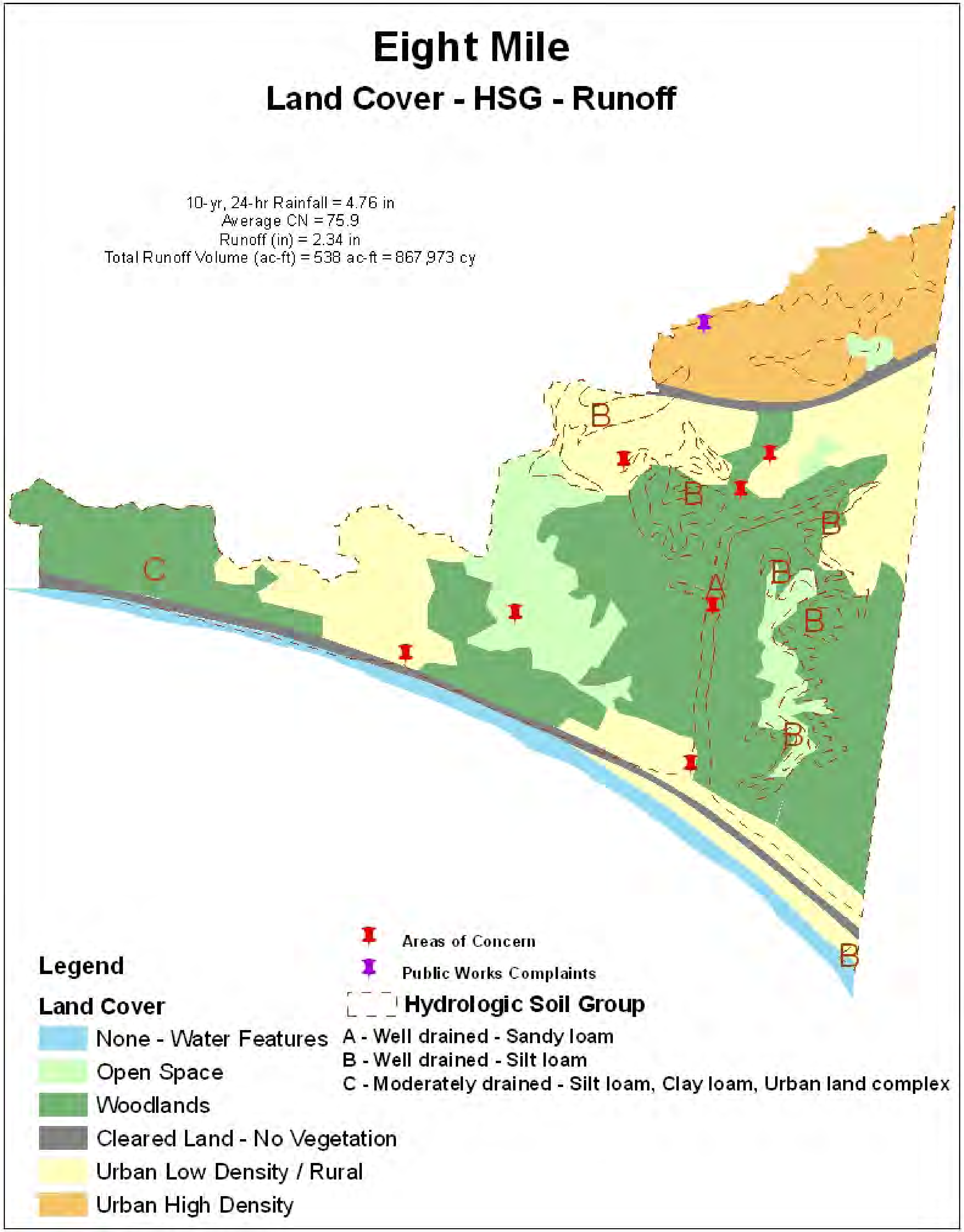


FIGURE 26: LAND COVER IN EIGHT MILE SUBWATERSHED. SOURCE: CAGIS 2006.

FIGURE 27 STORMWATER ISSUES IN EIGHT MILE SUBWATERSHED. SOURCE: CAGIS 2006

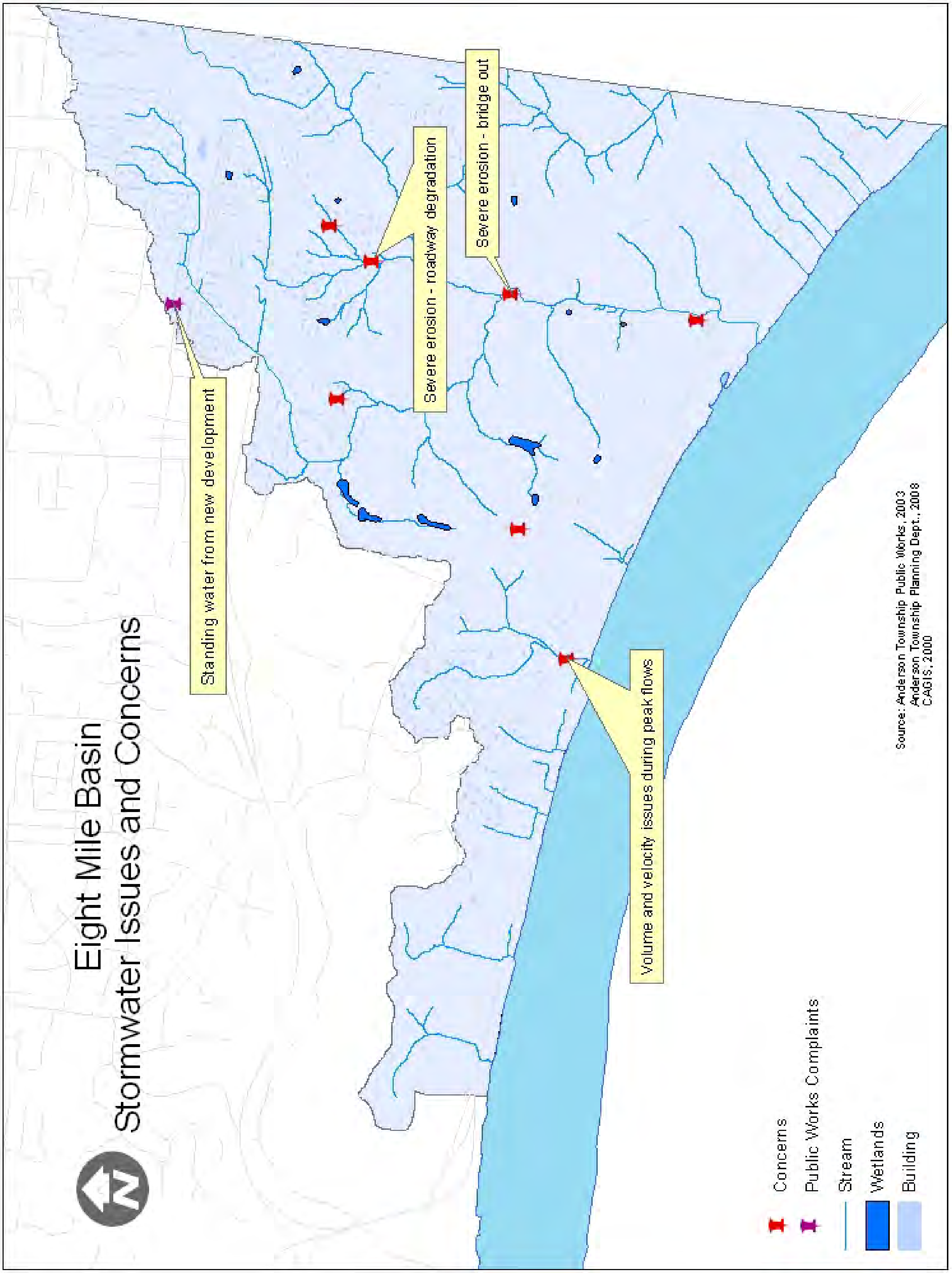


FIGURE 28 STORMWATER ISSUES IN EIGHT MILE SUBWATERSHED. SOURCE CAGIS 2006

FIGURE 29 AND 30: IMPROVEMENTS IN AREAS PRONE TO FLOODING ALONG ASBURY.

Additionally, the area immediately north of U.S. Route 52 along Asbury receives runoff from strictly urban low density land cover with significant slopes of at least 30 percent. As pointed out by Township staff, this area has been prone to flooding along Asbury with significant soil erosion. Although it appears that recent improvements have been made to ameliorate this situation, the Township should be vigilant in ensuring that those improvements hold.

Future Build-out and Stormwater-Related Issues

Because Eight Mile is only 75 percent developed, future land use changes, as noted by Anderson Township, will contribute runoff directly into the Eight Mile Creek. The anticipated change from 'open land' and 'woodlands' cover types to urban low-density will contribute to additional runoff which may further result in the degradation of the riparian zone as well as existing physical infrastructure unless future action is taken during and after new development construction to limit runoff and increase the infiltration of peak flows during storm events.

Four sizeable stormwater detention ponds exist within Eight Mile Subwatershed. Two are in the northern headwaters of Eight Mile and are able to catch a limited amount of runoff during peak flows that enter the conveyance zone. New detention subwatersheds will be a significant opportunity to slow peak flows and increase infiltration.

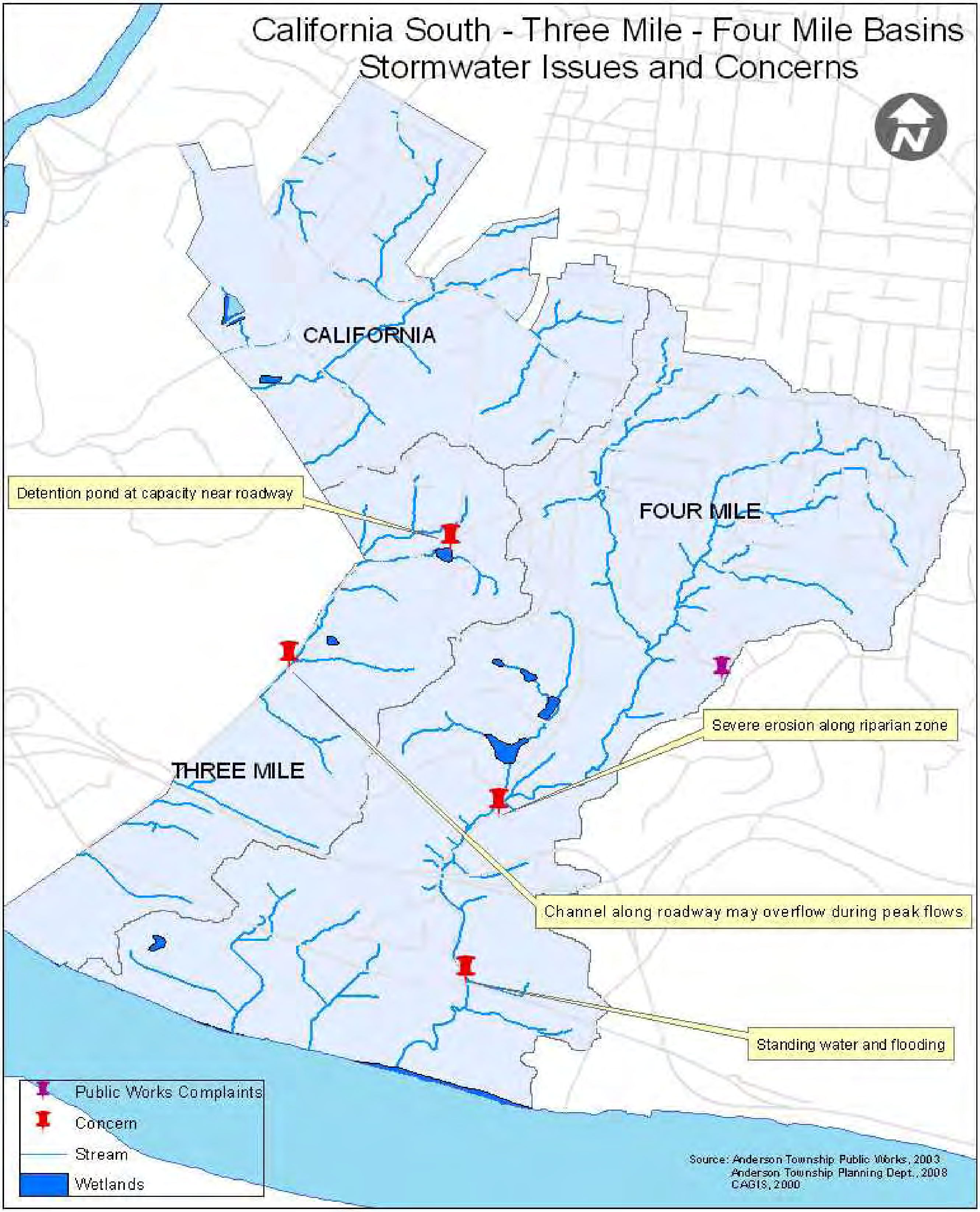


FIGURE 31: STORMWATER ISSUES IN 3 MILE AND 4 MILE.

Three Mile and Four Mile Subwatersheds

General Characteristics

The Three Mile and Four Mile Subwatersheds are located at the southwest corner of Anderson Township, and runoff from these subwatersheds collects in Three Mile Creek and Four Mile Creek, respectively. Both creeks outlet into the Ohio River. It is important to note that, although the Three Mile Creek is located in Anderson Township, only half of the Three Mile Subwatershed lies within Township. Significant runoff into Three Mile Creek comes from property within the City of Cincinnati. It is therefore important to communicate with the City of Cincinnati when addressing stormwater runoff issues within the Three Mile subwatershed.

Both Three Mile (433 acres) and Four Mile (1,246 acres) are 89% developed and can therefore be considered 'fully developed'. Most of the two subwatersheds are covered with Type C soil. A small section of the more permeable Type B soil is present along the banks of the Ohio River. Of the 4.76 inches of rain that falls in a 10-year, 24-hour rainfall, roughly 2.5 inches runs off into the Three Mile Subwatershed and 2.91 inches runs off in the Four Mile subwatershed. While both subwatersheds generate about the same depth of runoff, the Four Mile subwatershed is more than twice the size and produces approximately 440,440 cubic yards of runoff while the Three Mile subwatershed produces approximately 138,747 cubic yards of runoff. The majority of the Three Mile subwatershed has a slope greater than 30%, which allows for more wooded area and less runoff volume due to the difficult building conditions. This steep slope also leads to a higher velocity of stormwater runoff flowing down Three Mile Creek into the Ohio River.

Because both subwatersheds are 'fully developed', the build-out analysis shows only minimal future development in the area. As a result, there is not likely to be a significant increase in the amount of stormwater runoff.

Existing Stormwater-Related Issues

Several reoccurring stormwater runoff issues have been identified in both the Three Mile and the Four Mile Subwatersheds based on those noted by the Township (see Figure 31).

One example of a stormwater volume/velocity issue is located off of Lakehill Drive, where runoff from the neighboring business district to the north (along Beechmont Avenue) flows down into the residential community. There are several small ponds (pictured below in Figure 32) within the community that the water is likely to drain into. Based on the amount of rainfall, these ponds may overflow into the neighbors' yards, though this has not been observed. The neighborhood is relying on these un-engineered, informal subwatersheds for detention. There are several detention subwatersheds along Beechmont Avenue in the high-density area that help to reduce the runoff rate emanating from the business district. There is also a detention subwatershed to the southeast along Kellogg Avenue that can collect runoff from the Subwatershed.

FIGURE 32: POND USED AS DETENTION SUBWATERSHED IN A RESIDENTIAL AREA.

FIGURE 33: POND ALONG EVERSOLE AND SUTTON.

Another example of stormwater volume/velocity issues was found in the Three Mile subwatershed at the intersection of Sutton and (East) Eversole Roads as seen in Figure 33. There are several ponds (one of which seems to be located on private property) that may flood during storms, though this has not been observed first hand. The pond on private property is flanking the intersection and may cause dangerous road conditions during flooding conditions. A third example of runoff volume and velocity occurs along Sutton Road. Because this road is built adjacent to Three Mile Creek and winds along the valley of the surrounding steep slopes, the road has the ability to flood and cause dangerous driving conditions for this highly trafficked road. There is a channel along the side of several sections of the road, which can overflow onto the road during storms. Steeps slopes surrounding the road can lead to a high flow velocity which will likely overburden the shallow channel spilling onto the roadway. There is infrastructure in place (as seen in the photo below) that can help alleviate runoff problems. There are also a few wetland areas within Three and Four Mile subwatersheds that can slow the stormwater and reduce the amount of runoff. Additional wetlands could be constructed to further reduce the volume and velocity issues that the township is experiencing in the two subwatersheds. According to the Township, during a storm event, water from Sutton Road rushes down Three Mile Creek and into Lake Como at Coney Island. Lake Como, then, functions as another informal detention subwatershed.

FIGURE 34: CHANNEL ALONG SUTTON MAY OVERFLOW IN HEAVY RAINFALL.

The second issue that has been identified in Three and Four Mile subwatersheds is extreme flooding in the floodplains. Not only do these areas flood as the Ohio River rises, but these level areas collect excess runoff from the steep slopes from the entire Three and Four Mile subwatersheds. The Kellogg Avenue soccer fields, as seen in Figure 35, are one example where the level soccer fields are consistently flooded due to their location in the floodplains at the bottom of the subwatershed's slopes and their level surface. Drains have been placed along the fields to aid in the water collection. This is shown in Figure 36. Because this area is located in the floodplains, further development would be difficult and expensive. The Recommendations section of this document provides runoff mitigation techniques upstream in order to alleviate flooding issues further downstream. It is likely that the Township will need to hire an engineer to investigate options by which the ponding can be eliminated through infrastructure and re-grading.

Erosion is the third issue present in Three and Four Mile subwatersheds. Four Mile Creek is an example in which steep slopes along the banks of the creek cause erosion. This example is located to the south of a confluence of two streams that aid in increasing the stream flow velocity. The surrounding wooded and low-density residential areas can help reduce the amount of runoff though the steep slopes do play a large role. A possible solution would include a stabilization of the banks with retaining walls, preferably made of natural, permeable material.

FIGURE 35: PONDING ON A SOCCER FIELD ALONG KELLOGG AVENUE.

FIGURE 36: DRAIN ALONG SIDE THE SOCCER FIELD.

FIGURE 37 AND FIGURE 38: EROSION IN THREE MILE AND FOUR MILE SUBWATERSHEDS.

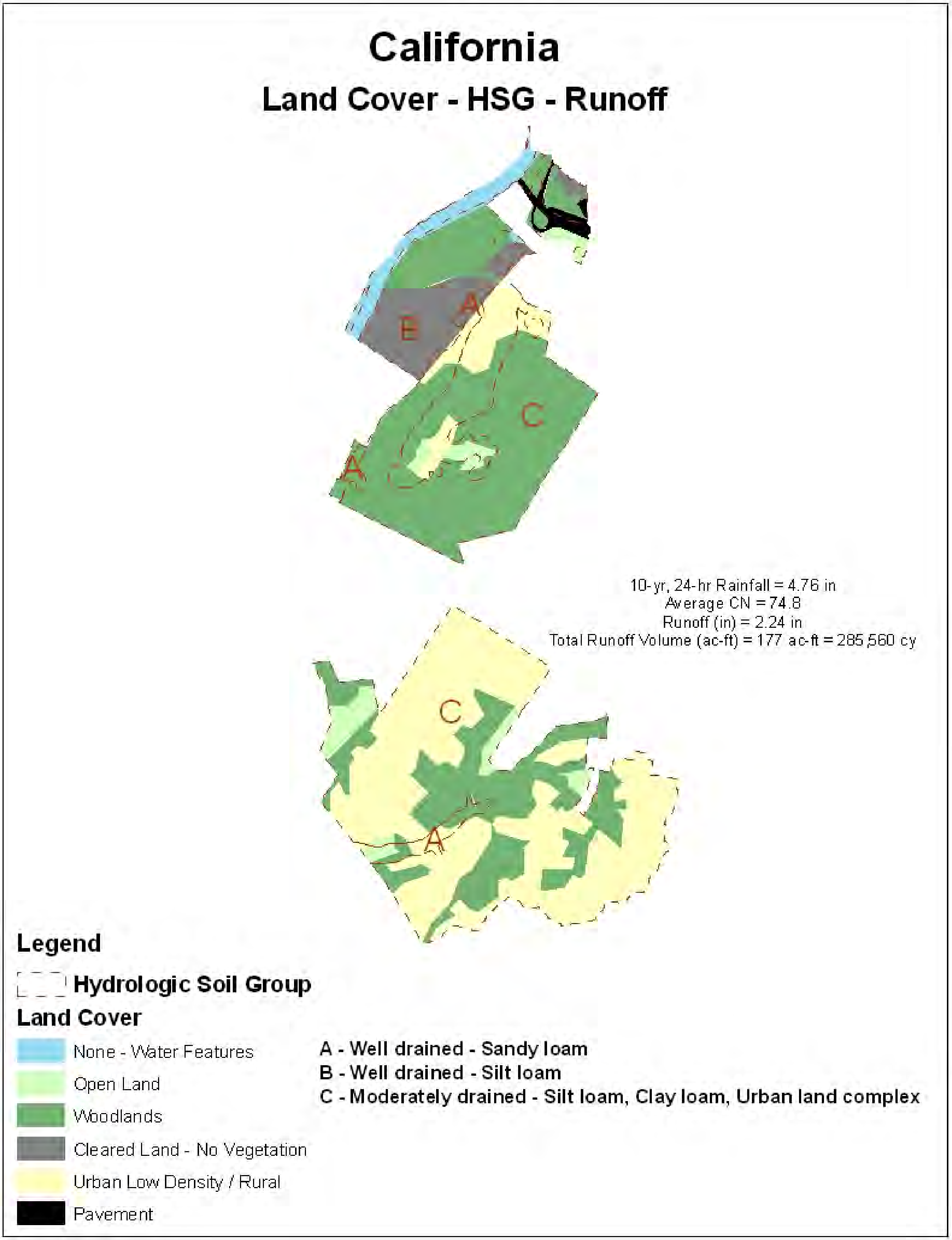


FIGURE 39: LAND COVER IN CALIFORNIA SUBWATERSHED. SOURCE: CAGIS 2006.

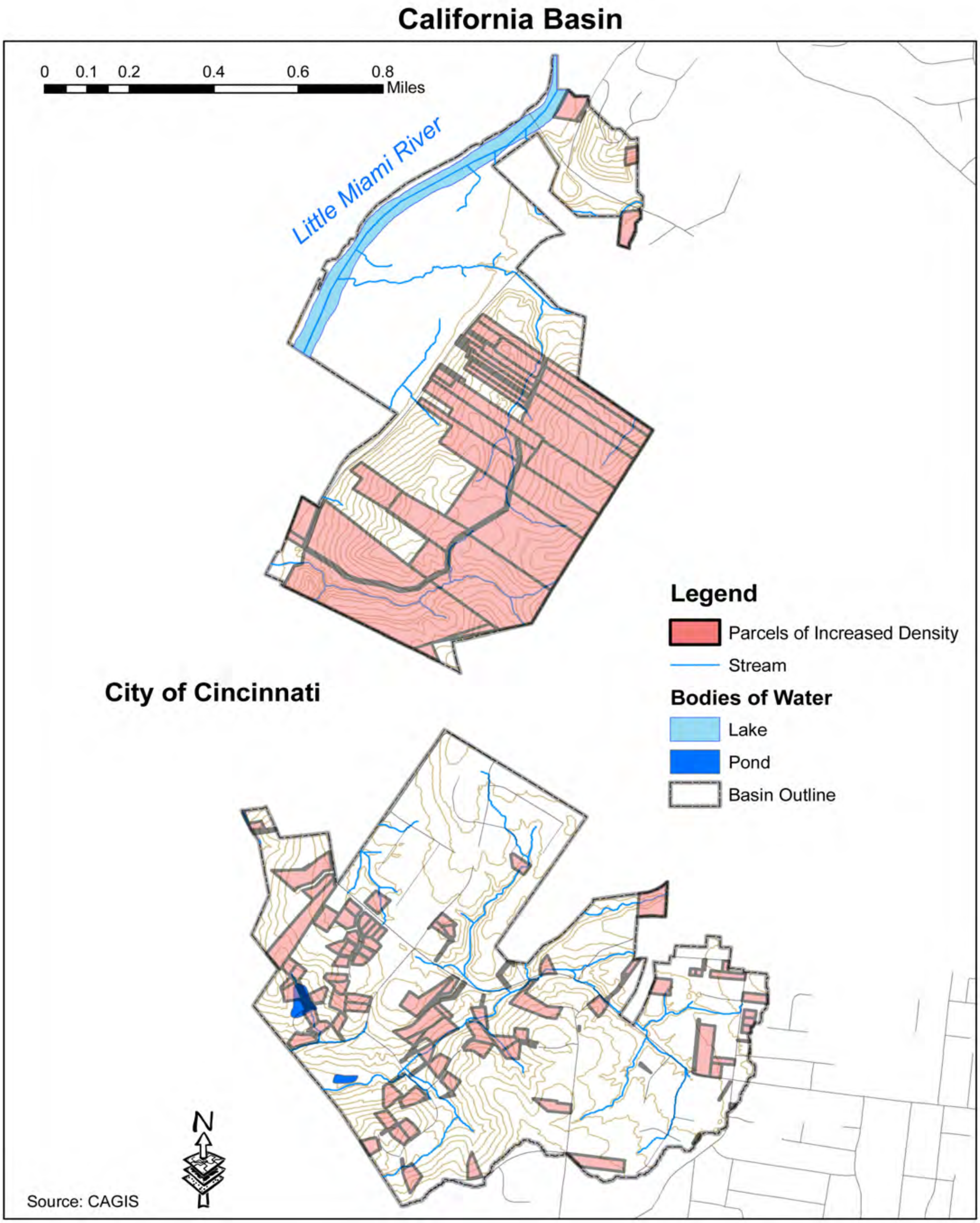


FIGURE 40: FUTURE CHANGES IN CALIFORNIA SUBWATERSHED.

California Subwatershed

Located on the western edge of Anderson Township, the California subwatershed is almost entirely surrounded by the City of Cincinnati. The neighborhood by the name of California borders to the South, and the subwatershed's 988 acres which are part of the Township are completely separated by the neighborhood of Mount Washington – also part of the City. The northern section of the California Subwatershed drains into the Little Miami River via two unnamed creeks. The vast majority of the more developed southern section is drained by one main stream, which then drains into the neighborhood of California. The topography of the area is moderately steep with significant areas with slopes greater than 30 %. In terms of soil makeup, the subwatershed is dominated by Hydrologic Soil Types A and C, though some Hydrologic Soil Type B exists in the flood plain near the Little Miami River. As indicated by Table 4, the existing stormwater runoff volume generated by the California subwatershed is estimated to be approximately 285,560 cy.

There were no issues nor resident complaints mentioned by the township staff in the California subwatershed. Moreover, surveys completed by our team did not identify notable problem areas. Most of the problems with stormwater runoff in the California Subwatershed are sure to occur in the future. The subwatershed is 64% developed, however this aggregate number ignores the vast difference between the sections north and south of the Mt. Washington neighborhood of the City of Cincinnati. Land cover is categorized as 38 % Urban Low Density and 46 % Woodland (See Figure 39), and much of that Woodland is in the northern section of the subwatershed. The northern section of the subwatershed is sparsely developed. Most parcels are large wooded plots with one or two built structures and no roadways. The Anderson Township Comprehensive Plan of 2005 proposes a change in Land Use to the southeast of Elstun Road. As evidenced by Figure 40, many of the parcels currently classified as Agricultural will become Single Family Residence and there will likely be changes in the characteristics of the land and its vegetation which can lead to drainage issues. There is likely to be an increase in stormwater runoff of approximately 10 %. Though detention ponds will be required of any new development, increased water velocity and volume can be anticipated along the drainage ways with the build-out of the area. Problems related to this new development can be expected along the two creeks which drain the northern section. These problems include, but are not limited to, erosion along unimproved creek banks and backup in the areas leading to the floodplain of the Little Miami State Scenic River Area.

The southern section of the subwatershed is considered to be almost completely built out. Parcels in this area are relatively large and the possibility exists that these could be further subdivided and developed leading to an increase in impervious surface. Though there are no problems reported by Anderson Township residents or officials in the southern section as of yet, problems with rainwater runoff could be affecting persons residing in the City of Cincinnati to where the major creek in this area flows.

Clough Subwatershed

General Characteristics

The Clough Subwatershed is centrally located in Anderson Township and contains a majority of the business district as well as the city buildings. Topography is hilly, with slopes 30% or higher along the riparian zone of Clough Creek and some of its headwaters. Clough Creek is the subwatershed's main conveyance, and it runs northwest, emptying into the Little Miami River. Soil type for the area is mostly type C, which has a slow infiltration rate. The land covers in Clough, as indicated in Figure 41, breakdown as follows: 56% is urban low density/rural (residential); 20% is woodland; 10% is urban high density (predominantly commercial); and the remainder is mostly undeveloped with small areas of concentrated pavement. The runoff resulting from this combination of land covers, slopes and soil types in the Clough Subwatershed, when unmitigated, create erosion, areas that remain wet for long periods of time, and flooding. These problems are anticipated, especially in the Northwest region of the subwatershed where the water travels down slopes of over 30%.

The total area of the Clough Subwatershed is 3,976 acres, making it the largest subwatershed in the township. Ninety one percent of the Clough Subwatershed is built out, so the subwatershed is considered to be fully developed. Over 56% of the land is classified as low density urban. Ten percent of the area has land cover related to high density urban use, which correlates to a high percentage impervious land cover. Another four percent of land cover is pavement or cleared land with no vegetation. The high density urban uses, bare ground, and impervious surfaces increase storm water runoff volume more than the remaining land covers in the subwatershed.

Currently the subwatershed experiences a runoff volume of over 1.3 million cubic yards during the twenty-four hour period of a ten year storm. Fortunately, planned future land uses will not have a significant impact on the runoff potential for the subwatershed as a whole, so the main focus for the Clough Subwatershed will be solving current storm water issues and continuing to practice good storm water management. See Figure 43 for a display of the current issues and concerns.

Existing Stormwater-Related Issues

Reports from the southeast quadrant of the subwatershed mainly focus on maintenance issues such as clogged culverts and storm ditches. Only one area had a standing water problem, and it was in a relatively flat area, so that may be a place to focus some attention right now. Otherwise, these areas seem fine. There are a moderate number of retention and detention ponds in this area along the commercial strip, constructed with new development or redevelopment. Future land use changes from single family to transitional mixed use along parts of Beechmont could have additional impacts, though likely not significant.

In the southwest quadrant of the subwatershed, issues and

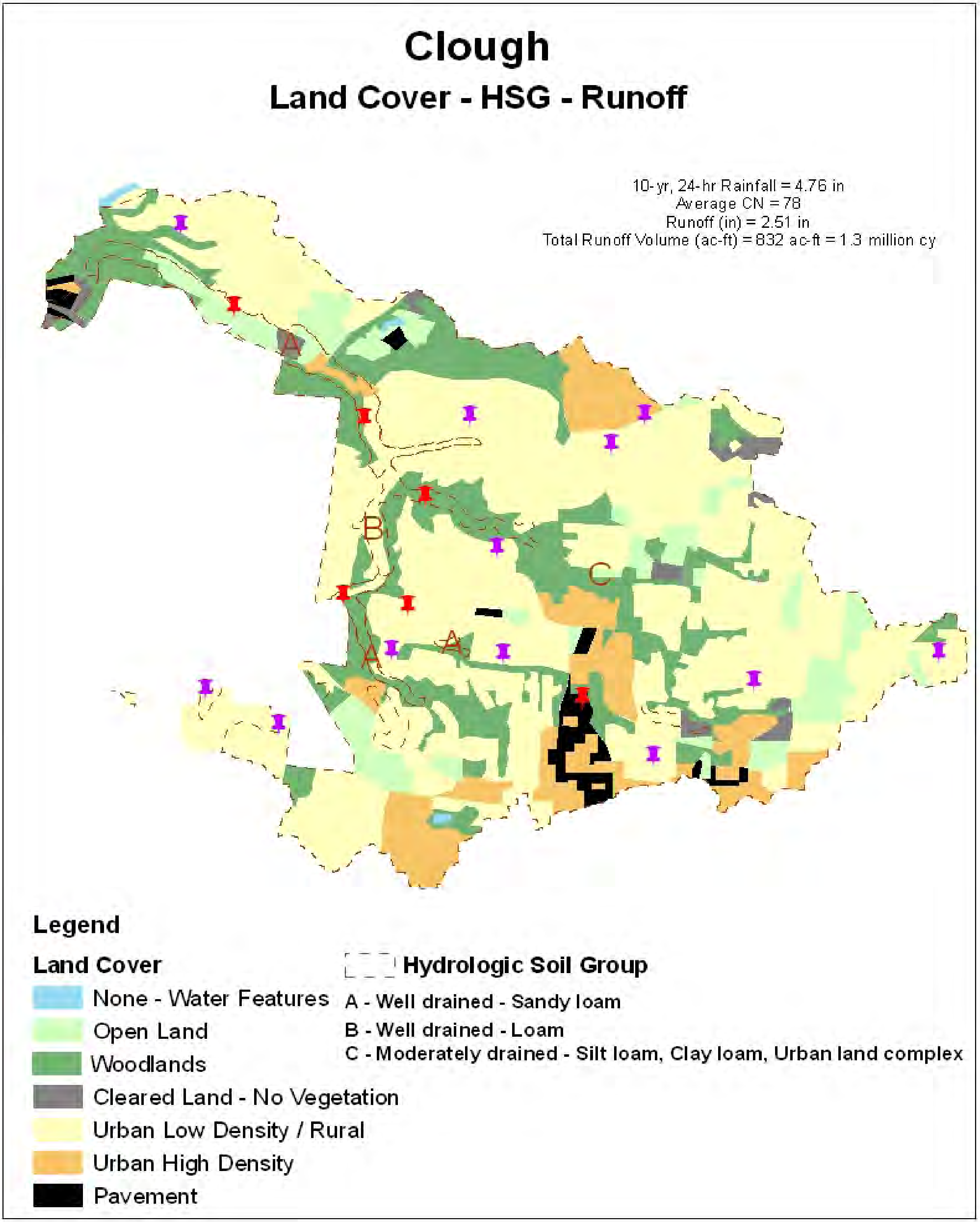


FIGURE 41: LAND COVER IN CLOUGH SUBWATERSHED. SOURCE: CAGIS 2006.

concerns downstream of newer retention and detention ponds should be revisited to determine if the problems remain. Some issues of standing water, flooding, erosion, and one case of a sink hole were reported. These occurred in the older neighborhoods along the western side of Five Mile and north of Beechmont in medium density residential areas. Report issues were all very close to streams and in areas with no detention subwatersheds. One public works complaint outside of Anderson Township is worth noting, which is a combined sewer overflow on Berkshire and Beechmont. The impervious pavement in Anderson Township upstream is a potential cause of the overflow problem.

Very few problems were reported for the northeast quadrant, and they were maintenance issues. This is an area that doesn't have a high degree of slope but does have low to medium density residential development. The future use in this area is going to change for approximately 83 acres of land from what is currently recreation, low-density residential and open space into medium density residential. This could have additional runoff implications

The most severe area of concern according to the issues and problems observed in the field as well as problems reported into the township and public works is Clough Creek from the Township building to where it outlets into the Little Miami River. Reports and observations included flooding, exposed sanitary sewers due to erosion of the creek, the undermining of retaining walls holding back the creek bank, and massive bank erosion where soil and tree slippage from the banks above into the creek were observed. See Figure 42.

The majority of the Clough subwatershed was developed prior to 1996, and the uncontrolled runoff has certainly taken its toll. It should be noted, however, that very recently a new regional retention pond was constructed in conjunction with the construction of the township building with a drainage are covering 317 acres, including Clough Creek headwaters. This may result in a significant improvement to the runoff conditions affecting Clough Creek (See Figure 44).

Although very little of the Clough Subwatershed remains to be developed, we note that future land use in this area, as indicated in Figure 47, is shifting from very low impact to somewhat higher impact uses from a land cover perspective.

Over the coming years, 347.2 acres of land are designated to change uses. For these reasons and those stated above, the Clough Creek area may require initial focus by the township to address current and future storm water runoff issues. Following that, the southwest quadrant should be addressed as opportunities arise for improving storm water management or as issues become more urgent. Current site preparation practices within the northeast and southeast quadrants seem to be managing storm water runoff effectively.

FIGURE 42. EROSION OF THE CLOUGH CREEK. SOURCE: WASTEWATER ENGINEERING DIVISION, MSD

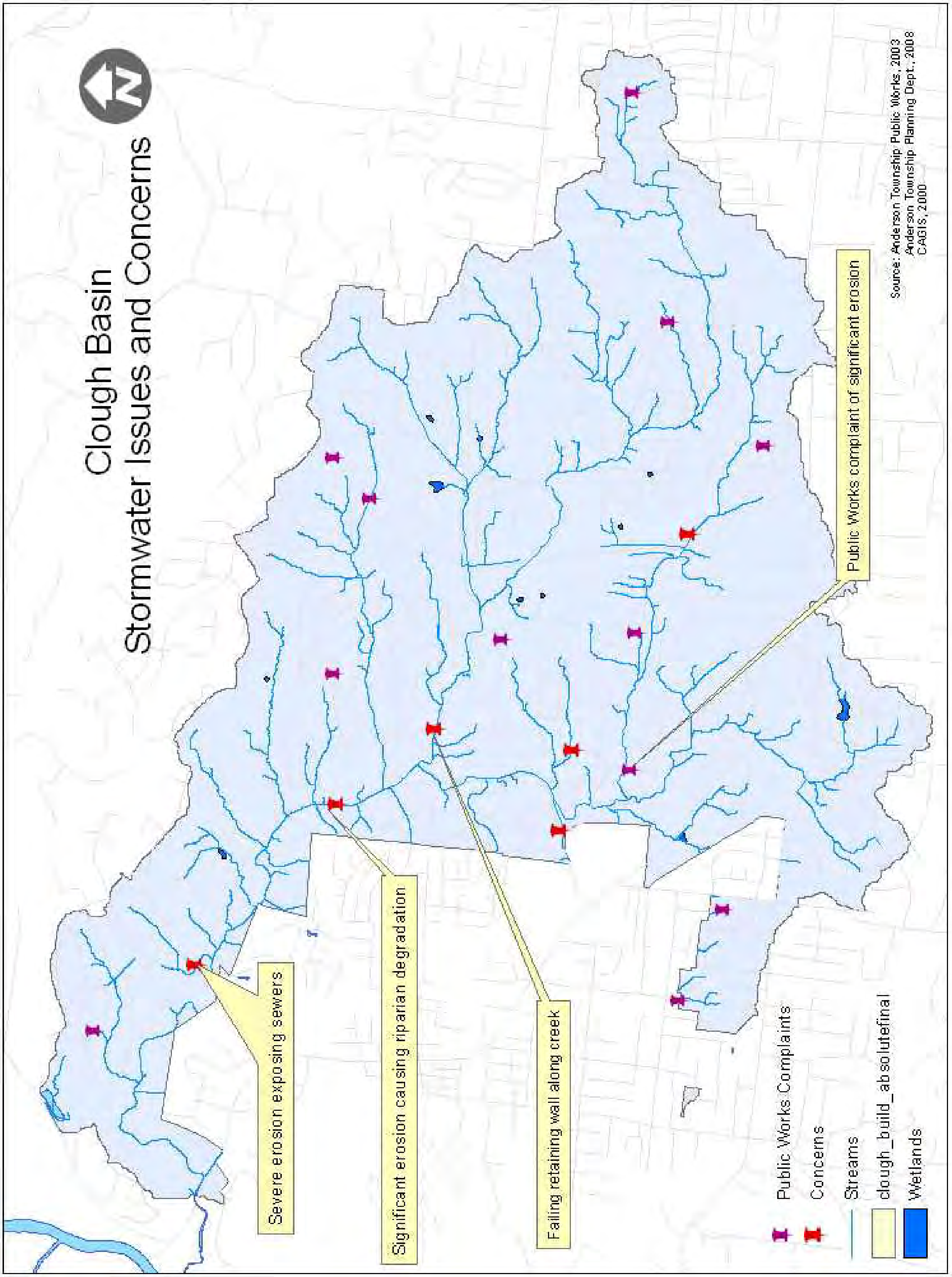


FIGURE 43: STORMWATER ISSUES IN CLOUGH SUBWATERSHED STORM. SOURCE: CAGIS 2000

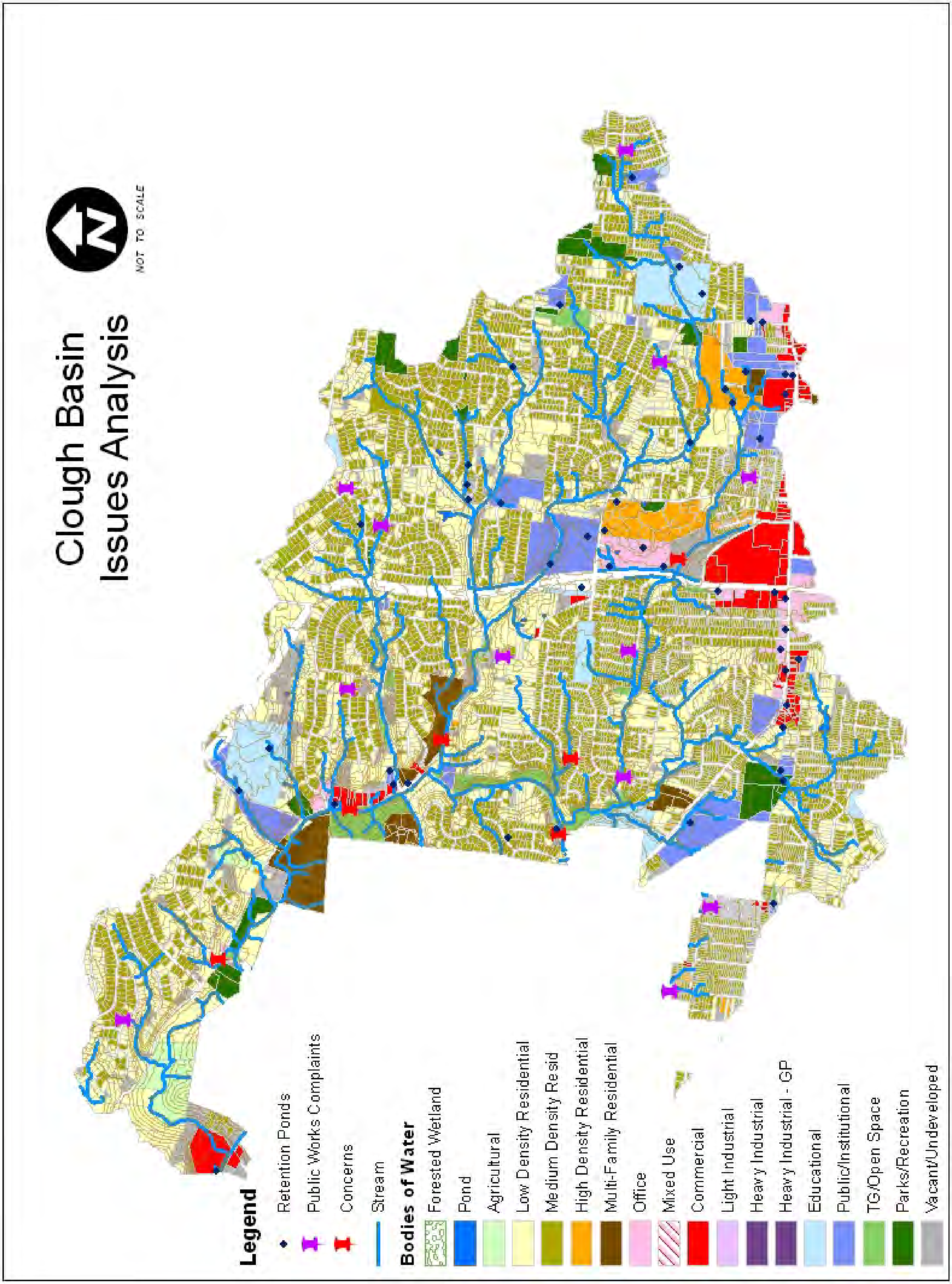


FIGURE 44. ANALYSIS POINTS OF CLOUGH SUBWATERSHED ISSUES AND CONCERNS.

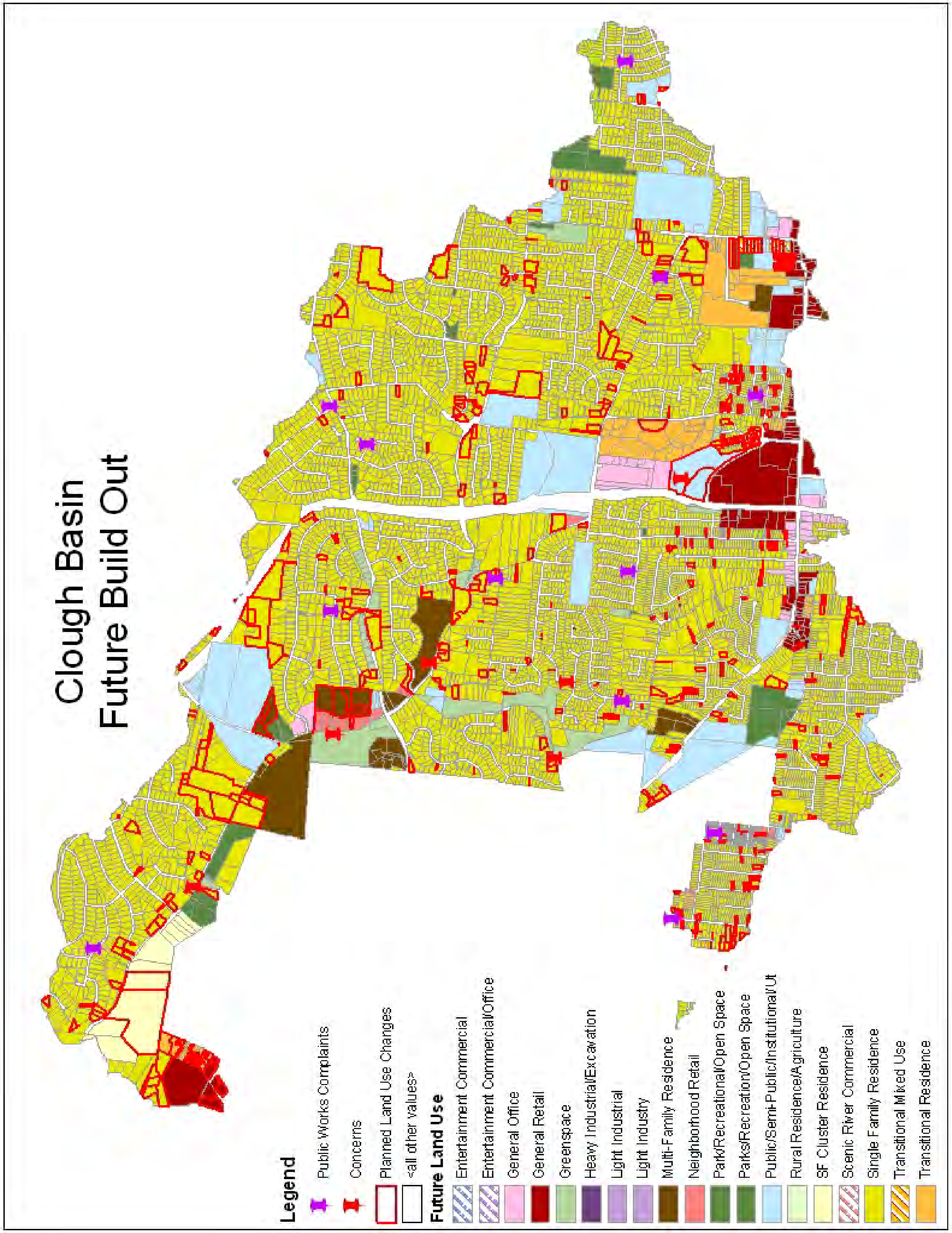


FIGURE 45 FUTURE USE IN CLOUGH SUBWATERSHED. SOURCE: CAGIS 2000

Recommendations

In the Analysis section of this report, we focused on defining the stormwater-related issues experienced by the Township. We looked at these issues in light of the existing runoff generated within each of the Township's ten subwatersheds, and we identified potential future problems as they relate to the additional stormwater runoff that will be generated if the Township were to fully build out based on its future land use plan and its current development regulations.

In this Recommendations section , we shift our focus to solutions. We identify specific strategies the Township can use to adjust its overall approach to stormwater management,. These include comprehensive land use strategies, revising regulatory controls, implementing programs to provide incentives to community involvement, and demonstrating best management practices. All of these strategies are recommended to ensure that future development does not exacerbate existing stormwater-related issues or create new ones, and that re-development improves the current stormwater conditions.

The first strategy addresses existing stormwater-related issues. Here, we recommend the Township contract with a consultant to evaluate, rank and design structural solutions for the most pressing issues.

The next strategy aims its recommendations at Anderson Township's Comprehensive Land Use Plan. Here we suggest that the Township take a broader approach to stormwater management by considering impacts of land use and impervious surfaces on a watershed-level basis and by protecting the Township's natural waterways from development and disturbance.

The third set of recommendations focuses on the regulations that govern development within the Township. These include Hamilton County Subdivision Regulations and street and stormwater management design standards and Anderson Township's Zoning Resolution. Recommendations in this section range from improving landscape regulations and ensuring stormwater management for minor subdivisions to enacting a stormwater management overlay district over the entire Township.

In the last strategy, we suggest a comprehensive program aimed at increasing the installation of BMPs on private property and two demonstration programs that will establish the Township as a leader in improving stormwater management. Recommendations for funding are also provided.

Throughout these Recommendations we refer to green infrastructure methods which can be utilized as best management practices (BMPs). These are introduced and explained in the next section. Green infrastructure BMPs have been in use in many areas of the country for years, but they are just recently working their way into the Cincinnati region, likely due to the enforcement of EPA's NPDES Phase II requirements. By focusing on green infrastructure implementation now, the Township will be one of the first area communities to signal its commitment to sustainable development.

Although the Township is primarily focused on controlling the quantity of stormwater runoff, the proposed recommendations also serve to improve the quality of stormwater runoff, an issue which receives increasing attention due to the severity of nonpoint source pollution in our nation's natural water bodies. The health of the Township's waterways and the health, safety, and welfare of the Township's residents are interconnected, and this document provides a first step towards better protecting the Township's water and, as a result, its citizens.

Green Infrastructure Best Management Practices

The high costs associated with urban stormwater result from the destruction of free, natural stormwater treatment systems—trees, meadows, wetlands, and other forms of soil and vegetation. Researchers at the University of California at Davis have estimated that for every 1,000 deciduous trees in California's Central Valley, stormwater runoff is reduced by nearly 1 million gallons—a value of almost $7,000 (USDA Forest Service 2006).

While traditional engineering approaches – pipes, tanks, pumps and detention ponds – will likely play a major role in resolving the Township's stormwater runoff problems, green infrastructure could transform the look and function of many neighborhoods.

In many instances, green infrastructure is less costly to install than conventional stormwater infrastructure, and provides an opportunity to decrease the economic burden of stormwater management over time. Studies in Maryland and Illinois show that new residential developments using green infrastructure stormwater controls saved $3,500 to $4,500 per lot (quarter- to half-acre lots) when compared to new developments with conventional stormwater controls (Haugland 2005).

Green Infrastructure BMP Inventory

Green Roof

A green roof minimizes the amount of runoff that occurs from rain falling on a rooftop. The soil and vegetation serve as a natural sponge that absorbs smaller rain events without any runoff. Native and drought-resistant vegetation is normally used. Green roofs are capable of retaining 25-75% of stormwater runoff (Hamilton County Regional Planning Commission 2002). There are two basic types of green roofs which are illustrated below in Figures 46-48: Extensive and Intensive. An Extensive green roof system consists of very shallow bedding (1-5" of soil) that supports only low grown vegetation with smaller root systems. An Intensive system has a depth of 6 inches to 15 feet and supports a wider variety of plants (including trees and shrubs).

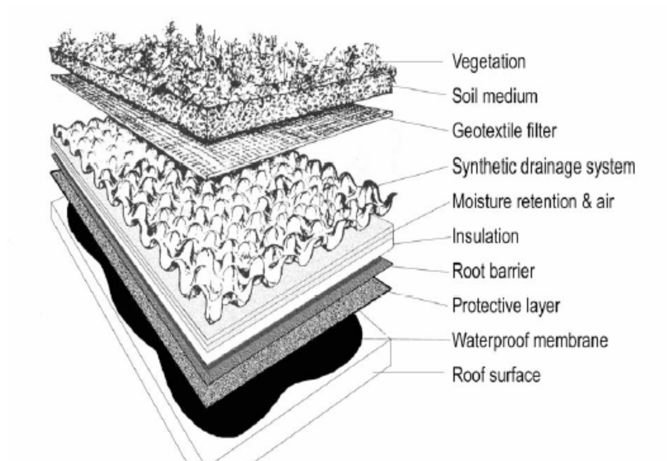


FIGURE 46. DIMENSIONS OF A GREEN ROOF. SOURCE: MINNESOTA URBAN SMALL SITES BMP MANUAL

FIGURE 47 GREEN ROOF. SOURCE: SANITATION DISTRICT NO. 1

FIGURE 48. CARRABBA'S IN GREENSBORO. SOURCE: HTTP://WWW.GREENROOFS.COM/EXCLUSIVES.HTM

Porous/Permeable Pavement

Alternative paving materials can be used to minimize the amount of runoff and pollution that reach our local waterways and increase the groundwater recharge. Porous pavement allows water to pass through to the soil below. Types of porous pavement include: aggregate, paver-blocks, porous concrete and porous/permeable asphalt. Permeable asphalt pavements achieve their porous characteristics by removing the fine aggregates from the mix design to create void spaces between the larger stones. Examples of porous/permeable pavement treatments are illustrated below in Figures 49-51.

Typical maintenance activities for porous pavement include the following:

- Monthly- Remove debris sediments from the pavement area.
- Quarterly- Vacuum sweep to keep the surface free of sediment
- Annually- Inspect the surface for deterioration
- As Needed- Incorporate erosion control measures in surrounding areas (WMI 1997).

FIGURE 49. PERVIOUSNESS OF POROUS PAVEMENTSOURCE: HAMILTON COUNTY REGIONAL PLANNING COMMISSION

FIGURE 50. PERVIOUS PAVEMENT. SOURCE: RHODE ISLAND URBAN ENVIRONMENTAL DESIGN MANUAL 2005

FIGURE 51. PERVIOUS PAVERS. SOURCE: SANITATION DISTRICT NO. 1

Grass Swale or Bio-swale:

A grass or bio-swale is a linear vegetated ditch that receives stormwater runoff. These swales are effective at reducing runoff velocity and are applicable in residential areas and near highways (Sanitation District No. 1, 2008). They also utilize the biofiltration to reduce pollutants. Biofiltration is a natural process whereby certain plants, bacteria, and other soil-living remove or break down water pollutants. Biofiltration can reduce the amount of toxic metals, oil, gasoline, and particulates carried by runoff. An example of the elements of a bio-retention or vegetated swale is illustrated in Figure 52. As seen in Figure 53, Sanitation District No. 1 uses biofiltration to filter runoff from its parking areas before it reaches natural waterways. Grass swales can be retrofitted onto small sites by replacing drainage ditches (Sanitation District No. 1, 2008). Homeowners can incorporate these swales into their landscaping plans as well (see Figure 54.). Typical maintenance activities:

- At Project Completion-Water the plants daily for two weeks
- Monthly- Remove debris and litter and inspect for erosion
- Bi-annually- Treat or replace dead and diseased vegetation
- Annually- Add mulch and replace tree stakes and wire (The Stormwater Manager's Resource Center 2004)

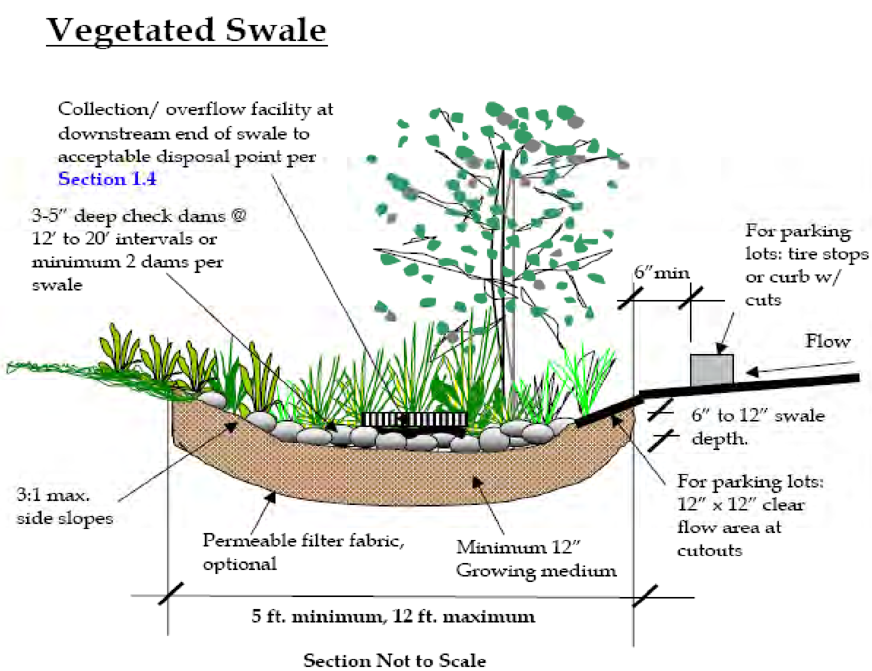


FIGURE 52. CONSTRUCTION OF GRASS SWALE. SOURCE: HTTP://WWW.PORTLANDONLINE.COM/BES/INDEX.CFM?C=35122&

FIGURE 53. GRASS SWALE. SOURCE: SANITATION DISTRICT NO. 1

FIGURE 54. GRASS SWALE NEAR ROADWAY. SOURCE: HTTP://WWW.PORTLANDONLINE.COM/BES/INDEX.CFM?C=35122&

Wetlands

In a wetland ,the water level remains near or above the ground surface for most of the year (see Figure 55). Wetlands are usually found in a landscape's low spots where water naturally pools and the water table is high. Most wetlands also contain soils that drain slowly, which further retains water.

Wetlands can attract a diverse range of plants and animals, including endangered species. Many migrating birds depend on wetlands for food and water and as stopover points while making their long journeys. Wetlands are also natural water treatment facilities. Wetlands improve water quality by absorbing pollutants, slowing down rainwater runoff, and capturing sediment. Wetlands can also serve as an aesthetic addition to a homeowner's landscape.

FIGURE 55. WETLAND AREA. SOURCE: HTTP://PROANDASSOCIATES.COM/PERMIT.HTM

Rainscapes and Rain Gardens

Rainscapes and rain gardens recreate natural ecosystems, help to capture soil and filter rain water, and recharge groundwater..

Rain gardens are shallow depressions, planted with different types of flowers, grasses or shrubs which collect storm water and allow it to soak into the ground. They can be located in various locations on a property to retain different sources of storm water (see Figures 56 and 57). For example, a rain garden can be placed at the end of a roof downspout, at the downhill end of a sloping yard, or in a boulevard with a cut-away section of street curb. Compared to a conventional patch of lawn, a rain garden allows about 30% more water to soak into the ground.

FIGURE 56. RESIDENTIAL RAIN GARDEN. SOURCE: HTTP://WWW.RFCITY.ORG/ENG/STORMWATER/YOURPROPERTY/YOURPROPERTY.HTM

FIGURE 57. RAINSCAPING EXAMPLE. SOURCE: HTTP://WWW.PORTLANDONLINE.COM/BES/INDEX.CFM?C=35122&

Rain Barrels

Rain barrels are attached to downspouts to collect storm water running off of a roof (See Figures 58 and 59). An overflow system allows excess water to be directed elsewhere. Rainwater collected can be used for watering plants or gardens and for washing your car. Most rain barrels are 55-75 gallons and cost an average of $150 (depending on the size).

FIGURE 58. WOODEN RAIN BARREL. SOURCE: HTTP://WWW.THISOLDHOUSE.COM/TOH/ARTICLE/0,,1180779,00.HTML

FIGURE 59. PLASTIC RAIN BARREL. SOURCE: HTTP://WWW.RFCITY.ORG/ENG/STORMWATER/YOURPROPERTY/YOURPROPERTY.HTM

Cistern

A cistern, like the one shown in Figure 60, is a tank that stores collected rainwater in larger amounts than a rain barrel. Cisterns remain a valuable way for homes and businesses to conserve water today. Collected rainwater can be used for landscape watering, vehicle washing, and other uses that don't require treated water.

FIGURE 60. CISTERN. SOURCE: SANITATION DISTRICT NO. 1

Retention Subwatershed

A retention subwatershed/pond, illustrated in Figure 61, is a constructed pond that maintains a permanent pool of water. It allows stormwater to collect and for pollutants to settle to the bottom. Solids, metals, nutrients in particulate form and organics are the target pollutants. Removal efficiencies are dependent upon the amount of time that runoff remains in the pond.

FIGURE 61. RETENTION Subwatershed/POND. SOURCE: SANITATION DISTRICT NO. 1

Preservation of Natural Areas

Too often, development removes nearly all existing natural features. Simply preserving native trees and vegetation, open space, and stream buffers and incorporating them into the community will help maintain water quality and manage stormwater runoff while lessening the need for additional stormwater controls.

Detention Subwatershed

Figure 64 illustrates a detention subwatershed. A detention subwatershed remains dry until a storm event occurs. The subwatershed is designed to control the peak rate of storm water runoff from a site to a level that does not exceed pre-development conditions.

FIGURE 62 DETENTION Subwatershed.
SOURCE: SANITATION DISTRICT NO. 1

Trees / Urban Forest

Planting trees are one of the easiest ways to reduce stormwater runoff and improve water quality. By capturing rainwater on their leaves, soaking up polluted water around their trunks and reducing erosion by holding soil in place with their roots, urban forests not only help control the quantity of storm water runoff, but also improve its quality. Some examples of items that make up an urban forest are included in Figures 63 and 64 below. These include individual trees, parks, green space, woods and forests within an urban area.

FIGURE 63. FORESTED URBAN PARK. SOURCE: HTTP://WWW.FORESTRY.KY.GOV/PROGRAMS/URBAN/

FIGURE 64. MAINTAINENCE OF URBAN FOREST. SOURCE: HTTP://WWW.CITYOFLFP.COM/CITY/TASKFORCE/FOREST/DEFAULT.HTML

Protection of Natural Riparian Zones

Riparian zones such as the one illustrated in Figure 65 are buffers along rivers and streams. These contain areas of differing vegetation and animal diversity and density. Riparian zones protect streams from structural damage and pollutants that can occur as a result of stormwater. A natural riparian zone will provide water absorption during storm events which will moderate the volume and energy of significant amounts of water. Additionally, natural riparian corridors will assimilate and filter a limited amount of pollutants from non-point and point sources. (Stormwater Management Rule 2004 and Cuyahoga Remedial Action Plan 2007).

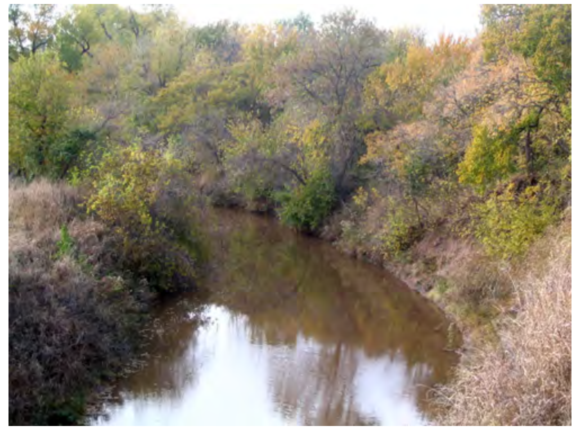


FIGURE 65. NATURAL RIPARIAN ZONE. SOURCE: HTTP://WWW.OK.GOV/OKCC/AGENCY_DIVISIONS/WATER_QUALITY_DIVISION/BLUE_THUMB/LOVE_YOUR_STREAM.HTML

FIGURE 66. OIL/WATER SEPARATOR. SOURCE: SANITATION DISTRICT NO. 1

Oil/Water Separator

Sanitation District No. 1 installed an oil/water separator in the rear parking lot of the site to address the issue of water quality. The separator tank is buried under the pavement and connected to catch subwatersheds in the parking lot. This multi-chamber device is designed to remove solids such as silt and trash in the first chamber. The runoff then passes through a vertical baffle system, which separates oil from the water prior to discharging into the stream. The oil/water separator allows access for cleaning. This BMP could be implemented on a commercial site where vehicle (especially trucks) volume is high. An example is shown in Figure 66.

Curb elimination/vegetated extensions

Because curbs function as channels for stormwater, runoff flows at high velocities, carrying with it sediments and other contaminants. Without curbs, runoff can be spread over large vegetated areas (i.e. rain gardens or swales along the roads) where runoff velocities can be reduced and pollutants can by absorbed by plants and soils. Sections of existing curb can be removed and curb outlets can be installed at carefully chosen intervals to allow stormwater to flow onto well-vegetated areas while avoiding erosion, flooding and trash accumulation. An example of a curb extension is shown below, in Figure 67. Street cleaning programs should be modified to maintain these areas.

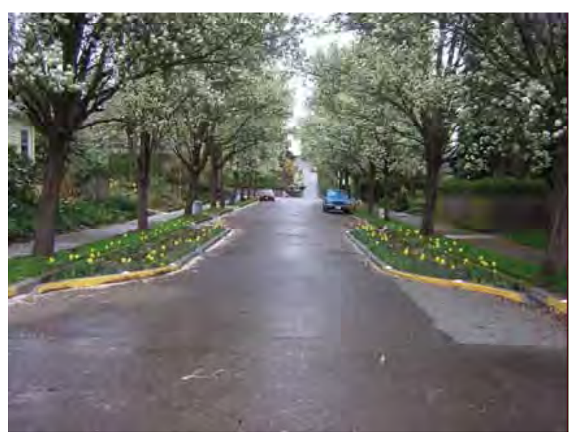


FIGURE 67. VEGETATED CURB EXTENSION. SOURCE: THE PORTLAND BUREAU OF ENVIRONMENTAL SERVICES

Recently, BMP performance has been evaluated based on the pollutant removal efficiency of a practice as well as runoff reduction (RR) (Table 6). Data was used from the Runoff Reduction Method Center for Watershed Protection & Chesapeake Stormwater Network to recreate the data table below. Pollution removal occurs through a variety of mechanisms, including filtering, biological uptake, adsorption, and settling. There is a wide variability in the ability of BMPs to remove nutrients from runoff through the mechanisms listed below. Table 6 provides a comparative summary of how the combination of Runoff Reduction and Total Phosphorus (TP) and Total Nitrogen (TN) Pollutant Removal translate into Total Removal (TR) for a range of BMPs.

The biggest issue to the data in Table 6 is the limited number of studies available that reported BMP runoff reduction or EMC (event mean concentration) based nutrient removal efficiencies. As a result, some of the numbers listed in the tables will be subject to change as more studies and data become available. The numbers in the tables are the authors' best judgment based on currently available information.
(Technical Memorandum 2008)

TABLE 6. BMP POLLUTANT REMOVAL

Comparative Runoff Reduction, Pollutant Removal for Total Nitrogen & Phosphorus			
Practice	Runoff Reduction (RR) (%)	Pollutant Removal (PR)1 - Total Nitrogen (%)	Pollutant Removal (PR)1 - Total Phosphorus (%)
Green Roof	45 to 60	0	0
Rooftop Disconnection	25 to 50	0	0
Raintanks and Cisterns	40	0	0
Permeable Pavement	45 to 75	25	25
Grass Channel	10 to 20	20	15
Bioretention	40 to 80	40 to 60	25 to 50
Dry Swale	40 to 60	25 to 35	20 to 40
Wet Swale	0	25 to 35	20 to 40
Infiltration	50 to 90	15	25
Sheetflow to Open Space	50 to 75	0	0
Filtering Practice	0	30 to 45	60 to 65
Constructed Wetland	0	25 to 55	50 to 75
Wet Pond	0	30 to 40	50 to 75
1 EMC based pollutant removal			
2Numbers are provisional and are not fully accounted for in Version 1 of the BMP			

Source: USEPA Preliminary Summary of Urban Storm Water BMPs, August 1999.
Note: 1991 and 1997 costs increased by rate of inflation to reflect 2005 typical costs of BMPs in southwest Ohio.

TABLE 7. BMP COSTS

Typical Base Capital Construction Cost for BMPs		
BMP Type	Typical Cost ($/cubic foot)	Source
Retention and Detention Subwatersheds	0.70 - 1.30	Adapted from Brown and Schueler (1997b)
Constructed Wetland	0.80 -1.70	Adapted from Brown and Schueler (1997b)
Bioretention	7.1	Adapted from Brown and Schueler (1997b)
Grass Swale	0.8	Adapted from Brown and Schueler (1997b)
Filter Strip	0 - 2.05	Adapted from SWRPC (1991)

Source: USEPA Preliminary Summary of Urban Storm Water BMPs, August 1999.
Note: 1991 and 1997 costs increased by rate of inflation to reflect 2005 typical costs of BMPs in southwest Ohio

Strategy 1: Professional Engineering Analysis

In the Analysis and evaluation section of this project, we evaluated the existing stormwater-related issues and concerns throughout Anderson Township, some identified by Township staff, some by concerned residents, and some observed in the field by team members. Because many of these existing issues can only be solved through structural means which are beyond our scope and expertise, we recommend that the Township hire a consulting engineer to evaluate and rank the priority of each of the Township's stormwater-related issues. The consultant may also work with the Township to detail a schedule by which the stormwater-related problems of the greatest urgency will be resolved and may provide design solutions to the problem.

Strategy 2: Watershed Protection Management

Stormwater issues tend to be recurring and their causes often confound those charged with resolving them. Effective storm water management requires a comprehensive and unified approach that looks at the broader context within which these issues occur. This approach focuses on land uses associated with imperviousness and, vegetation, and riparian corridors to identify the sources of runoff and the extent of its damage potential. These areas also reveal opportunities for mitigating stormwater problems when strategically managed. This section will discuss overarching recommendations to the township regarding the watershed management approach and will also address recommendations for changes to the township's comprehensive land use plan.

WATERSHED-BASED STORMWATER MANAGEMENT

The stormwater issues facing the Township arise out of a combination of factors related to precipitation and the physical features of the land upon which it falls. These features were described in detail in the Analysis section of this report. The context of these physical features, such as slope, soil permeability or quantity of impervious surface, is not arbitrary. It is defined by the watershed – a general area of land that contributes runoff to a lake, river, stream, wetland, estuary, or bay (EPA 2008, 1-2).

Non-point source pollution, such as chemicals, sediments, and solids, is the greatest threat to watershed water quality. Stormwater is the primary transporter of this pollution. Stormwater too is the culprit in issues related specifically to water volume, such as flooding, ponding and erosion.

The watershed depicted in Figure 68 shows the natural hydrologic cycle. Precipitation occurs and is either absorbed through soils or runs off. The more disturbances to the ground cover, the more runoff generated.

Recommendation: Manage stormwater at the subwatershed level

By examining the interdependent relationship between the physical characteristics of the bounding watershed, the water flows within, and specific water impairment issues, the Township can better assess, prioritize, and address these issues.

According to the EPA, watersheds of the 5th and 6th level hydrologic unit code are a good scale for watershed projects. Larger issues should be identified at the subwatershed level but implemented on subwatershed/catchment level:

1. Catchment (area that drains development sites to their first intersection with stream)
2. Subwatershed – 1-10 sq mi, second order streams
3. Watershed – 10 – 100 sq mi
4. Subsubwatershed – 100-1000 sq mi
5. Subwatershed – 1000 – 10,000 sq mi (Randolph 2004, 257-258).

The subwatershed level is best managed because it falls within the legal jurisdiction of a local governing body. Anderson Township has 10 subwatersheds: Indian Hill – Terrace Park, Duck Creek, Dry Run, Eight Mile, Five Mile, 3 Mile, 4 Mile, Clouth, California, Newtown.

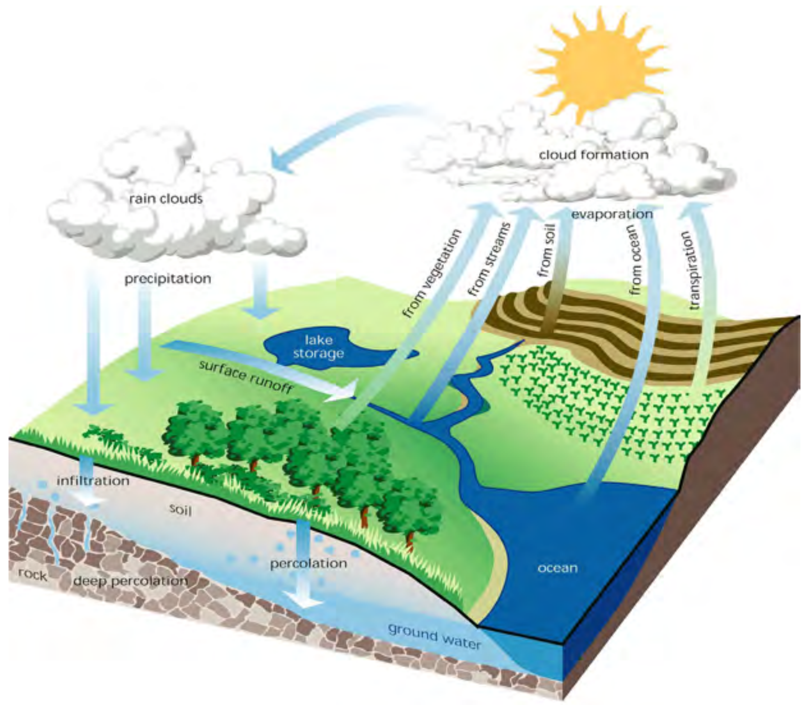


FIGURE 68. NATURAL DYNAMICS OF PRECIPITATION AND RUNOFF IN A WATERSHED. SOURCE: RANDOLPH 2004, 364

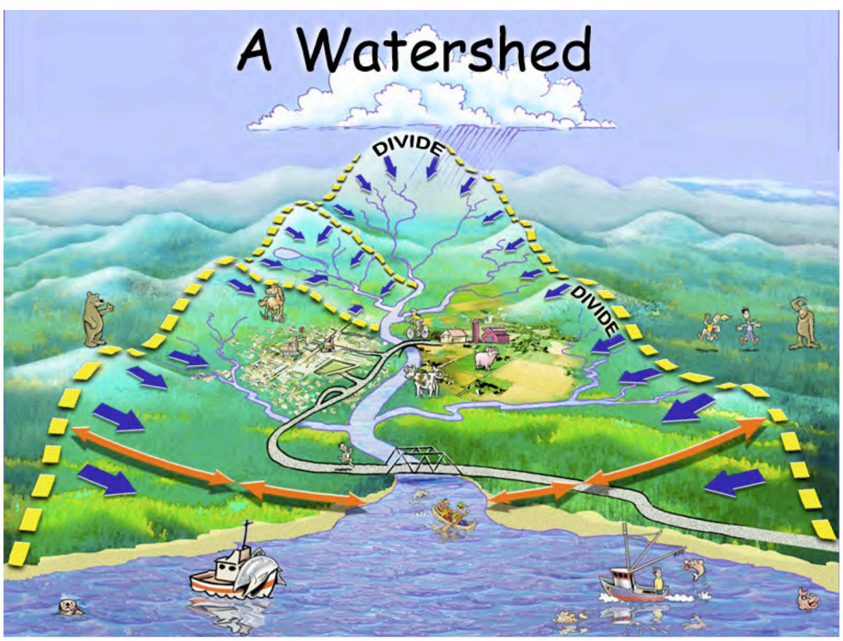


FIGURE 69. TYPICAL WATER FLOWS THROUGH A WATERSHED. SOURCE: COUNTY OF SAN MATEO, 2008

A HEALTHY watershed is one in which the natural hydrology is intact or engineered solutions do not negatively impact down-stream flows. It is one in which the natural water bodies are safe for wildlife and human recreation. Its drinking water supplies are not threatened from pollutants or from depletion due to lack of groundwater recharge.

Land Uses and Watershed Protection Management

Development of the watershed is the ultimate source of stormwater-related problems in the watershed. With structures and uses come impervious surfaces and chemical pollutants. Different types of uses such as residential, commercial, and agriculture have different levels of imperviousness, types of pollutants, and requirements for stormwater management.

The Impervious Surface Ratio (ISR) in the watershed is the most critical factor related to stormwater-related issues because impervious surface prevents stormwater from infiltrating the ground, and increases it runoff velocity. It is also a major source of chemical pollutants. The presence of vegetated land cover is directly related as it provides for pollutant filtration and treatment, and slows the velocity of stormwater runoff.

Riparian areas, the ultimate receiver of stormwater runoff, can be examined to qualify and quantify levels of impairment and to trace sources of impairment back to their respective land uses and physical characteristics. Degraded riparian areas are an indicator of watershed health and can further serve to undermine it. Through lack of vegetation and increased erosion, degraded riparian areas allow chemical pollutants and sediments to wash into the waterways.

Strategies such as land use controls related to types and proximity to riparian areas, cluster development to reduce imperviousness and preserve vegetation, land conservation around impacted riparian areas, and stream restoration and buffers can be utilized to mitigate the effects of stormwater runoff.

IMPACTS OF LAND USE CHANGES

Three types of development need to be addressed in the Township watersheds – the development of vegetated or wooded parcels, the potential for minor subdivisions in these areas and on vacant land, and areas that will be redeveloped from residential to commercial uses according to the future land use plan. Each type of change represents a different challenge or opportunity for stormwater management.

Where new development can occur there will be an increase in stormwater runoff. Minor subdivisions, residential development on five or less parcels, do not require stormwater detention, which can compound existing problems. On the other hand there is a retro-fitting opportunity in areas that are being transformed from residential to commercial uses.

The following map, Figure 70, shows where new residential development and minor subdivisions can occur. A total of 318 parcels, 1424 acres, can be subdivided for residential development according to the respective lot area regulations for each zone. While this represents a small percentage of total land area in the township, only seven percent, the effect on the subwatersheds varies. Table 8 lists the changes per subwatershed.

TABLE 8. MINOR SUBDIVISIONS PER WATERSHED

Subwatershed	Area in Acres	Percent
8 Mile	400	14
New Town	299	7
Dry Run	267	6
California	166	6
4 Mile	46	4
5 Mile	100	3
3 Mile	21	2
Clough	126	2

Parcels which are currently residential but are planned for commercial uses are illustrated in Figure 71. These areas represent a retro-fitting opportunity in the township. However, as they make up only a marginal area, 29 acres total, their redevelopment will have minimal impact on the subwatersheds.

Recommendation: Provide Necessary Controls in Minor Subdivisions

We recommend that the Township consider overall stormwater increases in areas where minor subdivisions can occur to determine if extra control measures are necessary. Particular attention needs to be paid to large concentrations of potential minor subdivisions in Eight Mile, California, New Town, and Dry Run.

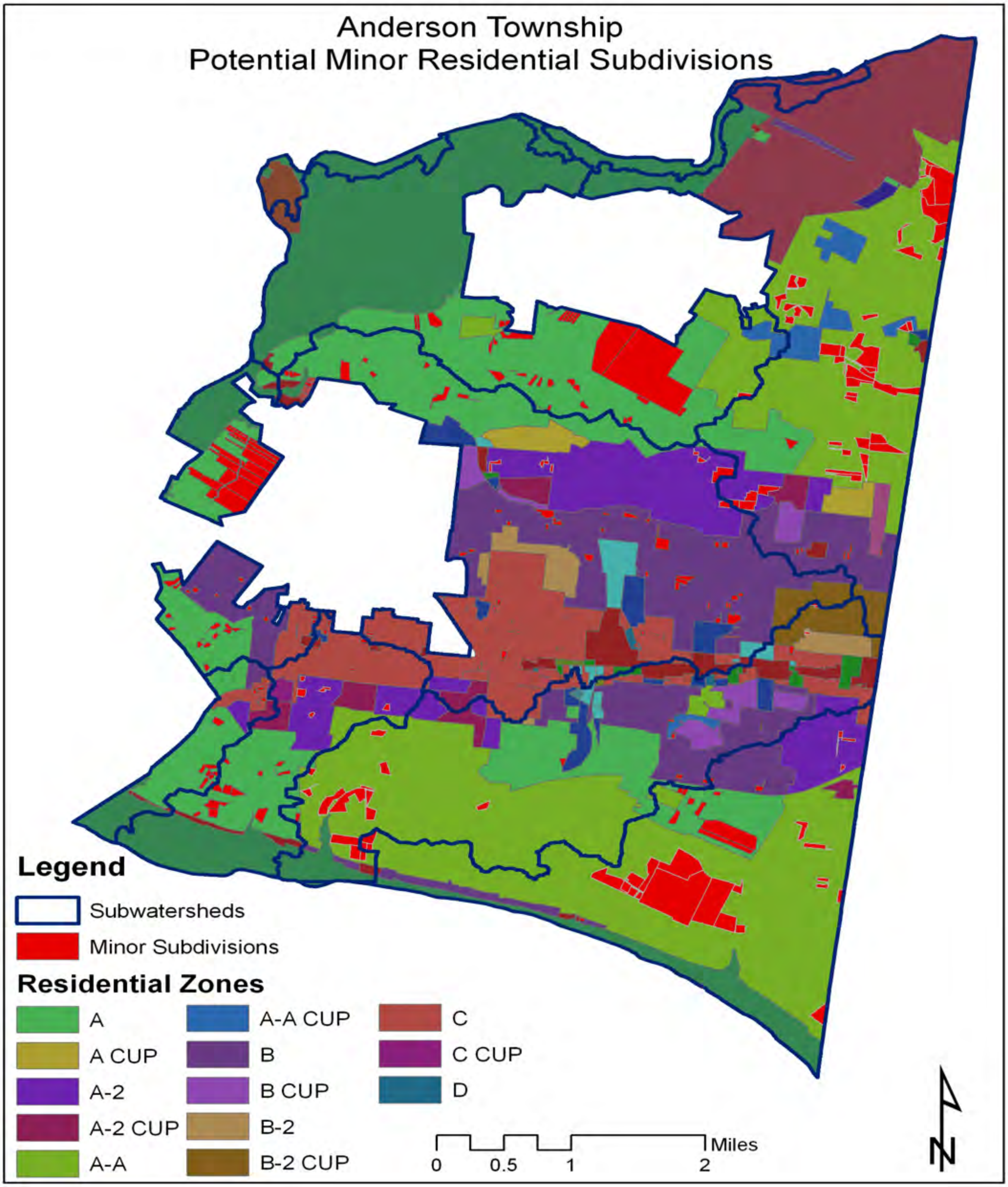


FIGURE 70. MINOR SUBDIVISION DEVELOPMENT PER ZONE AND SUBWATERSHED.

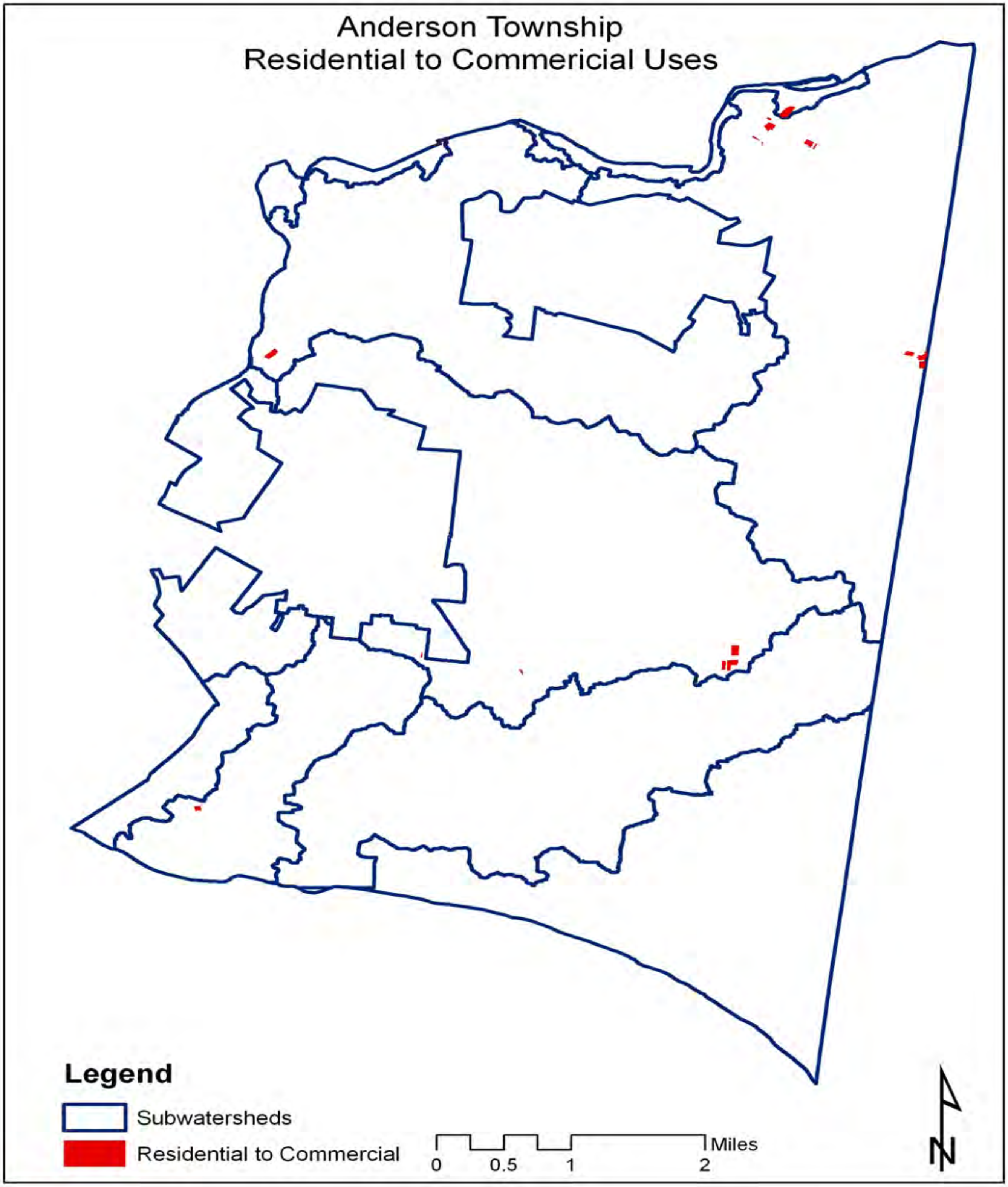


FIGURE 71. RESIDENTIAL TO COMMERCIAL USES ACCORDING TO FUTURE LAND USE PLAN.

Imperviousness/Vegetation and Watershed Protection Management

Impervious Surface Ratios, or ISRs, are measures of the amount of impervious surface - roads, driveways, sidewalks, and rooftops- present in a watershed. We calculated the ISR of each subwatershed by dividing the area of impervious surface by the total area of the subwatershed. The areas for buildings and roads in Anderson Township were readily available from CAGIS. An average width for driveways (14 feet) and sidewalks (four feet) was determined using random sampling, and then multiplied by total lengths of each type, again using CAGIS. Only the large parking lots displayed in land cover maps were counted. As well, other smaller sources of impervious surface and compacted soil were not taken included. This likely led to a slight underestimate of impervious surface, especially in the Clough subwatershed, which which contains a large number of parking lots.

Different levels of impervious surface impact watersheds in different ways (see Figure 72). Watersheds with ISR's below .1, are generally considered to be healthy, with minimal runoff and associated problems. In some cases effects can be seen when ISRs reach the .1 level. All watersheds with ISR's above .1 are considered impacted.

An impacted watershed suffers from serious problems which affect both the natural and human worlds. Problems faced by humans include erosion and other damage to properties and infrastructure. Flash floods can also be a dangerous problem. Habitats are impacted as well by the sediments, contaminants, and heat washed from the impervious surface into the waterways. When such problems occur, actions must be taken to mitigate these effects. At ISRs over .25, impacts can be so severe that the watershed is unlikely to fully recover (EPA 2005). Most new residential developments allow ISRs of .12, but in the past, residential areas often reached ISR's of .2. Commercial areas can reach ISR's of .7 (Watson et al. 2004).

FIGURE 72. ISR AND SUBWATERSHED IMPACT.

The ISR's of the subwatersheds in Anderson Township vary greatly (see Table 9). The Anderson Township portion of the Duck Creek watershed has a very low ISR, just .002. The township as a whole has a .11 ISR. But the township's portion of the Three Mile subwatershed has a very high ISR of .28. The trend is clear. The less developed northern areas of the township all have lower ISR's while the central and southern areas, which have higher densities of both residential and commercial areas, have much higher ISR's.

TABLE 9. IMPERVIOUS SURFACE RATIO PER SUBWATERSHED

Subwatershed	Impervious Surface Ratio
Anderson Township	.11
Duck Creek	.002
Indian Hill-Terrace Park	.03
Newtown	.06
Dry Run	.08
California	.11
Eight Mile	.12
Four Mile	.20
Clough	.22
Five Mile	.23
Three Mile	.28

Recommendation: Coordinate with surrounding jurisdictions

Anderson Township completely contains only two of its ten subwatersheds. The others are shared with the City of Cincinnati, the Village of Newtown, and Clermont County. For the purpose of this plan, ISRs have been calculated only for the portions of the subwatersheds within township boundaries. It is important to inspect the subwatersheds in their entirety as well though (see Figure 73). Surrounding regions have similar amounts of impervious surface as Anderson Township which means that ISR's should be fairly accurate for the whole watersheds as well. The exceptions to this are Duck Creek and Indian Hills- Terrace Park. While the portions within the township are small and in the floodplain, preventing too much build up, the portions outside are much larger and contain much more development. The Newtown subwatershed is also likely to see a somewhat higher ISR with the inclusion of the Village of Newtown.

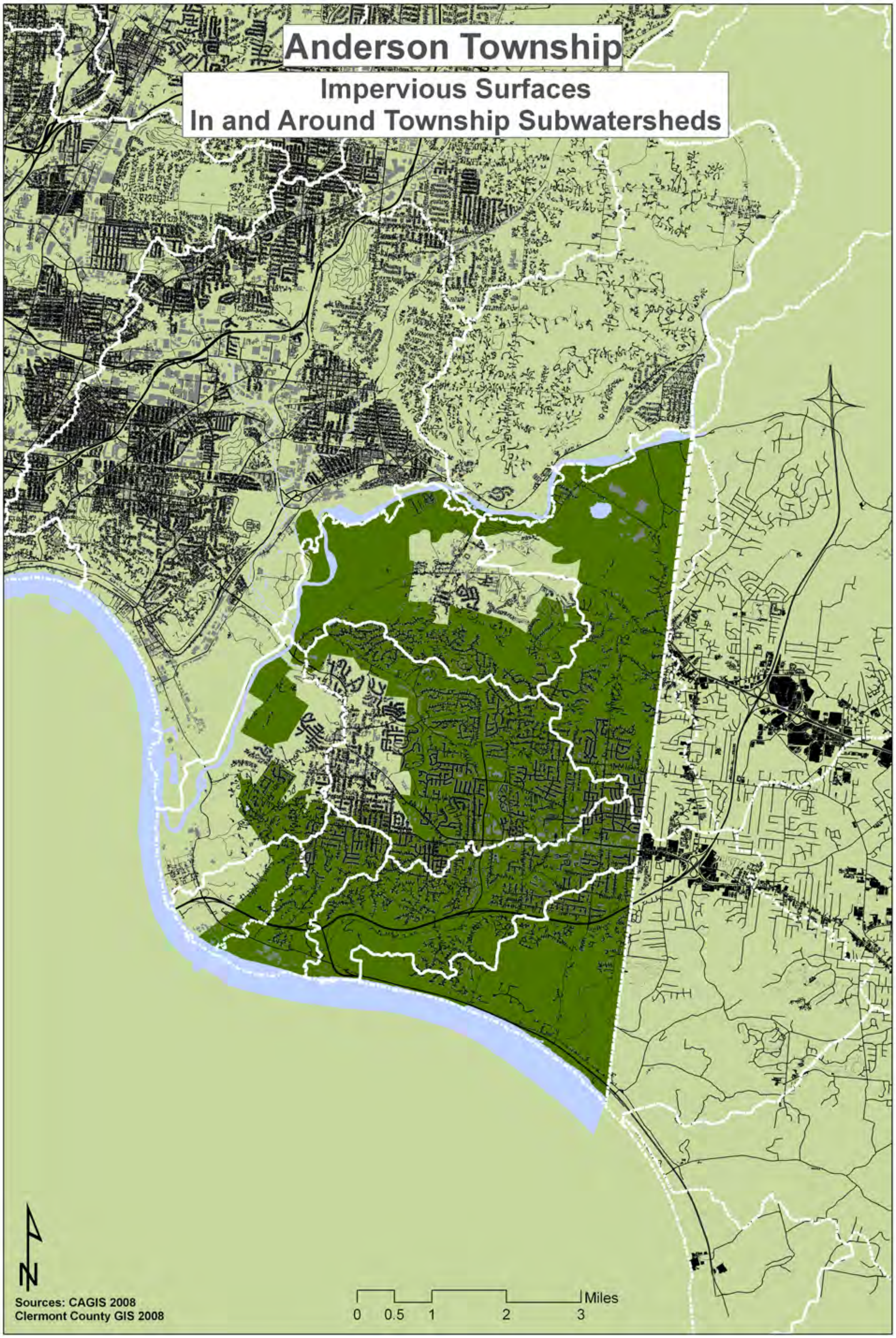


FIGURE 73. IMPERVIOUSNESS IN SUBWATERSHEDS, INCLUDING SURROUNDING JURISDICTIONS.

Recommendation: Implement Development Policies that Protect Subwatersheds

Overall, Anderson Township has manageable amounts of impervious surface. The subwatersheds, for the most part, have not experienced significant degradation. However, several of the subwatersheds do have ISR's which are outside of the healthy range. Several recommendations in the Anderson Comprehensive Plan can be expanded to ensure that future development does not cause a dramatic increase in the amount of impervious surface. We specifically recommend implementation of the following policies:

Protect Greenspace	Ensure that greenspace is made up of a variety of vegetation, with a special focus on trees, shrubs, and other dense types.
Allow some development of Slopes and Floodplains	Limit development in sensitive areas. Do not allow developments that have a large negative impact on subwatersheds.
Encourage Cluster Development	Require cluster development or other types of preservation development on all hillsides. Develop clustering regulations.
Focus on Redevelopment	Place a greater emphasis on redevelopment than new development. Incentivize redevelopment to make it a more attractive option.

The Comprehensive Plan calls for protection of greenspace, floodplains, and hillsides, which are all important to the health of watersheds. Hillsides are especially sensitive to the effects of runoff since water gains velocity as it travels down the hill, resulting in increased erosion. Vegetated hillsides are much more able to handle runoff than developed or bare hillsides. Greenspace is especially important, as it offers an area for water to absorb into the ground. The best types of vegetation for both hillsides and greenspace are dense and shrubby native plants. These have deep, dense root structures which hold both water and soil in place. Turf and grasses, though not as effective as trees and bushes, perform a similar job (EPA 2001). The township should ensure that both types of vegetation are protected in their greenspaces, floodplains, and hillsides, with special emphasis on preserving the denser vegetation.

Anderson Township does not plan to prohibit all development on hillsides and floodplains. As such, developments in these and other sensitive areas should be limited in number. Their site plans should be carefully reviewed to ensure that projects take watershed health into consideration. Anderson Township already encourages developers to build around environmentally sensitive areas, especially in the Ancor area. This encouragement should be continued and strengthened.

In the Anderson Plan, the township recommends the use of cluster developments in new residential areas for several reasons. These include safety, to cost, to preservation and aesthetics. This recommendation should extend to hillsides and floodplains. Cluster developments serve a dual purpose of preserving vegetation while limiting impervious surface. Cluster developments will help preserve the health of the watersheds while maintaining the natural beauty the township currently enjoys.

Finally, the Anderson Plan notes the township's intention to place a high value on redeveloping old areas over adding new development. This is good for watersheds. Avoiding large amounts of new development makes it unnecessary to start building in sensitive areas, protecting hillsides and vegetation. With previously developed areas being reused, less impervious surface will need to be put in place, limiting the amount being placed as well as ensuring that impervious surface that is already in place is being used and is not unnecessary.

Riparian Corridors

The protection of natural riparian corridors in Anderson Township will require a significant action plan with a broad spectrum of stakeholders engaged towards the vision of a region-leading sustainable environmentally conscious community. The current amount of impervious surface significantly contribute to riparian degradation through nonpoint source pollution, creating impacted riparian areas such as the one pictured in Figure 74 below. Additionally, due to the high total area throughout the Township of hillside slopes of 30 percent or greater, Anderson Township's streams require comprehensive solutions to protect those resources as well as residents' property and public infrastructure. Research indicates that water quality in receiving water bodies is degraded when watershed imperviousness levels are at or above 10 percent and that aquatic species can be harmed at even lower levels (Beach, 2002).

FIGURE 74. IMPACTED RIPARIAN ZONE. SOURCE: HTTP://WWW.TWPUSC.ORG/COMDEV/STORMWATER/FAQ.HTML

During storm events, streams spread out across riparian zones, dispersing the energy of flooding flows. A strong vegetative riparian zone holds soils in place and protects against the erosive force of peak storm events. Development that disturbs riparian corridors is likely to aggravate flooding or erosion problems on adjacent property and downstream property (Cuyahoga Remedial Action Plan 2007).

Land use zoning, subdivision regulations, and subsequent developments can have incredible impacts on riparian corridors when they do not recognize and protect these areas. First, a lack of managed runoff from the urban environment increases the erosion, sedimentation, and undercutting of stream banks, trees, and property. Significant storm flows threaten Anderson Township's residents and infrastructure such as the bridge along Eight Mile shown in Figure 75 which recently collapsed from severe erosion and powerful flows or this bridge in Dry Run shown below in Figure 76.

FIGURE 75: IMPACTED INFRASTRUCTURE. SOURCE: AUTHORS

FIGURE 76: IMPACTED INFRASTRUCTURE. SOURCE: AUTHORS

Second, encroaching streamside development removes the vegetative cover along riparian zones which reduce excessive sunlight exposure and limit erosion. This affects the stream's ability to maintain oxygen levels, limit nutrient enrichment, and maintain healthy aquatic life (Beach 2002). The process of urbanization begins with construction, which alters and eliminates trees, vegetation, and topsoil—key components of the natural hydrologic system that otherwise control runoff. Construction also exposes sediment and construction materials to precipitation, which then washes materials into storm drains or directly into nearby bodies of water.

Third, healthy watersheds and riparian corridors limit nonpoint source pollution from increased storm water runoff in numerous ways. Runoff from homes, industries, streets, and parking lots contribute to harmful levels of pollutants such as pesticides, metals, fecal coli-form, oils, and grease into receiving streams. Automobiles, for example, are major sources of environmental releases of petroleum products, nutrients, toxic fluids, and heavy metals; home and yard maintenance contribute nutrients, chemicals, and pesticides; industrial and transportation activities generate airborne pollutants that settle upon urban surfaces. In addition, failure to pick up after pets can lead to high levels of bacteria in runoff. Without management or treatment, polluted runoff degrades streams, lakes, wetlands, and drinking water supplies (James 2002).

Lastly, channel alteration from development impacts the natural riparian system. Straightening, smoothing, and armoring the stream bank eliminates many natural functions of riparian zones. Many times altered stream banks will increase the velocity of peak flows thereby accelerating erosion to downstream corridors and property. This is not only illustrated in Figure 77 below but throughout Anderson Township. Sensitivity to stormwater quantity and quality can lead to better channel construction for stormwater management, as in Figure 78 below.

FIGURE 77: ALTERED CHANNEL WITHOUT IMPROVEMENTS. SOURCE: AUTHORS

FIGURE 78. ALTERED CHANNEL MADE TO REDUCE VELOCITY. SOURCE: AUTHORS

Cluster development, recommended earlier, will also benefit riparian zones through reduced pollutant runoff. Moreover, cluster development brings other benefits. It can save money by reducing clearing costs and infrastructure requirements such as pavement and utilities. Cluster development can also increase property values based on proximity to parks, open space, and natural areas (Weicher and Zerbst, 1990).

Protecting Riparian Zones In Anderson Township

The physical shapes of existing streams within Anderson have been altered as a result of increased runoff during peak storm events. Additional impervious surfaces and urbanization will result in increased flows that will widen and erode more streams within natural riparian corridors. Ultimately, the risks include damage to roads, bridges, and other physical infrastructure.

The Cuyahoga River Remedial Action Plan notes that development at the headwaters of streams significantly impact riparian corridors by limiting the stream's capacity to handle peak flows, "leaving fewer miles of stream to handle the increasing amount of storm water runoff" (2007). This statement could very well have been referring to the impact of development on Anderson Township's stream and riparian areas. This is an especially important aspect of the situation for Five Mile and Clough Watersheds that both have commercial corridors and significant impervious surfaces at the headwaters of those streams.

Although Five Mile and Clough Watersheds have significantly impacted streams and channels, Eight Mile stands out as having 9.1 percent future increases in runoff as indicated by the build out analysis in addition to the characteristics of Five Mile and Clough Watersheds. Anderson Township might view Eight Mile as a strategic watershed to implement some of the following recommendations because of the several characteristics outlined in Analysis section of this report that indicate that the Eight Mile Watershed is considerably impacted.

Although the Lower Little Miami River and tributaries have not been assessed using a Total Maximum Daily Load (TMDL) study, as required by the EPA, since 1998, it remains on the list as not meeting water quality for aquatic life targets. However, the Little Miami, from Caesars Creek to the confluence with the Ohio River does meet recreational use targets. Duck Creek is on the Ohio EPA 303(d) list of impaired waters. It is currently impaired water quality for aquatic life goals as well as human recreation targets (EPA 2006).

Currently, groups such as the Little Miami River Partnership are seeking to enhance the environmental quality of the Lower Little Miami River through projects like the Conservation Reserve Enhancement Program which would bring investment for conservation practices and easements (Little Miami River 2007). Other groups are receiving grants from the Ohio EPA such as the Non-point Source Pollution 319 Grant which could be used for improving riparian corridors and stabilizing degraded streams such as in Five Mile, Eight Mile, and Clough Watersheds.

Recommendation: Tools for Riparian Zone Recovery and Protection

STREAM BANK RESTORATION PROJECTS

Other communities have experienced measurable improvements in reducing erosion, flooding, stream restoration, and improved water quality through these programs. The goal of such a program should be the "act of restoring natural conditions of a degraded stream channel, including stabilizing the stream and stream bank, planting native trees, shrubs and grasses. Measurable results of this project would include reduced erosion and flooding, re-established buffers, improved water quality/habitat and enhanced stream aesthetics" (Lee et al 2001). These efforts must focus on the restoration of the urban forest and street tree canopy; the protection of riparian corridors and steep slopes to control erosion; and optimization of city parks and public spaces for stormwater management.

In one example, the City of Griffin, Georgia was able to partner with private companies, at little cost to the city, to begin to mitigate degraded riparian corridors. The program accomplished this by allowing private companies to mitigate degraded streams and restore natural areas with the subsequent right to sell mitigation credits to other developers who may need to impact certain streams with such infrastructure as piping or road crossings (Woodworth, 2002).

CONSERVATION EASEMENTS

Anderson Township's comprehensive plan should designate critical riparian areas for their conservation value and establish the importance of protecting those areas from future degradation. Voluntary conservation easements by private landowners in Anderson Township assures that the property will be perpetually preserved in its predominately natural, scenic, historic, agricultural, forested, and open space condition.

The purposes of a conservation easement is to protect the property's natural resource and watershed values; to maintain and enhance biodiversity; to retain quality habitat for native plants and animals, and to maintain and enhance the natural features of the property. Any uses of the land which may impair or interfere with the conservation values are expressly prohibited (Ohio Revised Code 2008).

COMPREHENSIVE PLAN APPROACH

Elements of the comprehensive plan need to account for storm water management issues and seek to create the impetus for best management practices throughout the township.

Where possible, Anderson Township should maintain and enhance the existing hydrological and ecological function of stream or drainage corridors or wetland areas. Incentives to developers or landowners to conserve land (open space design, density bonuses, stormwater credits, or lower property taxes) should be incorporated in both the review process and within the comprehensive plan.

Reducing or preventing stormwater runoff is the most effective way to minimize pollution because it prevents pollutants from being transported to water bodies. Incorporating green infrastructure and Low-Impact Development practices into the earliest stages of community development can negate or limit the need for larger-scale, more expensive stormwater controls. Minimizing imperviousness, preserving existing vegetation, and incorporating green space into designs all decrease the impact that urbanization has on water quality. Used in this way, green infrastructure design is a more cost-effective strategy, often costing less to develop per lot while yielding more lots at an increased sale price (Haugland 2005).

TRANSFER OF DEVELOPMENT RIGHTS (TDR)

The Transfer of Development Rights (TDR) Program is a program that allows individuals to purchase and sell residential development rights from lands that provide a public benefit. Such lands include farm, forest, open space, regional trails and designated urban separator lands and habitat for threatened or endangered species. Landowners receive financial compensation without developing or selling their land and the public receives permanent preservation of the land. Transferred development rights can be used to build additional houses on other parcels in more appropriate areas (King County 2008).

Strategy 3: Regulating A Healthy Watershed

The previous section recommended in broad strokes how Anderson Township can rethink its approach to stormwater management. This section we will make recommendations regarding how Anderson Township can implement stronger stormwater management through its regulatory authority. In addition to making recommendations regarding the effective implementation of the recommendations made in the previous section, this section will also examine the current regulations that govern development within the township, including both Anderson Township resolutions and Hamilton County standards and ordinances, and highlight roadblocks that prevent the implementation of alternative stormwater management methods.

REGULATORY FRAMEWORK

Because of Anderson Township's status as a township, it does not have full control over every aspect of development within its boundaries. Anderson has authority over its own zoning code and the issuance of zoning permits, but relies on Hamilton County to set engineering standards and provide engineering reviews and approvals for new developments. Therefore, while Anderson Township has jurisdiction over such development issues as setbacks, densities, parking requirements, and landscape requirements, Hamilton County has control over the design of public streets, the design of storm sewer and stormwater management facilities, and the location of utilities.

LOW IMPACT DEVELOPMENT (LID)

One of the most significant ways in which to reduce the impacts of stormwater runoff is to design developments such that they mimic the natural hydrologic processes of the land as closely as possible. The EPA refers to this type of development as "Low Impact Development" or LID (EPA 2008). LID design encourages the reduction of impervious surfaces and the use of more natural methods of stormwater conveyance other than storm sewer to reduce stormwater runoff and to improve the quality of stormwater runoff entering natural waterways.

LID development differs from cluster development or conservation development in that cluster or conservation development utilizes one centralized stormwater management facility to control runoff, while LID development is characterized by the distribution of micro-scale stormwater detention and retention areas to reduce runoff at its source and improve infiltration and groundwater recharge (EPA 2000, 1-2). In short, the goal of LID is to utilize BMPs to decrease the Effective Impervious Surface (EIS) of the watershed area as opposed to the conventional stormwater practices which aim to collect and convey stormwater as quickly and efficiently as possible, but nothing more (EPA 2000, 1-2). Extensive information on LID is available through the U.S. EPA website at the following address: http://www.epa.gov/owow/nps/lid/.

STORMWATER MANAGEMENT REGULATION IN ANDERSON TOWNSHIP

In general, the regulations that govern development within Anderson Township are conventional with regards to stormwater management. Evaluating Anderson Township regulations utilizing the Codes and Ordinances Worksheet provided by the Center for Watershed Protection (CWP), we find that the development regulations of Anderson Township and Hamilton County score very low in terms of their protection of the environment (see Appendix for completed worksheet). Based on the score the local regulations received, the CWP states that "Serious reform is needed" to improve the protection of Anderson Township's waterways from the impacts of development.

In this section, we address the issue of improving development regulations. We make recommendations to establish a riparian setback, increase open space requirements and improve landscaping requirements to make the landscape work for both aesthetics and stormwater management. We also make recommendations for a stormwater management overlay district which would require new developments to add LID elements to their site designs, and we recommend that the Township encourage residential developers to seek out more aggressive LID designs requiring variances to Hamilton County's subdivision and construction standards. Lastly, we provide opportunities for Anderson Township to offer incentives to developers to implement more expensive green infrastructure, like green roofs. Without firmer regulations in place, Anderson Township cannot improve stormwater management within its boundaries in a widespread and impactful way.

Recommendation: Establish Stormwater Management Overlay District

The addition of a Stormwater Management Overlay District will provide property owners and developers with consistent standards designed to protect and maintain natural waterways, avoid damage to private property and public infrastructure and beautify the built areas of the Township.

EXTENT

The Stormwater Overlay District can be applied to individual subwatersheds within the Township (i.e Clough, Three Mile, etc.). As shown in previous sections of this document, some subwatersheds are impacted by excessive stormwater runoff more than others. However, it is our opinion that the sub-watersheds which are not yet experiencing erosion, flooding and other problems related to stormwater runoff are the areas where this Overlay District has the most potential to preempt those problems. Therefore, we recommend that this District encompass the entirety of the Township jurisdiction.

STANDARDS AND GUIDELINES

In order to address the most pressing issues regarding stormwater runoff and to prevent future problems, the Overlay District shall employ a two-pronged approach, each with its specific purpose and restrictions or requirements:

1) Riparian Setback Requirement
2) Stormwater Management Practices Program

The suggestions contained herein were taken either in part or in whole from existing programs or ordinances in jurisdictions similar to Anderson Township.

We recommend that the Stormwater Management Overlay Zone be added to Anderson Township's Zoning Resolution in a new Article XIII-H.

RIPARIAN SETBACK REQUIREMENT

The presence of natural vegetation on stream banks provides protection against erosive forces within streams and on adjacent lands. The protection of riparian areas results in the presence of plants best suited to each individual environment along a stream, with proven capability for survival and regeneration at no cost.

PURPOSE

The system of streams within Anderson Township contributes to the health, safety and general welfare of the residents. The purpose of this Riparian Setback Ordinance is to protect and preserve the water quality within streams of Anderson Township and to protect residents of the Township from property loss and damage because of flooding and other impacts of the stream. The method of implementing this ordinance is by controlling uses and developments within a Riparian Setback that would impair the ability of the riparian area to:

a) Reduce flood impacts by absorbing peak flows, slowing the velocity of floodwaters and regulating base flow.
b) Stabilize the banks of streams to reduce bank erosion and the downstream transport of sediments eroded from stream banks.
c) Reduce pollutants in streams during periods of high flows by filtering, settling and transforming pollutants already present in streams.
d) Reduce pollutants in streams during periods of high flows by filtering, settling and transforming pollutants in runoff before they enter streams.
e) Provide areas for natural meandering and lateral movement of stream channels.
f) Reduce the presence of aquatic nuisance species to maintain diverse and connected vegetation.
g) Provide high quality stream habitats with shade and food to a wide array of wildlife by maintaining diverse and connected riparian vegetation.
h) Benefit Anderson Township economically by minimizing encroachment on stream channels and reducing the need for costly engineering solutions such as dams and riprap, to

protect structures and reduce property damage and threats to the safety of watershed residents, and by contributing to the scenic beauty and to the environment of Anderson Township, the quality of life of the residents of Anderson Township and corresponding property values.
i) Protect the health, safety, and welfare of the citizens of Anderson Township.

DESCRIPTION

We recommend that the Township revise its zoning code so as to incorporate the Riparian Setback requirement. This section shall state that no preliminary plan, building, or zoning approvals will be issued by Anderson Township without compliance with the terms of this Riparian Setback. These regulations will not limit or restrict the application of other provisions of law. Where this ordinance imposes a greater restriction upon land than is imposed or required by any other provision of law or regulation, the provisions of this ordinance will supersede.

STREAMS

The widths of setbacks will be in relation to the drainage area of the stream. What follows is an example used in Summit County, Ohio.

1. A minimum of 120 feet on each side of all streams draining an area greater than 20 square miles.
2. A minimum of 75 feet on each side of all streams draining and area greater than 0.5 square mile (320 acres) and up to 20 square miles.
3. A minimum of 50 feet on each side of all streams draining an area greater than 0.05 square mile (32 acres).
4. A minimum of 30 feet on each side of all streams draining an area less than 0.05 square mile (32 acres).

WETLANDS

The Riparian Setback shall consist of the full extent of the wetlands plus the following additional setback widths:

a. A 50 foot setback extending beyond the outer boundary of Category 3 wetlands.
b. A 30 foot setback extending beyond the outer boundary of Category 2 wetlands.
c. No additional setback will be required adjacent to Category 1 wetlands.

FLOOD ZONES

Regulations pertaining to development within Flood Zones and FEMA Special Flood Hazard Zones are addressed in the H zoning district code. In areas where multiple regulations apply, the ordinance that imposes a greater restriction shall control. Hence, where the width of the flood area buffering a stream is greater than that of the above minimums, the flood area will be used.

APPLICATION

Prior to any soil disturbing activity, the applicant will be responsible for delineating the Riparian Setback, identifying this setback on all subdivisions, land development plans, and/or building permit applications, and placing construction fencing or other suitable material on site providing delineation.

PERMITTED USES

We recommend that uses permitted within the Riparian Setback be limited to:

a. Passive recreational activity
b. Removal of damaged or diseased trees, revegetation and/or reforestation.
c. Stream bank stabilization/ Erosion Control Measures.
d. Crossing (limited to one driveway per parcel)
e. Placement of stormwater quality retention or detention facilities.

PROHIBITED USES

We recommend that the following uses be specifically prohibited within the Riparian Setback:

A. Construction (except as permitted above).
B. Dredging or dumping.
C. Roads or driveways (except as permitted above).
D. Motorized vehicles.
E. Modification of natural vegetation.
F. Parking lots.
G. New surface and/or subsurface sewage disposal or treatment area.

These regulations do not apply to structures in existence at the time of their passage. Certain modifications and restorations to existing structures within a specified time frame shall be allowed.

VARIANCES

Variances to the provisions of the ordinance will be submitted to the Township Board of Zoning Appeals. Rules governing the granting of variances should be set at the time of passage of the Riparian Setback Ordinance. Anderson Township can perform inspections when a subdivision plat is submitted, a building or zoning permit is requested or prior to any soil disturbing activity to inspect the delineation of the Riparian Setback. The Setback should also be inspected annually or as time permits for compliance with any approvals under these regulations or at any time evidence is brought to the attention of Anderson Township that uses or structures are occurring that may be expected to violate the provisions of these regulations.

The Runoff Factor

We recommend that Anderson Township develop a set of stormwater management requirements which would strongly encourage the use of LID practices in the management of stormwater. The intent of the Runoff Factor is to improve the extent and quality of onsite storrmwater management practices to a degree which is above and beyond that which is required by Hamilton County Public Works, while providing flexibility for developers and designers to meet these requirements and to utilize the open space on their sites more effectively.

PURPOSE

To promote public health and safety and sound economic development in the Community, it is important to provide homebuilders, developers, and landowners with consistent, technically feasible, and operationally practical standards for storm water management.

As a part of the Stormwater Overlay District, we recommend a program which involves natural drainage features and landscaping for new development or re-development. It will offer developers a variety of options that promote natural onsite stormwater management. Besides avoiding the environmental and infrastructure costs of increased runoff due to impervious surfaces, instituting these practices will have fringe benefits for the landowner and neighboring properties. Many of the management practices of this program will provide aesthetic benefits as well as help to mitigate urban heat island effect. The increase in shade from trees and greenroofs also lowers summer cooling costs.

DESCRIPTION

The Runoff Factor, if implemented, will require developers to include a minimum amount of stormwater management infrastructure to reduce stormwater runoff volume and to encourage stormwater infiltration. This minimum will be established by the Township in conjunction with a consultant. To provide flexibility in meeting this requirement, the resolution will establish a menu of stormwater management options, primarily LID designs, ranging from trees, shrubs and groundcovers to green roofs, bioswales and rain gardens. Each option will be assigned a specific point factor. Lower values will correspond to lawn and small plants, while higher values will be associated with trees, green roofs, vegetated walls and bioswales. The number of plants or landscaping features and the square footage of ground cover or greenroof will be multiplied by its point factor. The developer can then adjust the number and proportion of each to accomplish an aggregate minimum set by the Township. Again, we recommend that Township staff, in conjunction with a professional consultant with experience in natural methods of stormwater management, determine the exact point value of each feature and the minimum total based on the conditions of Anderson Township.

FEATURES

The point value of each stormwater management practice should reflect the relative benefit of each in terms of mitigating runoff. Practices can be roughly grouped by the following:

High Point Value:	greenroof bioswale vegetated wall large tree
Intermediate Point Value:	medium-sized and small tree retention pond rain garden permeable pavement rain barrel
Low Point Value:	shrub groundcover grass

(For a description of each feature, please see the green infrastructure BMP section)

APPLICATION

This program shall apply to all development and redevelopment in the Township. Plans and zoning permit applications submitted to the Township for review will be assessed by the Township in accordance with the above program. Instructions can then be attached to the plan before being forwarded to the Hamilton County Department of Building Inspections for approval. Assuming an appropriate level of understanding and desire for cooperation, a streamlined process will ensure that no additional delays hinder the permitting process.

Recommendation: Require Stormwater Management for Minor Subdivisions

INTRODUCTION:

Anderson Township staff has indicated their concern regarding the stormwater management of minor subdivisions. A minor subdivision, as defined by the Hamilton County Subdivision Regulations, is the subdivision of a parcel of land located along an existing public street into no more than five lots and requiring no opening, widening, or extension of public road to serve the new lots created (Hamilton County 2008). Hamilton County does not require stormwater detention for minor subdivisions, and the Township would like to remedy this situation in some manner.

CURRENT MINOR SUBDIVISION APPROVAL PROCESS:

Applications for land division for minor subdivisions are submitted to Anderson Township for approval. Then an application is made to the subdivision coordinator of Hamilton County Regional Planning Commission, where the minor subdivision is approved on a staff level, and the minor subdivision plat is then recorded (Hamilton County 2008). This process so far only addresses the subdivision of land, not the construction of buildings and pavement within the minor subdivision. For major subdivisions, on the other hand, the construction documents and the record plat are reviewed and approved concurrently (Hamilton County 2008).

Prior to the construction of a building on a lot within a minor subdivision, a building permit must be issued for the proposed construction. To obtain a building permit, the builder or developer must first obtain a zoning permit from Anderson Township. The builder or developer can then submit an application for a building permit to the Hamilton County Building Inspections Department. Through the building permit process, reviews are completed by several different agencies, including Hamilton County Public Works, prior to the issuance of the permit. From this simplistic outline of the approval process, two steps in the permitting process have potential for enforcing additional stormwater management controls: at the zoning permit review with Anderson Township and at the building permit review with Hamilton County Public Works.

HAMILTON COUNTY PUBLIC WORKS POLICY:

If Hamilton County Public Works already reviews applications for building permits, why are developments in minor subdivisions not required to detain stormwater runoff like all other developments? The answer can be found in the Hamilton County Public Works Rules and Regulations Governing the Design, Construction, Operation, Maintenance, and Use in the County of Hamilton Storm Drainage System, which outlines HCPW's requirements with regards to stormwater management for the unincorporated area of the county, including Anderson Township. According to Section ST 301 of the Rules and Regulations, HCPW must review every proposal for the construction of a new structure for its compliance with required flood protection measures. Only developments which would have required storage volumes of 850 cubic feet or less are exempt from providing stormwater detention "unless known drainage problems exist immediately downstream of the project as determined by Public Works" (HCPW 2007).

Because the division of land for minor subdivisions is approved without requiring detention for the entire subdivision and because the building permit reviews reach HCPW on a lot by lot basis, the stormwater management requirements are applied to each lot in a minor subdivision on a lot by lot basis rather than to the subdivision as a whole. Therefore, it is likely that stormwater detention is not required because the individual lots do not have enough impervious surface to generate 850 cf of required storage volume.

RECOMMENDATION: PARTNERING AND ZONING CONTROLS

We offer two solutions to resolve the current lack of stormwater management required for the development of minor subdivisions:

1. Negotiate with HCPW such that detention requirements are never waived for new development in Anderson Township. HCPW would then be utilizing the exception to their waiver clause in Section ST 405 (b). The result would be that each individual homebuilder would be required to provide stormwater detention if it were not provided as part of the larger subdivision.
   a. Homebuilders of minor subdivisions could band together to coordinate stormwater detention to reduce the time and cost associated with providing detention lot by lot. We recommend that Anderson Township develop a policy of notifying minor subdivision applicants to suggest that they combine and coordinate their detention efforts.
   b. Anderson Township should also develop a policy for notifying zoning permit applicants for individual new construction of single family residences that proof of stormwater detention will be required through HCPW.

2. Revise the Anderson Township Zoning Code to require stormwater management for all new developments and redevelopments within the Township. Proof of stormwater management would be required prior to issuance of zoning permit. We recommend that the zoning code and application process be revised in the following manner:
   a. Article XII "ID" Industrial Development District Regulations in Anderson Township's Zoning Resolution includes a Section 118.10: "Stormwater Management: Stormwater runoff from the post development condition shall not exceed the peak rate of runoff from the same area before development for all 24 hour storms with frequencies of 2, 5, and 10 years. The peak runoff rate for storms greater than 10 years but less than or equal to 50 years shall be the 10 year pre-development rate (i.e. detention/retention will be required to hold the difference between the 10 year pre-development and 50 year post development runoff rate).
   There may be certain channels, watercourses, or other stormwater runoff carriers that would be damaged or flooded by the additional runoff or extending the time of discharge from detention/retention subwatersheds. For areas in question, the Zoning Inspector may require the developer to provide study data. Where the study indicates, the Zoning Inspector may require additional controls. At the discretion of the Zoning Inspector, the Hamilton County Soil and Water Conservation District and other agencies may be asked for assistance."
      i. We recommend that this section be moved from the "ID" District Regulations to Sec. 61 under Article V General Provisions so that it applies to all development in Anderson Township.
      ii. We recommend the addition of the following clause to this section: "If the volume of required storage, for detention or retention, is calculated to be 850 cubic feet or less, the applicant may apply for the requirement for detention or retention to be waived. Decisions regarding waiving of the detention requirement will be made by the Zoning Inspector on a case

by case basis with consideration of downstream impacts."

b. To enforce the detention requirement for all developments where Hamilton County does not require detention, Anderson Township would need to contract with an engineering consultant to work out the details of the stormwater detention requirements. The consultant would need to also review stormwater management calculations for compliance with Anderson Township requirements. This would add additional cost to the zoning permit application fee and additional time to the approval process.

3. As a final option, if the Township chooses to create a Stormwater Management Overlay District, as recommended previously, the requirements of the Runoff Factor will apply to all new construction, including the development of minor subdivisions. Therefore, the Stormwater Management Overlay District alone could be sufficient in addressing stormwater management for minor

Recommendation: Improve the Township's landscaping requirements

Vegetation, both natural and landscaped, can play a key role in mitigating storrmwater runoff. It slows the velocity of the stormwater flowing off impervious surfaces, cleans pollutants from the water, and decreases the quantity of runoff entering stormwater structures and outleting into the natural landscape (EPA, 2008). In this section we recommend that Anderson Township's landscaping requirements, included within the Township Zoning Resolution, be revised to include existing tree protection requirements, a native plant species list, landscaping for aesthetics and stormwater runoff, and the identification of plants useful in flood zone or delta areas.

ADD A TREE PROTECTION ORDINANCE TO THE ANDERSON TOWNSHIP ZONING RESOLUTION

Existing trees have a much greater capacity for providing stormwater management benefits than the smaller trees planted in new developments. Because they are larger in size and have well-developed root systems, they are able to absorb more rainwater and provide better erosion control. A study of existing trees in the Metropolitan Washington DC area indicated that the need for stormwater retention structures was reduced by 949 million cubic feet due to the area's 46 percent tree canopy. The associated cost reduction was $4.7 billion per a 20-year construction cycle (American Forests, 2008).

To protect large existing trees and the ecological benefits associated with them, we recommend that the Township add an existing tree protection ordinance to its zoning resolution under Article XIV, Section 150. Several municipalities already utilize this type of ordinance. Some examples are the following:

a. Lebanon, Ohio – Tree Protection Requirements
b. Portland, Oregon – Tree Protection Plan
c. Blaine, Minnesota – Tree Preservation Plan
d. Bellevue, Washington – Tree Preservation

The Tree Protection Requirements of the City of Lebanon, Ohio, for example, requires that a developer must submit a tree inventory of all trees on his site which are 6 inches in caliper or greater. The developer must also submit a tree protection plan indicating which trees will be removed due to the new development. For each tree greater than 6 inches in caliper that is removed, the developer must plant 4 new trees.

Other ordinances require existing trees of a 12 inch caliper or larger be tagged and protected during construction and existing trees of 8 inch caliper or larger be noted for protection, yet may not live through the construction stage. In this scenario, if one existing tree is cut down, 2 trees must be planted to replace that one.

Tree protection standards generally also provide requirements regarding how trees are protected during construction, including the establishment of tree protection fence around the root zone of each tree before construction, excavation, demolition, land clearing, or grading begins. All fencing is required to remain in place until all construction is completed.

Although the Township already places a high value on existing trees and foliage, we recommend that this value be formalized in a development regulation.

REVISE LANDSCAPE REQUIREMENTS TO PLACE EMPHASIS ON NATIVE PLANTINGS.

Native plants refer to species that have existed in the area for many centuries. These species usually do not need human help to grow or reproduce. They tend to be drought-tolerant and well adapted to the local climate of rainy winters and dry summers. Native plants provide good erosion control. Native grasses are very important for deep rooting to stabilize the soils, increase water infiltration, and recycle nutrients. Native grasses planted in urban landscapes are low-maintenance, drought-tolerant, and can filter polluted runoff (California Native Grasslands Association, 2008). We recommend that the landscaping requirements of Anderson Township's Zoning Resolution be revised to include a native plant list and the requirement that only native plants may be used to fulfill landscaping requirement. Some examples of native plant zoning regulations from other cities are the following:

a. Lebanon, Ohio – Native Plant List
b. Dublin, Ohio – Native Plant List
c. Chicago, Illinois – Landscape Ordinance
d. Seattle, Washington – Native Plant List

REVISE LANDSCAPING REQUIREMENTS TO INCLUDE SPECIFIC PLANTINGS FOR GREEN INFRASTRUCTURE BMPs, SUCH AS RAIN GARDENS AND BIO-SWALES.

The use of naturalized prairie style landscaping for rain gardens and bio-swales shall be encouraged adjacent to and within wetlands; low-lying and inactive open space areas for the control of erosion and stormwater runoff management. Rain gardens and Bio-swales can be placed in parking lot islands to capture rainwater runoff from the pervious parking area reducing the overall stormwater infrastructure. This can be reviewed in more detail within the "Green Infrastructure" section of this document. Establishing a plant list for rain garden and bio-swales allows residents and property owners to implement properly a rain garden and/or bio-swale on their site while maintaining the aesthetics of the place.

An examples of how to use landscaping to work for both aesthetics and stormwater runoff include The Ohio State University Fact Sheet from the School of Environmental and Natural Resources website: http://ohioline.osu.edu/ls-fact/0001.html, and the EPA's website noting Low Impact Development practices: http://www.epa.gov/nps/lid/.

Recommendation: Revise landscaping requirements to include special planting requirements for developments in flood zones.
Increasing the amount of plantings and the type of vegetation located in the flood zone will help to stabilize the banks erosion issues, filter sediments, filter nutrients such as pesticides and microbes, establish aquatic habitat, and stabilize flood protection (NRCS Planning & Design Manual, 2008). Existing natural vegetation is usually preferred along with native aquatic plants. Some examples of plants that can be used in flood zones are cattails, sedges, pondweeds, eelgrass, duckweed, cypress, red maples, swamp oaks, willows and bayberry to name a few (Randolph, 540).

Some examples of other cities emphasizing plants useful in flood zones are:

a. NRCS Planning & Design Manual
b. Georgetown County, South Carolina – Flood Protection Ordinance
c. Lebanon, Ohio – Flood Protection Standards

Recommendation: Add zoning bonus incentives to encourage use of green roofs.

As described in the green infrastructure BMP inventory earlier in this report, green roofs such as the one shown below in Figure 79 have significant ability to reduce stormwater runoff and improve stormwater quality. However, studies have indicated that although the use of green roofs is increasing, cost is still a barrier to the spread of green roofs, which can cost twice as much as a conventional roof but lasts two or three times longer. Therefore, zoning code bonus incentives can be used to encourage developers to provide features that support regional landscaping and stormwater management.

DENSITY BONUSES

Density bonuses commonly take the form of additional density, height, floor-area ratio (FAR), or a combination of them. All of the bonuses available through the zoning code affect the appearance of the built environment by changing the size and mass of buildings, or the amount and character of landscaping. The FAR is the ratio of the amount of floor area to the amount of site area. A Floor Area Ratio Bonus could refer to a formula that allows builders to increase their floor area ratio in exchange for either a greenroof or porous pavement. The square footage permitted for the exchange depends on the particular zoning code. Examples can be found in Portland, OR, and Minneapolis, MN, zoning codes.

FIGURE 79: GREEN ROOF. SOURCE: WWW.ECOGEEK.ORG

REDUCED PERMIT PROCESS TIME

In other communities, the incentive is reduced time to get a permit. For instance, a development utilizing a green roof may be moved to the top of the review list or may be guaranteed a specific time when the zoning permit is issued. Chicago, for example, cuts the time in half to get a building permit if the building design has a green roof.

Recommendation: Add open space requirements to the Anderson Township Zoning Resolution

Open Space is a significant element in stormwater management. Specifying the required open space land proportion can better guarantee the preservation of natural drainage, while discouraging unsocial activities and effectively dealing with pollution problem.

The Anderson Township Zoning Resolution only points out the yard and green buffer in the residential, mobile home and parking section, and set the open space requirement in Industrial zones. (ARTICLE XII "ID" INDUSTRIAL DEVELOPMENT DISTRICT REGULATIONS Sec. 118.6 Open Space and Landscaping: Maximum site coverage by buildings on any lot or tract shall not exceed

30%. Maximum site coverage by buildings, paved areas and other hard surfaces shall not exceed 75%. At least 25% of any developed tract shall be landscaped or preserved in its natural state) However, there are no clear definitions about open space, and also no particular specifications about open space requirements in commercial zones.

ADD DEFINITION OF OPEN SPACE TO ANDERSON TOWNSHIP ZONING RESOLUTION

Due to the significance of open space in Anderson Township stormwater management, we recommend the addition of an Open Space definition into Zoning Resolution, similar to that of the Hamilton County Zoning Resolution which defines open space in the following manner:
"OPEN SPACE – Land used for recreation, resource protection, hillside, floodway, lake, pond, amenity and/or buffers. In no event shall any area of a lot constituting the minimum lot area of said lot nor any part of an existing or future road or right-of-way be counted as constituting open space".

We recommend that Anderson Township base its defninition of open space onWashington Township's in Montgomery County, Ohio. It states that open space is "an area that is intended to provide light and air and free of any man-made structures. Open space may include, but is not limited to, meadows, wooded area, and water bodies and land designed specifically for recreation. A parcel of land or an area of water or combination of both land and water, and designed and intended for the use and enjoyment of the residents. Open space includes easements, parks, recreation areas, public open space, or other facilities dedicated by the developer for public use. Open space shall be substantially free of structures, or may contain such improvements as are approved as a part of the general development plan and are appropriate for the residents" (Montgomery County, 2008).

In the Washington Township definition, open space has two categories: one is natural ecological open space which used to protect natural environment, and the second is the manmade open space which is required to be provided by the developer for public open space for recreation and green space. If Anderson Township adds this definition to the zoning resolution, it clearly specifies the open space, and could also help residents, developers and all other organizations and groups to value the open space as the essential elements

ADD COMMERCIAL OPEN SPACE REQUIREMENTS TO ZONING RESOLUTION.

We suggest that Anderson Township add minimum open space requirements to commercial zones as it has in the industrial zones. Commercial developments usually are greatly occupied by building area and parking lot pavement. Open space requirements would establish a minimum percentage of open space required on each commercial site, which, in turn would serve to reduce their overall imperviousness and provide more room for the construction of green infrastructure BMPs.

FORMALIZE CLUSTER DEVELOPMENT ZONING IN ZONING RESOLUTION TO PRESERVE OPEN SPACE.

Currently, cluster residential development, as described earlier in this report, is encouraged for specific properties in Anderson Township's Comprehensive Land Use Plan and permitted under the PUD zoning application procedures in Anderson Township's Zoning Resolution. However, cluster development is not explicitly required on any property. We recommend that the Zoning Resolution be revised to require cluster development on these properties as indicated on the Comprehensive Land Use plan to preserve natural open space. Clustered subdivisions have an equal number of residential units as traditional development, but preserve up to 50% of natural open space, which then can serve to control stormwater runoff and the negative impacts of erosion.

Recommendation: Encourage developers to pursue Low Impact Development subdivision design.

Although LID design can be applied in a manner within Anderson Township's direct control, as discussed in the Stormwater Management Overlay District recommendation, LID design in residential subdivisions crosses jurisdictional responsibilities and powers. Hamilton County, as discussed previously, has authority over the design of public streets and stormwater management in the unincorporated land of the county, including Anderson Township. Therefore, because Anderson Township does not have direct control over the street design standards within the township, Anderson cannot require the use of LID practices as they may apply to street design in residential subdivisions. As will be discussed in this section, LID design practices will actually require variances from Hamilton County's current design standards for project approval. As a result, we recommend that Anderson Township encourage, either simply verbally or through negotiation in the PUD process, developers wishing to develop new residential subdivisions in the Township to utilize LID subdivision design.

LOW IMPACT DEVELOPMENT SUBDIVISION DESIGN

To further define the application of LID to residential subdivisions, LID Subdivisions generally have all or many of the following characteristics (University of Connecticut 2007):

- Reduced pavement width (approximately 20' to 24')
- One-way cul-de-sac design with landscaping or bioretention subwatershed in the center (as illustrated in Figure 82).
- Grass swales in right-of-way rather than storm sewer (see Figure 81)
- Shared driveways to reduce overall imperviousness of subdivision.
- Zero lot line setback which allows houses to be clustered closer together.
- Reduced front yard setback so that houses can be closer to the road, leaving more undisturbed land behind the homes.
- Downspouts disconnected from storm sewer and outleting to rain gardens or rain, seen in Figure 82.

FIGURE 81. ROADSIDE SWALES RATHER THAN CURB. SOURCE:
UNIVERSITY OF CONNECTICUT 2007

FIGURE 80: BIORETENTION Subwatershed IN CENTER OF CUL-DE-SAC. SOURCE:
UNIVERSITY OF CONNECTICUT, 2007

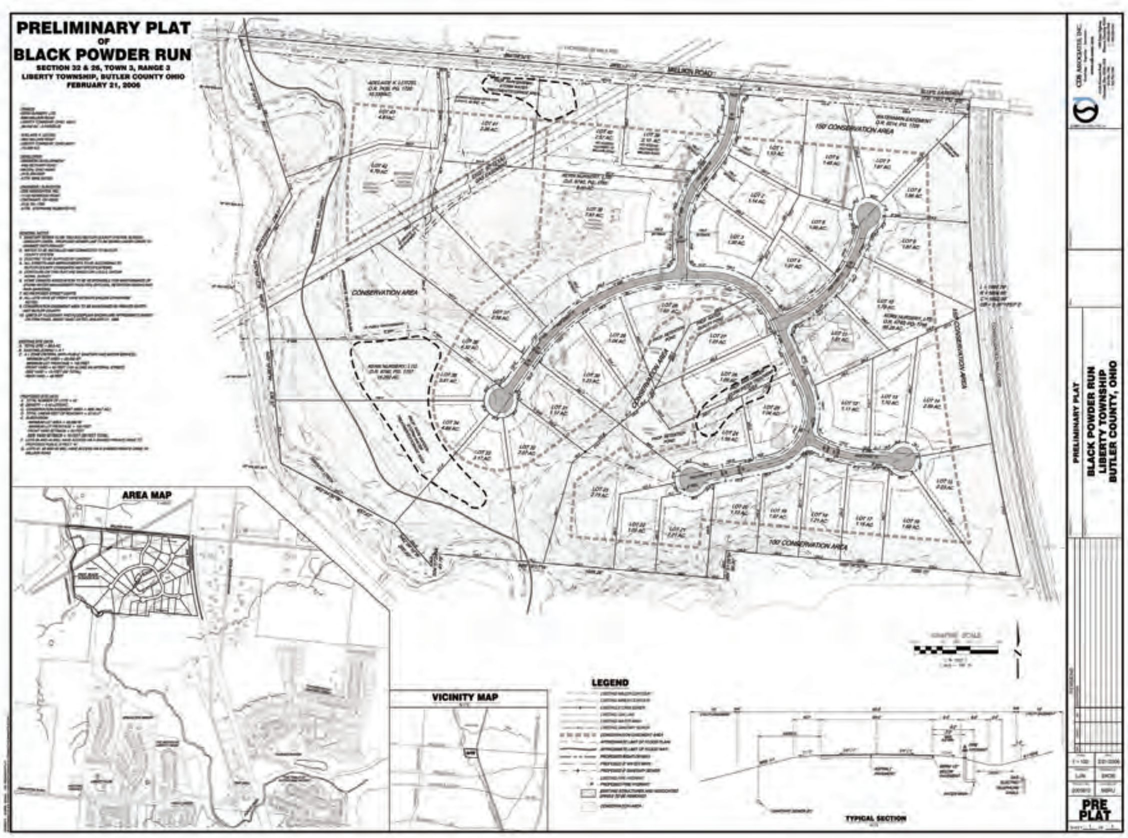
FIGURE 82: DOWNSPOUT DRAINING TO RAIN GARDEN. SOURCE:
UNIVERSITY OF CONNECTICUT, 2007

LID subdivision design has been in use for several years in areas such as Prince George, Maryland and Seattle, Washington. In fact, since 1999, Seattle has working under their Natural Drainage Systems program to re-construct existing residential subdivision streets, replacing them with a street design which utilizes the right-of-way areas created by the narrower pavement width as roadside biofiltration zones (see Figure 83). These biofiltration zones are characterized by landscaped swales, small wetland ponds, and stormwater cascades which all slow the stormwater runoff and provide opportunity for significant infiltration into the ground (Seattle 2008). Natural Drainage Systems are just one of Seattle's efforts to reduce stormwater runoff and improve stormwater runoff quality by constructing infrastructure that better mimics the natural hydrologic cycle.

FIGURE 83. SEATTLE NATURAL DRAINING SYSTEMS AT WORK IN THE SEA STREET PROJECT. SOURCE: SEATTLE 2008

Closer to Anderson Township, a LID subdivision design was approved through Liberty Township and Butler County, Ohio in 2006 which had no curb and gutter, no sidewalk, grass swales, and a mixture of rain gardens and retention ponds (see Figure 84). Approval required variances to the Butler County Engineer's Office street design standards and a specialized review of the stormwater management design for the development,. The proposed development was well received. Project construction is anticipated upon favorable housing market conditions.

FIGURE 84. APPROVED PRELIMINARY PLAN FOR A LID SUBDIVISION IN BUTLER COUNTY. SOURCE: CDS ASSOCIATES, INC. 2006



CURRENT HAMILTON COUNTY SUBDIVISION DESIGN STANDARDS:

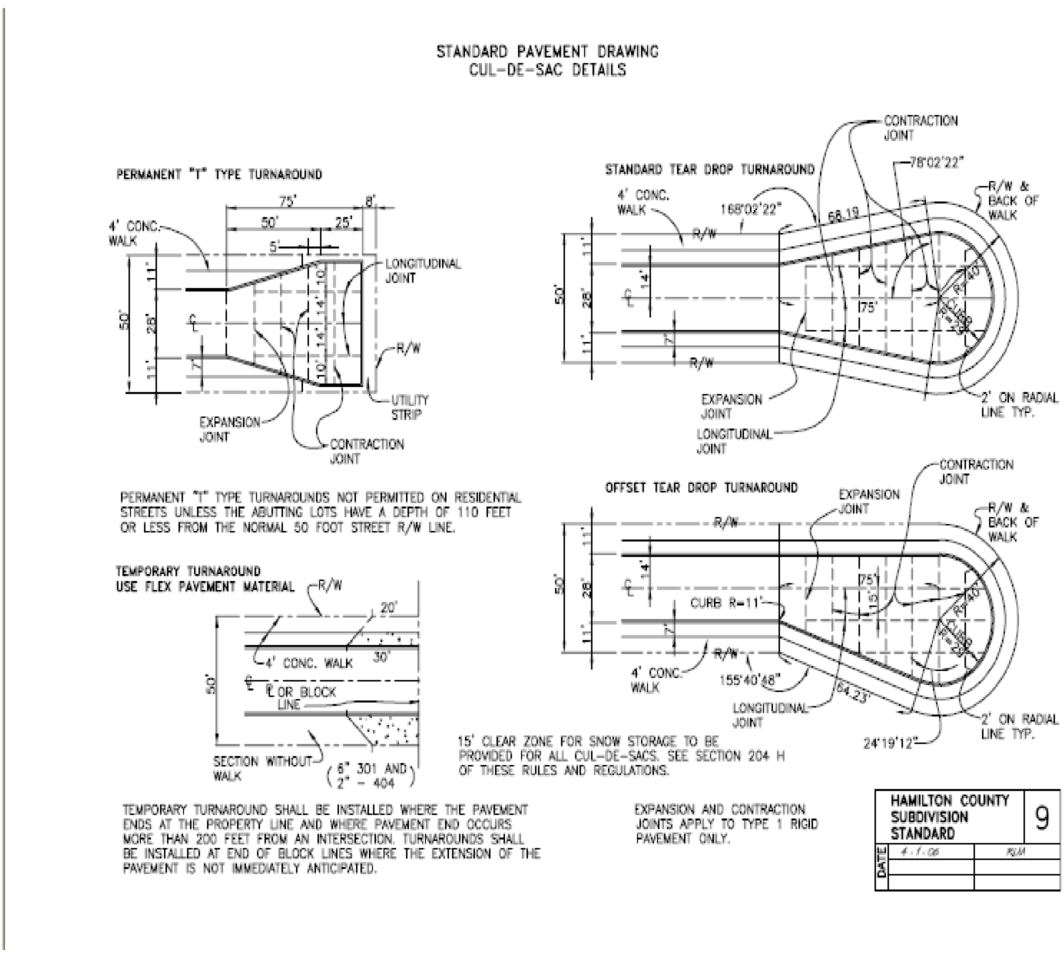
Hamilton County's development regulations at this time do not allow for LID subdivision design by right. Both the Hamilton County Subdivision Regulations and the Hamilton County Engineer's Rules and Regulations note that Hamilton County requires curb and gutter on all new streets. Not only is curb and gutter additional impervious surface, but it also forces the use of conventional underground storm conveyance measures: catch subwatersheds and storm sewer. Storm sewer can exacerbate stormwater runoff in two ways: it allows no possible opportunity for infiltration of stormwater into the ground, and its smooth lining, as compared to natural surfaces, serves to speed up the water as it flows to the outlet. The Rules and Regulations also indicate that the street width of a typical residential subdivision street must be 28 feet from back of curb to back of curb. Hamilton County does make allowances for publicly-owned PUD streets which are required to have a width of 25' back of curb to back of curb (Hamilton County 2006). Both of these pavement widths exceed the street widths recommended by LID standards. In addition, Hamilton County's typical cul-de-sac design, as shown in Figure 85 below, does not permit the center of the cul-de-sac to be landscaped.

While Anderson Township already encourages the use of single family cluster development, we recommend that Anderson Township take this one step further and, through the PUD process, encourage developers of residential subdivisions within the township to utilize LID subdivision design standards and to request variances from the Hamilton County regulations discussed in the section above in order to do so.

Members of the Hamilton County Regional Planning Commission have confirmed that although a LID subdivision has not yet been developed in Hamilton County, they are receptive to the notion (Landivar, 2008). Also, Ed Weber of Hamilton County Public Works, has indicated that he would be pleased to see County regulations move back in the direction of more natural stormwater conveyance and detention systems, yet he wasn't optimistic that the Hamilton County Engineer's Office would be receptive to revising their street standards to allow for LID street design explicitly (Weber 2008).

Although obstacles exist to LID subdivisions, opportunities also exist for Anderson Township to take a leadership role in Hamilton County utilizing progressive stormwater management methods.

FIGURE 85. HAMILTON COUNTY STANDARD CUL-DE-SAC AND STREET DESIGN. SOURCE: HAMILTON COUNTY, 2006



Strategy 4: Retrofitting and Demonstration Programs

Opportunities to build green infrastructure BMPs will arise within the context of new infill development, and these will be addressed through regulatory and zoning controls. However, the Township should also seek to retrofit BMPs to address areas where issues and concerns are most urgent. These will be most evident in older neighborhoods built prior to 1996, the year that retention and detention ponds became a requirement for new development, as well as along creek beds that are eroding badly. We recommend that the Township enact a storm water management program and become a lead actor in reducing storm water related problems. We conclude by introducing several funding suggestions that the Township might use to fund these recommendations.

Recommendation: Retrofitting Program

We do not anticipate that voluntary activity would encourage the amount of BMPs needed to bring storm water velocity and runoff to manageable points; therefore, our recommendation is that the Township institute a BMP retrofitting program. The goals of the program in our view are:

1. Protect private and public property against storm water damage
2. Reduce costs of infrastructure repair, maintenance and installation
3. Increase water quality to receiving bodies of water

In our vision the retrofitting program will be led by a paid employee of the Township who is knowledgeable in planning and environmental practices. This individual would be responsible for collecting data on problems and issues, working with the public to raise awareness, and working with private property owners to address problems. We suggest that this employee implement and manage a formal storm water program, the elements of which are:

- **Data Collection.** Problems and issues are best analyzed when information about them is consistent. This program will enable formalized data collection to assist analysis and prioritization going forward.
- **Swales for Trails.** This component would focus on building rainwater swales at or near target areas along the 15 miles of Anderson's trails system. This may require working with homeowners to get right-of-way access, as well as identifying a list of priority locations for installment. Installation could be through the public works department, civic or student groups.
- **RainScapes Rewards.** This program is based on a similar one of the same name, which is currently in running in Montgomery County, Maryland. Private property owners, both residential and commercial, are provided with rebates of up to $1200 and $5000 respectively, for installing appropriate storm water best management practices on their property (Montgomery County, 2008). We recommend a split of costs associated with installations between private owners and the Township. The program manager would be responsible for approving applications, awarding rebates and inspecting installations.
- Awareness. Awareness of storm water management practices and program components is an important part of the program. The program manager will build support for the program amongst residents and property owners by identifying vehicles and supplying content to these vehicles for distribution to residents. These might include: information about storm water and best management practices on the Anderson Township website, writing an article for the Anderson Insights or the Forest Hills newsletter, working with the Forest Hills community education program or the Hamilton County library to develop curriculum related to storm water landscaping and working with civic or student groups to assist with implementation of BMPs, such as Turpin's "Promote Environmental Awareness" club.

The elements of this management program are intended to make storm water management visible to Anderson Township's constituents and to identify the Township as a leader in storm water damage prevention strategies.

Recommendation: Demonstration Programs

In addition to the above recommendations, Anderson Township is encouraged to set an example to its constituents by retrofitting BMPs into its municipal facilities and incorporating them into future public works projects (see recommendations for the Anderson Trails and Swales for Trails).

To assist in the process of "leading by example", Anderson Township should institute a program similar to that of Sanitary District No. 1(SD1) of Northern Kentucky. Several types of BMPs are displayed at the administration facility with signage that is used as an education tool for the public. Their program is designed to educate fourth grade students and interested citizens about stormwater management and BMPs by providing actual examples. Anderson Township is encouraged to offer a similar interactive element to any BMPs that are installed on municipal property. By studying the example of SD1, Anderson Township can determine what is feasible for reproduction. Having a stormwater education component would enable Anderson Township to influence private property owners to use best management practices on their own property.

Another way Anderson Township could "lead by example" is to host a Green Home-a-rama that would incorporate green infrastructure BMPs and low impact development techniques, along with green building practices. The objective of the project would be to demonstrate what BMPs look like as well as their practicality, costs and benefits. A Green Home-a-rama would signal the Township's orientation toward the future – a future in which we are increasingly focused on energy efficiency and environmental sustainability.

Funding Sources

The approach to funding stormwater management programs (recommended above) can be traditional or nontraditional. This section provides options that Anderson Township can use to obtain funding for stormwater management programs. Most fiscally sound programs implement the use of stormwater utilities to pay for the cost of education, construction, and maintenance. Other mechanisms used to finance stormwater management programs are grants, loans, subsidies, and fees. There are numerous resources and references that provide detailed information for watershed funding. Anderson Township can visit http://www.epa.gov/owow/funding/databases.html for a catalog of federal funding sources for watershed protection. The following are a few examples of funding sources we recommend for consideraton by the Township:

Fees

STORMWATER UTILITIES

The stormwater utility funding method is growing in popularity because of its purpose to improve and manage the quantity and quality issues of stormwater. Revenues are typically generated through user fees which are collected because of the demand that a property places on the stormwater system. There are various methodologies used to determine the rate structure for user fees. Billing and collection of utility fees can be added to an existing monthly utility bill or to the annual property tax. A rate modifier in the form of a utility credit can be implemented as part of the rate structure to incentivize citizens to implement green infrastructures practices on their private property.

Stormwater utilities can cover the cost of administration, planning, engineering design, maintenance and operation, regulation and enforcement, and capital improvement with implementation of these elements phased over several years.
Surcharge Tax A tax surcharge is an additional levy to an established tax rate. Surcharges can be levied on a temporary basis to help raise revenues for specific projects that may not have been anticipated and that are not expected to recur.

Grants/Subsidies

ENVIRONMENTAL EDUCATION GRANTS

The Grants Program sponsored by EPA's Environmental Education Division (EED), Office of Children's Health Protection and Environmental Education, supports environmental education projects that enhance the public's awareness, knowledge, and skills to help people make informed decisions that affect environmental quality. EPA awards grants each year based on funding appropriated by Congress. Annual funding for the program ranges between $2 and $3 million. More than 75 percent of the grants awarded by this program receive less than $15,000.

TARGETED WATERSHED GRANTS

The Targeted Watershed Grants Program is designed to encourage successful community-based approaches and management techniques to protect and restore the nation's watersheds. Any governmental or nonprofit non-governmental entity is eligible to receive a grant under this program, and inter jurisdictional watershed partnerships are encouraged. TWG is based on the fundamental principles of environmental improvement: collaboration, new technologies, market incentives, and results-oriented strategies. Given

NONPOINT SOURCE IMPLEMENTATION GRANTS (319 PROGRAM)

Through its 319 program, EPA provides formula grants to the states and tribes to implement nonpoint source projects and programs in accordance with section 319 of the Clean Water Act (CWA). Nonpoint source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed.

WATERSHED PROCESSES AND WATER RESOURCES PROGRAM (NATIONAL RESEARCH INITIATIVE)

The Watershed Processes program sponsors basic and mission-linked research that address two areas: (1) Understanding fundamental processes controlling a) source areas and flow pathways of water, b) the transport and fate of water, sediment, nutrients, dissolved matter, and organisms (including water-borne pathogens), within forest, rangeland, and agricultural environments as influenced by watershed characteristics and contaminant origin, and c) water quality. (2) Developing appropriate technology and management practices for improving the effective use of water (consumptive and non-consumptive) and protecting or improving water quality for agricultural and forestry production, including the evaluation of management policies that affect the quantity and quality of water resources.

Loans

CLEAN WATER STATE REVOLVING FUND

EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection projects. Point source projects typically include building wastewater treatment facilities; combined sewer overflow and sanitary sewer overflow correction; urban stormwater control; and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silviculture, rural, and some urban runoff control; on-site wastewater disposal systems (septic tanks); land conservation and riparian buffers; leaking underground storage tank remediation, etc. Estuary protection projects include all of the above point and nonpoint source projects, as well as habitat restoration and other unique estuary projects.

Conclusion

Every municipality faces the concern of stormwater management. Development of the land inevitably disrupts natural processes, including the water cycle, which then can lead to flooding, stream damage, and endangerment of public property downstream, all of which have been experienced in Anderson Township. Conventional methods of managing stormwater have progressed from the purely structural method of utilizing storm sewer to collect runoff and discharge it directly to waterways to the still structural methods of today which require, for all but the smallest developments, the construction of detention subwatersheds to release runoff at a controlled rate. Currently, the trend in stormwater management is a progression one more giant step forward to a more environmentally-conscious approach which focuses on stormwater management at the watershed level, seeks to preserve and protect important natural drainage ways and features, and encourages the use of green infrastructure methods to mimic as closely as possible the natural water cycle of the locality.

While these “new” techniques of stormwater management have been in use elsewhere in the country for many years, they are only now beginning to catch on in the Cincinnati Region. Both Sanitation District No. 1 of Northern Kentucky and the Metropolitan Sewer District of Greater Cincinnati are currently working on developing strategies to utilize green infrastructure as a means of removing stormwater runoff from their combined sewer systems, a strategy which they feel will be much more cost effective than their typical structural solutions. And, even within Anderson Township, some green infrastructure techniques are already being utilized for their benefits beyond stormwater management. The Lutheran Church of the Resurrection on Nagel Road, for example, is utilizing a rain barrel system to collect stormwater to be used in irrigating their community garden. In addition, due to their long-standing struggles with stormwater runoff and the owners’ interests in improving stormwater management throughout the Cincinnati region, Turpin Farms on Turpin Lane Road has begun to focus its business on native plantings and rain gardens. People interested in installing rain gardens on their own property can visit Turpin Farms not only to purchase plantings for their rain gardens, but also to receive help in the design.

The above is evidence that attitudes towards stormwater management are already shifting away from conventional methods, towards techniques which work with environmental processes and not against them. In this document, all of these “new” techniques have been formalized into strategies which Anderson Township can implement as a means to achieving both a reduction in stormwater runoff and a reduction in stormwater pollution within its jurisdiction.

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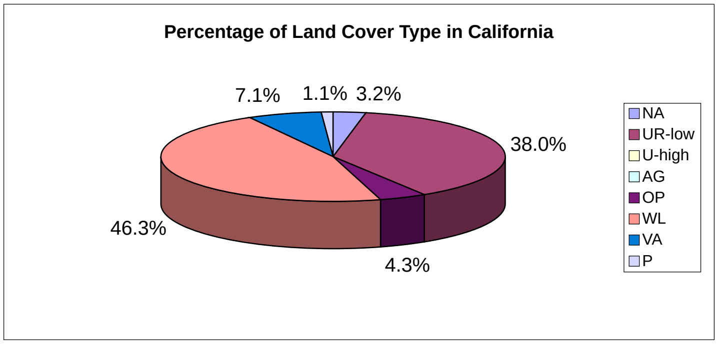
APPENDIX

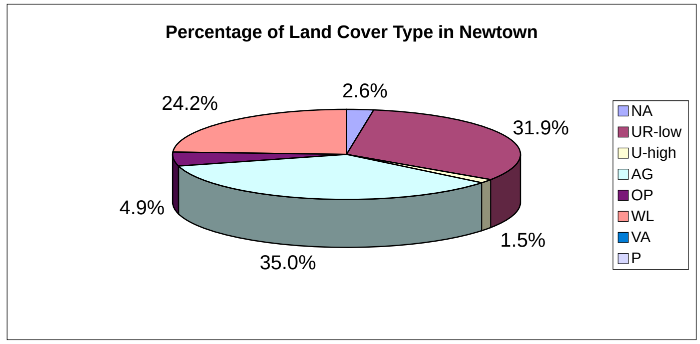
Watershed Characteristics Matrix

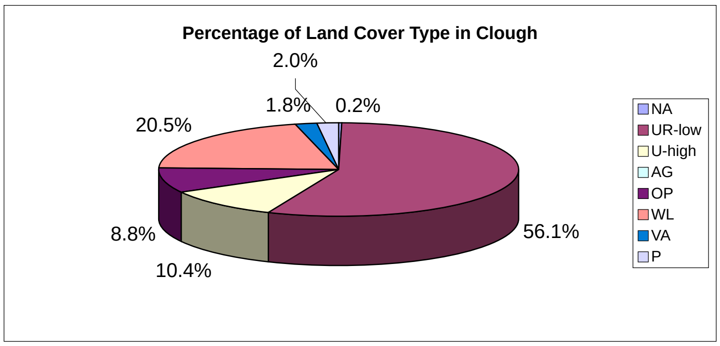
Name	Area in Acres	Watershed Classification	Soil Groups by %	Natural Drainage Summary (Acres)	30% Slope by %	Existing CN / Runoff(in) / Volume(ac-ft)	Future CN % Increase	Minor Subdivisions by %	Impervious Surface Ratio	Watershed Impactedness
3 Mile	433	Fully Developed	B(13) C(64)	Stream Length: 4 mi Stream Density: .01 mi/acre Wetlands: 1.3 River: .009	43	77.9 / 2.5 / 86	Not Significant	2	0.28	Damaged
4 Mile	1246	Fully Developed	B(5) C(63)	Stream Length: 13 mi Stream Density: .01 mi/acre Wetlands: .03 River: 1.3	21	82.4 / 2.91 / 273	Not Significant	4	0.2	Impacted
5 Mile	3184	Fully Developed	A(2) B(1) C(89) D(1)	Stream Length: 36 mi Stream Density: .01 mi/acre Wetlands: .004 Lakes: 1.3 Ponds: .3	22	83.9 /3.05 / 803	Not Significant	3	0.23	Impacted
8 Mile	2906	High	A(1) B(7) C(78)	Stream Length: 30 mi Stream Density: .01 mi/acre River: 316 Ponds: .8	41	75.9 /2.34 / 538	9.1	14	0.12	Impacted
California	988	High	A(2) B(19) C(74)	Stream Length: 12 mi Stream Density: .01 mi/acre Lakes: 1.3 Ponds: .2	36	74.8 / 2.24 / 177	10.2	6	0.11	Impacted
Clough	3976	Fully Developed	A(4) B(1) C(92)	Stream Length: 45 mi Stream Density: .01 mi/acre Wetlands: .03 Ponds: .4	13	78 / 2.51 / 832	Not Significant	2	0.22	Impacted
Dry Run	3886	High	A(1) B(22) C(64)	Stream Length: 52 mi Stream Density: .01 mi/acre Wetlands: .4 Lakes: 8 Ponds: 6 Riverine: 48	30	76.6 / 2.39 / 773	8	6	0.08	Healthy
Duck Creek	211	Medium	B(169)	Stream Length: 4 mi Stream Density: .02 mi/acre Wetlands: .2 Riverine: 52	0.7	68.8 / 1.77 / 26	Not Significant	0	0.002	Healthy
Indian Hill-Terrace Park	213	Fully Developed	B(53)	Stream Length: 6 mi Stream Density: .03 mi/acre Wetlands: 4 Ponds: .5 Riverine: 48	5	63.3 / 1.38 / 16	Not Significant	0	0.03	Healthy
Newtown	2943	Medium	A(1) B(49) C(46)	Stream Length: 36 mi Stream Density: .01 mi/acre Wetlands: 3 Lakes: 211 Ponds: .4 Riverine: 52	20	75.6 / 2.31 / 557	5.9	7	0.06	Healthy

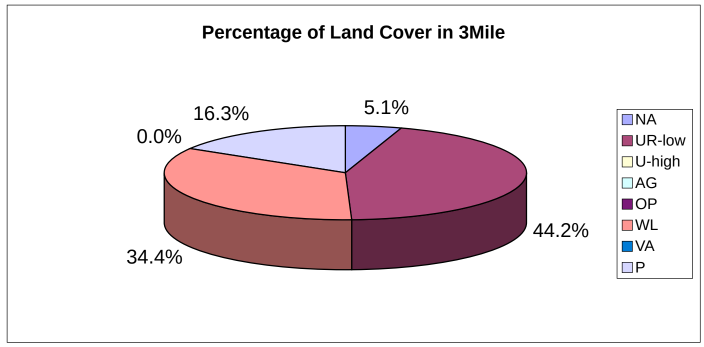
Land Cover By Subwatershed

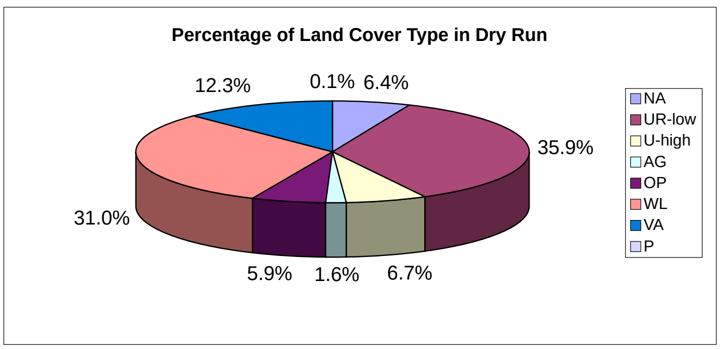
NA - None, Water Features | UR-low - Urban-Rural/Low Density | U-high - Urban-High Density | AG - Agricultural/Crops | OP - Open Land | WL - Woodland | VA - Cleared Land | P - Pavement

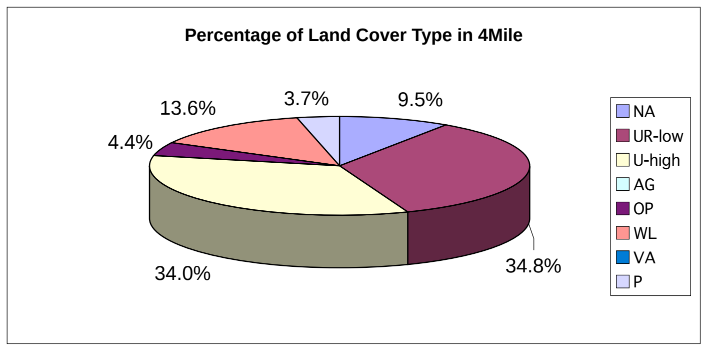


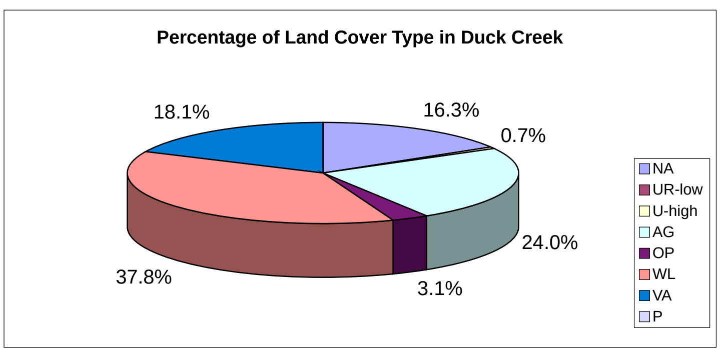


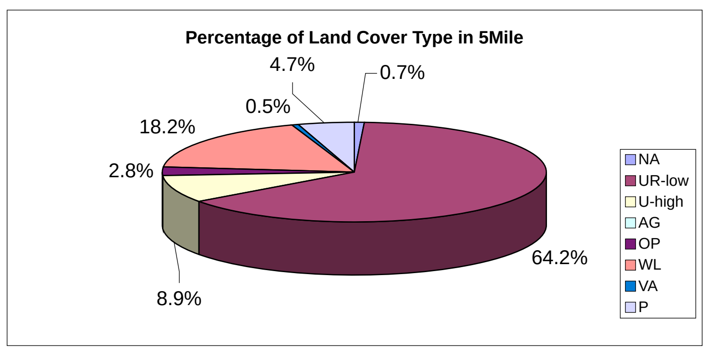


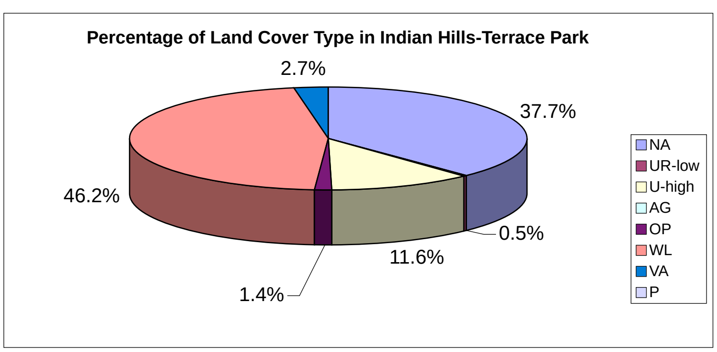


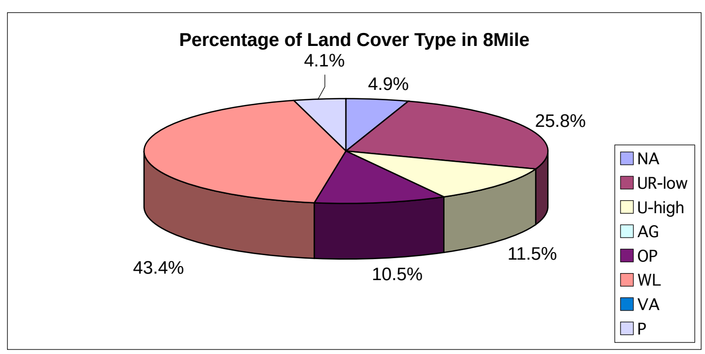












Land Uses By Watershed

Land Use By % Acres	Vacant/Undeveloped	High-Density Residential	Med-Density Residential	Low-Density Residential	Commercial	Office	Heavy Industrial	Light Industrial	Parks/Rec	TG/Open Space	Public/Institutional	Agricultural	Mixed Use	Multi-Family Residential
3 Mile	11.4	0	4.4	34.5	17.9	0	0	0	2	18	11.6	0	0	0
4 Mile	9.5	0.18	20.9	41.2	9.7	0.15	5.1	0	4.3	5.4	2.3	0.8	0.04	0.5
5 Mile	6.9	1.5	16.6	42	4.6	1.2	1.5	0	15.2	2.1	2	1.8	0.04	2.3
8 Mile	21.4	0.05	5.7	29.7	0.14	0	0	0	36.2	1.2	0.2	4.7	0	0
California	10.5	0.2	10.1	43.2	3.7	0.04	0	0	6.7	0	0.1	25.2	0	0.33
Clough	5.3	2.2	38.4	27.2	3.2	1.5	0	0	3.7	2.2	5.3	4.1	0.04	2.5
Dry Run	19.6	0.12	8.4	26.3	0.5	0.2	13.1	4.5	13.1	3.3	4.5	6.2	0	0
Duck Creek	0	0	0	0	0	0	11	0	28.9	0	0	60.1	0	0
IH-TP	3.3	0	0.7	3.9	0	0	41.8	0	23.9	0	26.5	0	0	0
Newtown	8.2	0.07	5.8	27.3	0.06	0	2.2	0	14.6	5.2	3.9	32.1	0	0

Codes and Ordinances Worksheet

Source: EPA Watershed Academy Web, Center for Watershed Protection

The Codes & Ordinances Worksheet, or COW, is a simple worksheet that you can use to see how the local development rules in your community stack up against the model development principles of Better Site Design.

The answers are found from "Hamilton County Subdivision Regulation", "Rule and Regulation of Office of County Engineer", and "Anderson Township Zoning Resolution".

1. Street Width

a. What is the minimum pavement width allowed for streets in low density residential developments that have less than 500 average daily trips (ADT)?

If the answer is between 18-22 feet, award 4 points
Answer: PUD 25, Standard 28
Points: 0

b. At higher densities are parking lanes allowed to also serve as traffic lanes (i.e., queuing streets)?

If the answer is YES, award 3 points
Answer: don't know, assume YES
Points: 3

2. Street Length

a. Do street standards promote the most efficient street layouts that reduce overall street length?

If the answer is YES, award 1 point
Answer: YES
Points: 1

3. Right-of-Way Width

a. What is the minimum right-of-way (ROW) width for a residential street?

If the answer is less than 45 feet, award 3 points
Answer: PUD 40, Standard 50
Points: 1

b. Does the code allow utilities to be placed under the paved section of the ROW?

If the answer is YES, award 1 point
Answer: NO
Points: 0

4. Cul-de-Sacs

a. What is the minimum radius allowed for cul-de-sacs?

If the answer is less than 35 feet, award 3 points

If the answer is 36 feet to 45 feet, award 1 point
Answer: 29
Points: 3

b. Can a landscaped island be created within the cul-de-sac?
If the answer is YES, award 1 point
Answer: NO
Points: 0

c. Are alternative turn arounds such as "hammerheads" allowed on short streets in low density residential developments?
If the answer is YES, award 1 point
Answer: NO
Points: 0

5. Vegetated Open Channels

a. Are curb and gutters required for most residential street sections?
If the answer is NO, award 2 points
Answer: YES
Points: 0

b. Are there established design criteria for swales that can provide stormwater quality treatment (i.e., dry swales, biofilters, or grass swales)?
If the answer is YES, award 2 points
Answer: NO
Points: 0

6. Parking Ratios

a. What is the minimum parking ratio for a professional office building (per 1000 ft2 of gross floor area)?
If the answer is less than 3.0 spaces, award 1 point
Answer: more than 3.0 (Banks-3, Office-3, Medical and Dental clinics or office-5)
Points: 0

b. What is the minimum required parking ratio for shopping centers (per 1,000 ft2 gross floor area)?
If the answer is 4.5 spaces or less, award 1 point
Answer: 4
Points: 1

c. What is the minimum required parking ratio for single family homes (per home)?
If the answer is less than or equal to 2.0 spaces, award 1 point
Answer: 2
Points: 1

d. Are the parking requirements set as maximum or median (rather than minimum) requirements?
If the answer is YES, award 2 points
Answer: YES, it uses Optimal
Points: 2

7. Parking Codes

a. Is the use of shared parking arrangements promoted?
If the answer is YES, award 1 point
Answer: YES
Points: 1

b. Are model shared parking agreements provided?
If the answer is YES, award 1 point
Answer: NO
Points: 0

c. Are parking ratios reduced if shared parking arrangements are in place?
If the answer is YES, award 1 point
Answer: YES
Points: 1

d. If mass transit is provided nearby, is the parking ratio reduced?
If the answer is YES, award 1 point
Answer: YES
Points: 1

8. Parking Lots

a. What is the minimum stall width for a standard parking space?
If the answer is 9 feet or less, award 1 point
Answer: 9
Points: 1

b. What is the minimum stall length for a standard parking space?
If the answer is 18 feet or less, award 1 point
Answer: 19-23
Points: 0

c. Are at least 30% of the spaces at larger commercial parking lots required to have smaller dimensions for compact cars?
If the answer is YES, award 1 point
Answer: don’t know, Assume No
Points: 0

d. Can pervious materials be used for spillover parking areas?
If the answer is YES, award 2 points
Answer: NO, “shall be asphalt or concrete”
Points: 0

9. Structured Parking

a. Are there any incentives to developers to provide parking within garages rather than surface parking lots?
If the answer is YES, award 1 point
Answer: No
Points: 0

10. Parking Lot Runoff

a. Is a minimum percentage of a parking lot required to be landscaped?

If the answer is YES, award 2 points
Answer: YES
Points: 2

b. Is the use of bioretention islands and other stormwater practices within landscaped areas or setbacks allowed?

If the answer is YES, award 2 points
Answer: YES
Points: 2

11. Open Space Design

a. Are open space or cluster development designs allowed in the community?

If the answer is YES, award 3 points
If the answer is NO, skip to question No. 12
Answer: YES
Points: 3

b. Is land conservation or impervious cover reduction a major goal or objective of the open space design ordinance?

If the answer is YES, award 1 point
Answer: NO
Points: 0

c. Are the submittal or review requirements for open space design greater than those for conventional development?

If the answer is NO, award 1 point
Answer: NO
Points: 1

d. Is open space or cluster design a by-right form of development?

If the answer is YES, award 1 point
Answer: NO
Points: 0

e. Are flexible site design criteria available for developers that utilize open space or cluster design options (e.g, setbacks, road widths, lot sizes)

If the answer is YES, award 2 points
Answer: YES, PUD
Points: 2

12. Setbacks and Frontages

a. Are irregular lot shapes (e.g., pie-shaped, flag lots) allowed in the community?

If the answer is YES, award 1 point
Answer: YES
Points: 1

b. What is the minimum requirement for front setbacks for a one half (? acre residential lot?

If the answer is 20 feet or less, award 1 point

Answer: >25

Points: 0

c. What is the minimum requirement for rear setbacks for a one half (? acre residential lot?

If the answer is 25 feet or less, award 1 point

Answer: > 30

Points: 0

d. What is the minimum requirement for side setbacks for a one half (? acre residential lot?

If the answer is 8 feet or less, award 1 points

Answer: >12.5

Points: 0

e. What is the minimum frontage distance for a one half (? acre residential lot?

If the answer is less than 80 feet, award 2 points

Answer: 75

Points: 2

13. Sidewalks

a. What is the minimum sidewalk width allowed in the community?

If the answer is 4 feet or less, award 2 points

Answer: 4

Points: 2

b. Are sidewalks always required on both sides of residential streets?

If the answer is NO, award 2 points

Answer: YES

Points: 0

c. Are sidewalks generally sloped so they drain to the front yard rather than the street?

If the answer is YES, award 1 point

Answer: NO

Points: 0

d. Can alternate pedestrian networks be substituted for sidewalks (e.g., trails through common areas)?

If the answer is YES, award 1 point

Answer: NO

Points: 0

14. Driveways

a. What is the minimum driveway width specified in the community?

If the answer is 9 feet or less (one lane) or 18 feet (two lanes), award 2 points

Answer: 8

Points: 2

b. Can pervious materials be used for single family home driveways (e.g., grass,

gravel, porous pavers, etc)?
If the answer is YES, award 2 points
Answer: YES
Points: 2

c. Can a "two track" design be used at single family driveways?
If the answer is YES, award 1 point
Answer: don’t know, Assume YES
Points: 1

d. Are shared driveways permitted in residential developments?
If the answer is YES, award 1 point
Answer: YES
Points: 1

15. Open Space Management

a. Does the community have enforceable requirements to establish associations that can effectively manage open space?
If the answer is YES, award 2 points
Answer: NO, No Open Space section in Anderson Township Zoning Resolution
Points: 0

b. Are open space areas required to be consolidated into larger units?
If the answer is YES, award 1 point
Answer: NO
Points: 0

c. Does a minimum percentage of open space have to be managed in a natural condition?
If the answer is YES, award 1 point
Answer: NO
Points: 0

d. Are allowable and unallowable uses for open space in residential developments defined?
If the answer is YES, award 1 point
Answer: NO
Points: 0

e. Can open space be managed by a third party using land trusts or conservation easements?
If the answer is YES, award 1 point
Answer: don’t know, Assume NO
Points: 0

16. Rooftop Runoff

a. Can rooftop runoff be discharged to yard areas?
If the answer is YES, award 2 points
Answer: YES
Points: 2

b. Do current grading or drainage requirements allow for temporary ponding of stormwater on front yards or rooftops?

If the answer is YES, award 2 points

Answer: NO

Points: 0

17. Buffer Systems

a. Is there a stream buffer ordinance in the community?

If the answer is YES, award 2 points

Answer: NO

Points: 0

b. If so, what is the minimum buffer width?

If the answer is 75 feet or more, award 1 point

Answer: NO

Points: 0

c. Is expansion of the buffer to include freshwater wetlands, steep slopes or the 100-year floodplain required?

If the answer is YES, award 1 point

Answer: NO

Points: 0

18. Buffer Maintenance

a. Does the stream buffer ordinance specify that at least part of the stream buffer be maintained with native vegetation?

If the answer is YES, award 2 points

Answer: NO

Points: 0

b. Does the stream buffer ordinance outline allowable uses?

If the answer is YES, award 1 point

Answer: NO

Points: 0

c. Does the ordinance specify enforcement and education mechanisms?

If the answer is YES, award 1 point

Answer: NO

Points: 0

19. Clearing and Grading

a. Is there any ordinance that requires or encourages the preservation of natural vegetation at residential development sites?

If the answer is YES, award 2 points

Answer: YES

Points: 2

b. Do reserve septic field areas need to be cleared of trees at the time of development?

If the answer is NO, award 1 point

Answer: don’t know. Assume NO
Points:1

20. Tree Conservation

a. If forests or specimen trees are present at residential development sites, does some of the stand have to be preserved?

If the answer is YES, award 2 points
Answer: NO
Points: 0

b. Are the limits of disturbance shown on construction plans adequate for preventing clearing of natural vegetative cover during construction?

If the answer is YES, award 1 point
Answer: NO
Points: 0

21. Land Conservation Incentives

a. Are there any incentives to developers or landowners to conserve non-regulated land (open space design, density bonuses, stormwater credits or lower property tax rates)?

If the answer is YES, award 2 points
Answer: NO
Points: 0

b. Is flexibility to meet regulatory or conservation restrictions (density compensation, buffer averaging, transferable development rights, off-site mitigation) offered to developers?

If the answer is YES, award 2 points
Answer: NO
Points: 0

22. Stormwater Outfalls

a. Is stormwater required to be treated for quality before it is discharged?

If the answer is YES, award 2 points
Answer: NO
Points: 0

b. Are there effective design criteria for stormwater best management practices (BMPs)?

If the answer is YES, award 1 point
Answer: some provided
Points: 0.5

c. Can stormwater be directly discharged into a jurisdictional wetland without pretreatment?

If the answer is NO, award 1 point
Answer: not clear, assume YES

Points: 0

d. Does a floodplain management ordinance that restricts or prohibits development within the 100 year floodplain exist?

If the answer is YES, award 2 points

Answer: YES

Points: 2

TOTAL 44.5

Scoring

90 - 100 Community has above-average provisions that promote the protection of streams, lakes and estuaries.

80 - 89 Local development rules are good, but could use minor adjustments or revisions in some areas.

70 - 79 Opportunities exist to improve development rules. Consider creating a site planning roundtable.

60 - 69 Development rules are likely inadequate to protect local aquatic resources. A site planning roundtable would be very useful.

Less than 60 Development rules are definitely not environmentally friendly. Serious reform is needed.