# Section 2 – Watershed Inventory

The Watershed Inventory is a comprehensive inventory that quantifies, describes, and summarizes all available watershed data. This inventory will be used to determine the current conditions of the watershed and identify the link between the stakeholder concerns and those watershed conditions.

Part One of the Watershed Inventory focuses on the data at a watershed-wide scale and includes broad topics not easily summarized at the subwatershed scale. Part Two of the Watershed Inventory provides detailed water quality data gathered at the subwatershed scale. And Part Three of the Watershed Inventory summarizes and explains the relationships of the data gathered in parts one and two.

## Part One of the Watershed Inventory

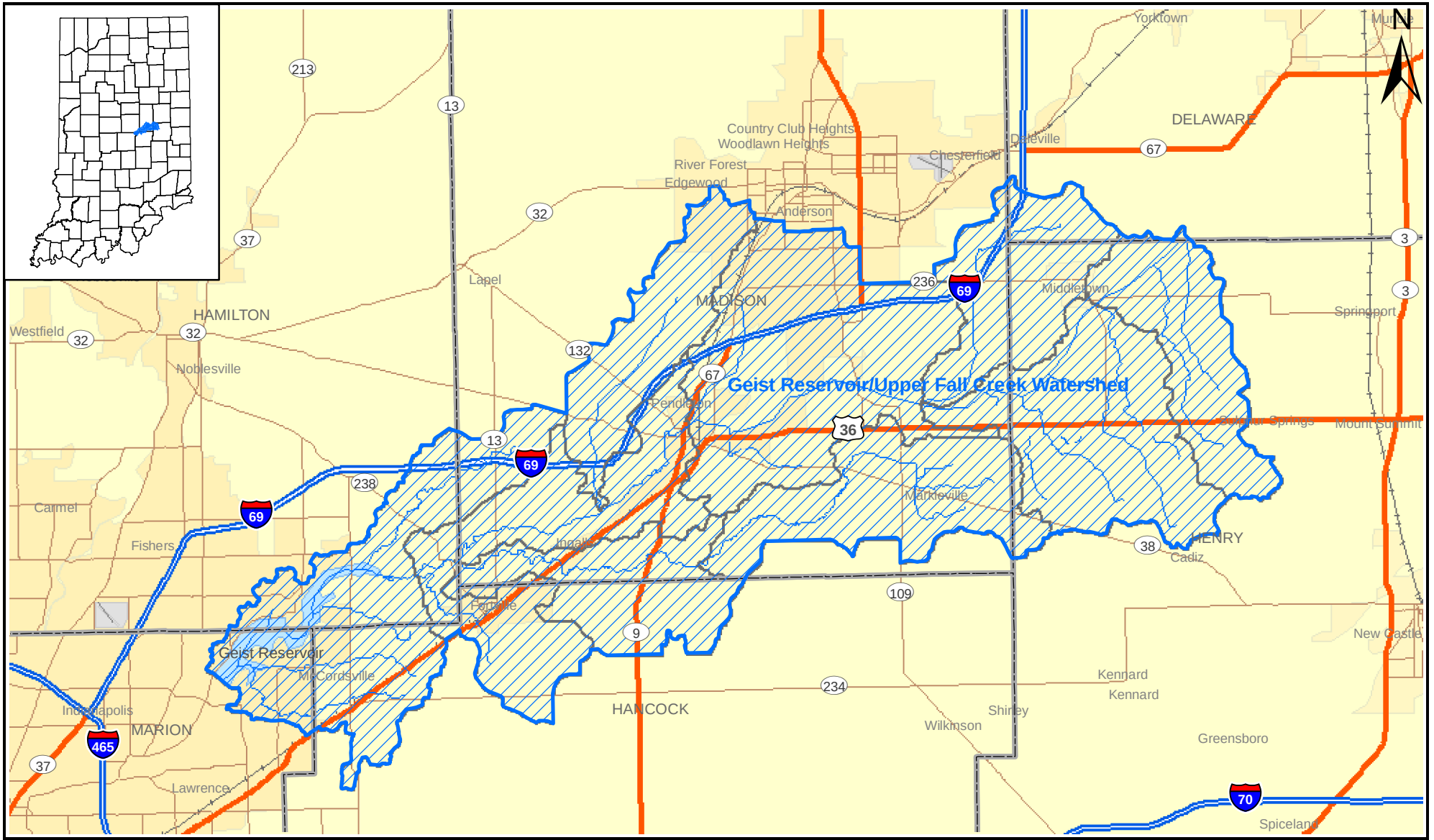
### Relevant Relationships

A healthy watershed is essential for a healthy environment and economy. The watersheds we live in provide us with drinking water, jobs, recreation, food and shelter. Watersheds are a unique, dynamic complex combination of natural resources; air, water, soil, plants and animals. Each characteristic of a watershed plays a role in the overall health of a watershed. How these characteristics interact with each other can not only negatively impact certain characteristics within the watershed but can also impact the watershed itself.

For example, sandy soils allow the ground to soak up water faster. This reduces surface runoff, but can affect ground water. Clay soils, on the other hand, are tighter and do not allow as much water infiltration. This can lead to more runoff and soil erosion. Similarly, wetlands utilize nutrients and tie up sediment to help improve water quality. Wetlands also act as natural sponges to absorb peak flows of water and reduce flooding. Many fish and wildlife species rely on wetlands for rearing their young, and for food and shelter. The combination of population centers and septic tank unsuitable soils may be a source of an *E.coli* problem. These are some of the ways that watershed characteristics are related to each other.

### Location, Characteristics and Size

Upper Fall Creek (HUC 0512020108) has its origins in northwest Henry County and flows southwest through Madison, Hamilton, and Marion Counties (Exhibit 1). The watershed also encompasses portions of Delaware and Hancock Counties. The Geist Reservoir/Upper Fall Creek Watershed consists of approximately 140,194 acres of mixed land use of which approximately 1,900 acres is Geist Reservoir. The distribution of watershed area within each county is shown in Table 1.

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|---|---|
| TITLE: | **Location Exhibit** |
| BASE LAYER: | StreetMap USA |
| CLIENT: | Upper White River Watershed Alliance<br>P.O. Box 2065<br>Indianapolis, Indiana 46206 |

| PROJECT: **Geist Reservoir/Upper Fall Creek Watershed Management Plan** | | |
|---|---|---|
| PROJECT NO.: 09006 | EXHIBIT: 1 | SHEET: 1 OF: 1 |
| QUADRANGLE: N/A | DATE: 09/30/10 | SCALE: 1" = 20,000' |

| Table 1: Counties Within the Watershed | | |
|---|---|---|
| **County** | **Acres** | **Percentage** |
| Delaware | 2,489 | 1.8% |
| Hamilton | 10,584 | 7.5% |
| Hancock | 17,907 | 12.8% |
| Henry | 31,919 | 22.8% |
| Madison | 73,349 | 52.3% |
| Marion | 3,946 | 2.8% |
| Total | 140,194 | 100% |

Approximately 140.5 linear miles of cumulative waterways are contained in the Geist Reservoir/Upper Fall Creek Watershed. Some of the cities and towns located in the watershed include: Middletown, Anderson, Markleville, Pendleton, Ingalls, Fortville, McCordsville, Lawrence, Fishers, and Indianapolis.

## Geology/Topography

The bedrock geology of Indiana formed primarily during the Paleozoic Era. The principal bedrock formations in the Geist Reservoir/Upper Fall Creek Watershed are associated mainly with rocks of Silurian and Devonian age, and consist mainly of limestone and dolomites with some shale or argillaceous zones, whereas the Silurian material consists of limestone, dolomite, and much more argillaceous material than in the Devonian age rock.

The topography of Upper Fall Creek, which lies in the Tipton Till Plain physiographic unit, consists of a flat to slightly rolling plain. Streams tend to have very low gradients, and lie only a few feet below the general land surface. Extensive alteration of the drainage system has occurred via ditching and the installation of drainage tiles. This has resulted in excellent land for agricultural production. Some rolling and hummocky areas may be present and are related to glacial activity. The gradient throughout the watershed ranges from an elevation of 1090 feet at the eastern edge of the watershed in Henry County to an elevation of 785 feet at the spillway of Geist Reservoir in Marion County, or a change of 305 feet.

## Hydrology

### Climate

The Geist Reservoir/Upper Fall Creek Watershed is within a humid continental climate region. The humid continental climate is marked by variable weather patterns and a large seasonal variance. Summers are often warm and humid with frequent thunderstorms and winters can be very cold with frequent snowfall and persistent snow cover.

The National Oceanic and Atmospheric Administration, National Climatic Data Center publishes the normals of average monthly and annual maximum, minimum, and mean temperature, monthly and annual total precipitation (inches), and heating and cooling degree days (base 65 degrees F) for individual locations throughout the United States, Puerto Rico, Virgin Islands, and Pacific Islands.

The monthly precipitation and temperature normals were obtained for Indiana for the time period of 1971 – 2000. Out of the 113 climate stations within Indiana, none fall within the Geist Reservoir/Upper Fall Creek Watershed, however one is located immediately

downstream of the watershed. Table 2 summarizes the temperature and precipitation data for the Oaklandon Geist Reservoir station.

**Table 2: NOAA Monthly Normals for Oaklandon Geist Reservoir, 1971- 2000**

| Month | Average Temperature ($^{o}$F) | Average Precipitation (in.) |
|---|---|---|
| January | 25.3 | 2.42 |
| February | 29.4 | 2.42 |
| March | 39.5 | 3.28 |
| April | 50.4 | 3.92 |
| May | 61.3 | 4.86 |
| June | 70.3 | 4.15 |
| July | 74.2 | 4.49 |
| August | 72.1 | 4.06 |
| September | 65.3 | 3.32 |
| October | 53.4 | 3.02 |
| November | 42.0 | 3.77 |
| December | 30.5 | 3.14 |

**Geist Reservoir**

Construction of Geist Reservoir was completed in 1944. The primary purpose of the reservoir was to provide a consistent source of water supply to the Indianapolis Water Company's Fall Creek Water Treatment Facility. In the early 1980's real estate development began around the reservoir, resulting in development along most of its 35 miles of shoreline. The reservoir has a maximum depth of approximately 48 feet, a storage capacity of 6.9 billion gallons, and a surface area of approximately 1,900 acres. In addition to water supply, Geist Reservoir is currently widely used for recreation purposes including swimming, boating, and fishing (Exhibit 1).

Geist Reservoir is characterized as a shallow turbid water body and has an average depth of 11 feet. Geist Reservoir is elongated with many branches representing the tributaries of the former stream or river. Geist Reservoir is a popular recreational lake due to its size and fishing opportunities. The majority of Geist Reservoir's shoreline is developed with a concrete, sheet pile seawall, or rock wall utilized for shoreline protection. Geist Reservoir is a man made water body, as it was formed by an impoundment of Fall Creek, and as such has upland soils that are not typically found as lake bottom substrates which also impacts the ability of aquatic vegetation to establish.

Geist Reservoir is rated as mesotrophic by IDEM. Mesotrophic lakes are lakes with an intermediate level of productivity, greater than oligotrophic lakes, but less than eutrophic lakes. These lakes are commonly clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients.

Based on information provided in previous studies (US EPA) for Geist Reservoir, the volume within the reservoir is completely replaced by the input volume (surface water, groundwater, direct precipitation, etc.) every 58 days. Therefore, meaning the hydraulic

retention time for the direct tributary area to the watershed is 58 days. Based on the size of the reservoir and tributary area, this is somewhat of a short retention time which ultimately suggests that the reservoir will respond in a short time after implementation of upstream BMPs for pollutant reduction.

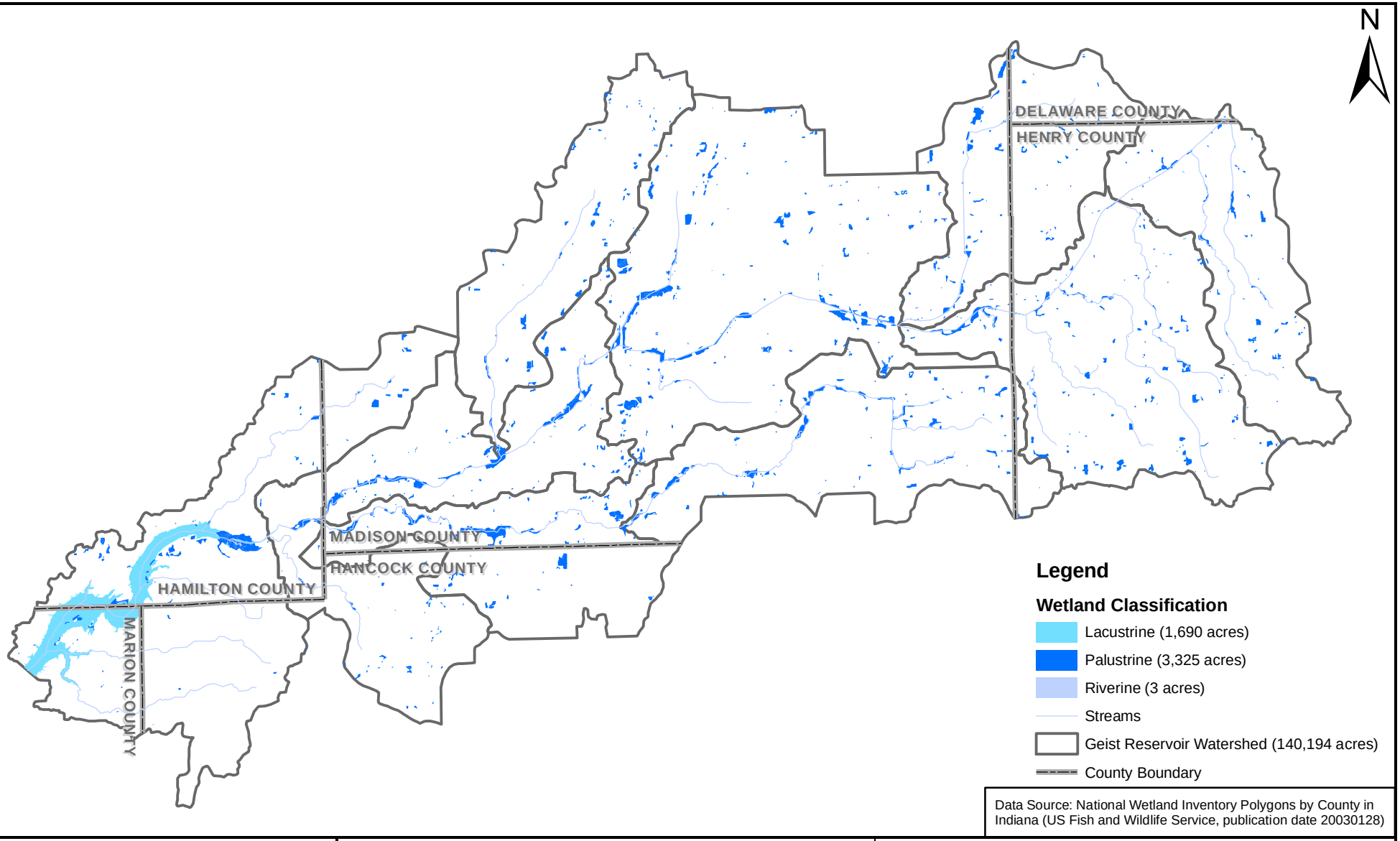
**Wetlands**

Wetlands are a valuable resource not only for the habitat they create but for the water detention/retention and filtration they provide within a watershed. Wetland classifications are based on attributes which can be measured and when combined, help to define the nature of a specific wetland and distinguish it from others. According to the National Wetland Inventory, the three wetland classifications within the Geist Reservoir/Upper Fall Creek Watershed include lacustrine, palustrine, and riverine. There are 5,018 acres (3.6% of the watershed) of wetlands scattered throughout the watershed. Among the three wetland classifications, 1,690 acres are considered lacustrine, 3,325 acres are palustrine, and 3 acres are riverine (Exhibit 2).

As defined by the U.S Fish and Wildlife Service, lacustrine wetlands are associated with lakes and are characterized by a lack of trees and a dominance of emergent and submersed aquatic vegetation. Lacustrine wetlands typically extend from the shoreline to depths of 6.5 feet or until emergent vegetation no longer persists. Lacustrine wetlands are important in removing sediment and nutrients as well as providing habitat for fish and macroinvertebrates which are a vital food source within a lake ecosystem. The Lacustrine System includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; and (3) total area exceeds 20 acres. Similar wetland and deepwater habitats totaling less than 20 acres are also included in the Lacustrine System if an active wave-formed or bedrock shoreline feature makes up all or part of the boundary, or if the water depth in the deepest part of the basin exceeds 6.6 feet at low water.

Palustrine wetlands are related to marshes, swamps and bogs. Palustrine habitats are wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. Palustrine habitats have structural features that provide feeding, breeding, nesting, over wintering and migration habitat for wildlife in addition to their natural filtration properties. Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Riverine wetlands are directly affected by streamflow including overbank and backwater conditions. Riverine wetlands are very important in sediment retention as well as pollutant removal.

Wetlands provide numerous valuable functions that are necessary for the health of a watershed. They play a critical role in protecting and moderating water quality. Water quality is improved through a combination of filtering and stabilizing processes. Wetland vegetation adjacent to waterways helps to stabilize slopes and prevent mass wasting, thus reducing the sediment load within the river system. An unprotected streambank can easily erode, which results in an increase of sediment and nutrients entering the water. Additionally, wetland vegetation removes pollutants through the natural filtration that occurs, or by absorption and assimilation. This effective treatment of nutrients and physical stabilization leads to an increase in overall water quality to downstream reaches.




Data Source: National Wetland Inventory Polygons by County in Indiana (US Fish and Wildlife Service, publication date 20030128)

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|---|---|---|---|
| TITLE: **National Wetland Inventory Map** | | PROJECT: **Geist Reservoir/Upper Fall Creek Watershed Management Plan** | |
| BASE LAYER: National Wetland Inventory | | PROJECT NO.: 09006 | EXHIBIT: 2 |
| CLIENT: Upper White River Watershed Alliance<br>P.O. Box 2065<br>Indianapolis, Indiana 46206 | | QUADRANGLE: N/A | DATE: 09/30/10 |
| | | SHEET: 1 OF: 1 | SCALE: 1" = 16,000' |

In addition, wetlands have the ability to increase storm water detention capacity, increase storm water attenuation, and moderate low flows. These benefits help to reduce flooding and reduce erosion. Wetlands also facilitate groundwater recharge by allowing water to seep slowly into the ground, thus replenishing underlying aquifers. This groundwater recharge is also valuable to wildlife during the summer months when precipitation is low and the base flow of the river draws on the surrounding groundwater table.

Although wetlands occupy a small percentage of the surrounding landscape, these areas typically contain large percentages of wildlife and produce more flora and fauna per acre than any other ecosystem. As a result of this high diversity, wetlands provide many recreational opportunities, such as fishing, hunting, boating, hiking and bird watching. Many of these recreational activities are available in the wetland areas within the Geist Reservoir/Upper Fall Creek Watershed. However, wetlands within this watershed have experienced degradation as a result of urbanization and development. Development projects that have wetlands present or adjacent to the property are applying for and receiving Section 404 of the Clean Water Act permits to fill and develop wetlands. This practice reduces the amount of wetland acreage in the watershed.

Isolated and adjacent wetlands are regulated through IDEM and the Army Corps of Engineers (ACOE), respectively. Although wetlands are typically avoided during the development phase, permits have been given to fill wetlands that cannot be avoided. Some isolated wetlands are being converted to detention/retention basins in new residential developments. Some development and agency permits require on-site mitigation, which includes the creation of wetlands and natural areas on the same piece of land where wetland impacts occur. Some development projects that impact wetlands are allowed to mitigate for wetland impacts at an approved off-site wetland mitigation bank facility. In this case, the wetland impacts are offset through the purchase of wetland mitigation credits at an approved wetland mitigation bank. For Indiana Department of Transportation (INDOT) projects, in general the Federal and State requirement is to mitigate for impacts to wetlands associated with roadway improvements within the same watershed. Stream enhancement and stream mitigation are some of the options that INDOT utilizes to offset wetland/stream impacts.

**Threatened or Endangered Species**

The Indiana Department of Natural Resources (IDNR) Division of Nature Preserves was contacted to provide any Indiana Natural Heritage Data or related records for all listed threatened, endangered (T&E) or rare species documented within the Geist Reservoir/Upper Fall Creek Watershed. Their response indicated that the watershed is home to a number of Species of Special Concern to Indiana, a number of State Endangered Species, and a number of Federally Endangered Species (Table 3).

| Table 3: Threatened or Endangered Species | | | |
|---|---|---|---|
| **Type** | **Common Name** | **State Status** | **Federal Status** |
| Bird | Loggerhead Shrike | Endangered | |
| | Least Bittern | Endangered | |
| | Red-shouldered Hawk | Species of Special Concern | |
| | Osprey | Endangered | |
| | Black-crowned Night Heron | Endangered | |
| | King Rail | Endangered | |
| | Cerulean Warbler | Endangered | |
| | Upland Sandpiper | Endangered | |
| Mammal | American Badger | Species of Special Concern | |
| | Bobcat | Species of Special Concern | |
| | Least Weasel | Species of Special Concern | |
| Mollusk | Clubshell | Endangered | Endangered |
| | Wavyrayed Lampmussel | Species of Special Concern | |
| | Little Spectaclecase | Species of Special Concern | |
| | Kidneyshell | Species of Special Concern | |
| | Purple Lilliput | Species of Special Concern | |
| Vascular Plant | Cucumber Magnolia | Endangered | |
| | Goose-foot Corn-salad | Endangered | |
| | Butternut | Watch List | |
| | Bog Bluegrass | Watch List | |
| High Quality Natural Community | Mesic Upland Forest<br>Fort Benjamin Harrison State Park | Significant | |
| | Central Till Plain Flatwoods<br>Stout Woods Nature Preserve | Significant | |

The Indiana Natural Heritage Data Center maintains the most comprehensive and up-to-date information about federal and state endangered, threatened, and rare species, high quality natural communities, and significant natural areas in Indiana. Requests for this information is assessed a fee based on the time needed to complete the request. This information is required by most regulatory agencies prior to issuing development permits.

**Nuisance Wildlife and Exotic Invasive Species**

According to IDNR, many wild animals in Indiana have become displaced as the result of urban growth and removal of their habitat. While some species may move to other areas where natural habitat exists, some species actually thrive in urban settings. Species such as raccoons, opossums, Canada geese and even red foxes are becoming more common in urban areas and are frequently seen by people. However, these animals can also cause problems when they use a person's attic for shelter, destroy shingles and soffits, utilize lawns as homes, and eat their garbage.

Canada geese are a particular problem within the watershed, specifically for the reservoir. As stated by the DNR, many people enjoy seeing Canada geese, but problems can occur when too many geese concentrate in one area. Typically, developers and landowners unknowingly cause the problem by creating ideal goose habitat. Geese are grazers and feed extensively on fresh, short, green grass. Add a permanent body of water adjacent to their

feeding area and you have the created the perfect environment for geese to set up residence, multiply and concentrate. Geese, including their young, also have a strong tendency to return to the same area year after year. Once geese start nesting in a particular place, the stage is already set for more geese in successive years. The problem is further exacerbated when well-intentioned people purposefully feed geese. Artificial feeding of geese tends to concentrate larger numbers of geese in areas that under normal conditions would only support a few geese. Artificial feeding can also disrupt normal migration patterns and hold geese in areas longer than what would be normal. With an abundant source of artificial food available, geese can devote more time to locating nesting sites and mating. Artificial feeding can also concentrate geese on adjacent properties where their presence may not be welcomed, resulting in neighbor/neighborhood conflicts.

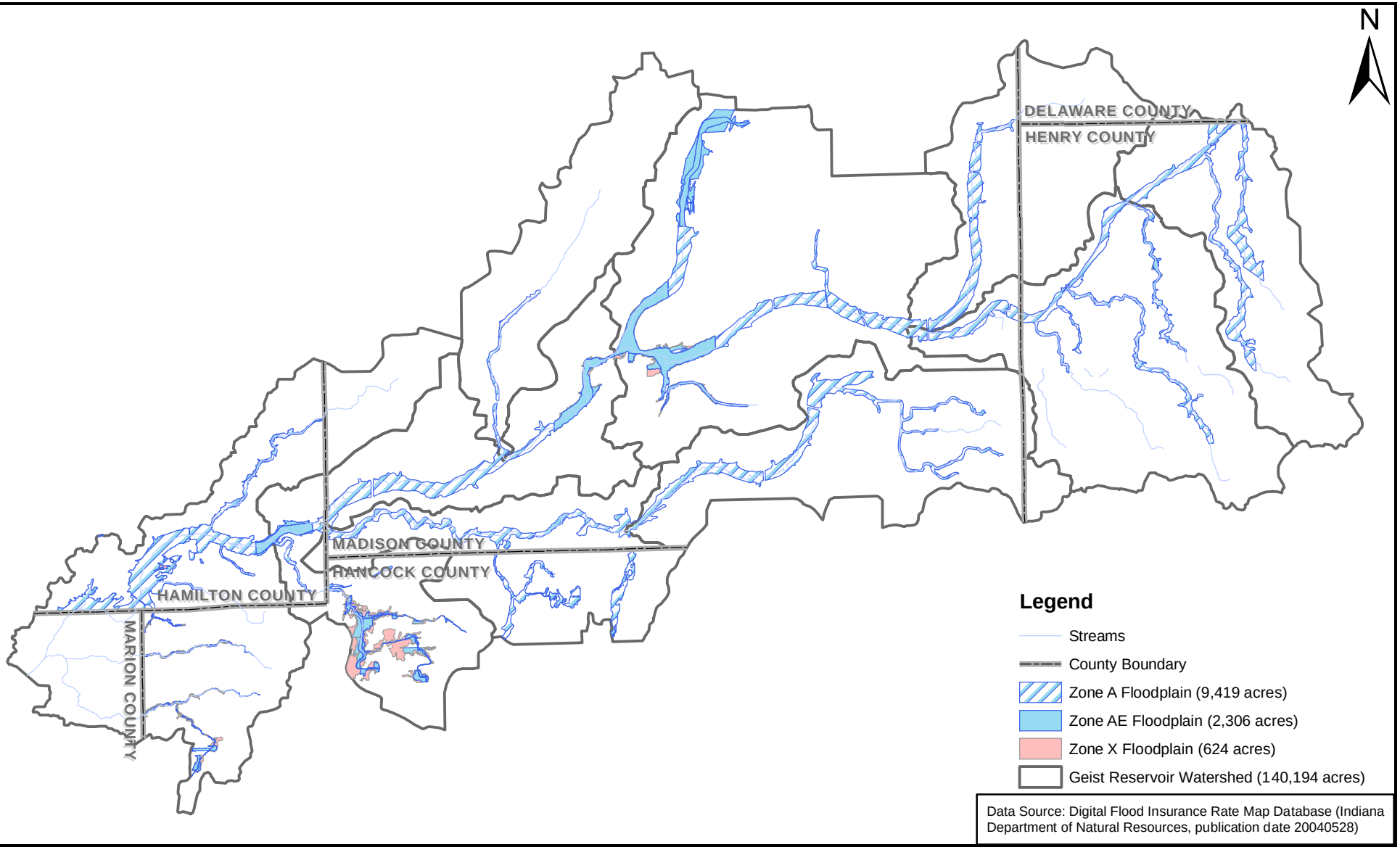
Congregating geese can cause a number of problems. Damage to landscaping can be significant and expensive to repair or replace, while large amounts of excrement can render swimming areas, parks, golf courses, lawns, docks, and patios unfit for human use. Since they are active grazers, they are particularly attracted to lawns and ponds located near apartment complexes, houses, office areas and golf courses. Geese can rapidly denude lawns, turning them into barren, dirt areas. Most of the problems in metropolitan areas occur from March through June during the nesting season. Breeding pairs begin nesting in late February and March. Egg-laying begins soon after nest construction is complete.

Based on information obtained from the DNR website, the Indiana Legislature created an Invasive Species Task Force in October 2007 to study the economic and environmental impacts of invasive species in Indiana and provide findings and recommendations on strategies for prevention, early detection, control and management of invasive species to minimize these impacts. Based on the Aquatic Vegetation Management Plan completed by V3 as a part of this project, Blue-Green Algae and Eurasian Watermilfoil have been reported in the Geist Reservoir. Zebra mussels were also report in the reservoir early spring of 2010.

Invasive plant species are a threat to natural areas. They displace native plants, eliminate food and cover for wildlife, and threaten rare plant and animal species. Many agencies and organizations have joined together to form the Invasive Plant Species Assessment Working Group (IPSAWG) to assess which plant species threaten natural areas in Indiana and develop recommendations regarding the use of that specific plant species. The IPSAWG's goal is that all partner agencies and organizations would utilize the species assessment when recommending or selling plants.

**Regulatory Floodplain**

Flooding is one of the most common hazards in the United States. Floods can occur on a local level, or can affect entire river basins. The Federal Emergency Management Agency (FEMA) has developed Flood Insurance Rate Maps (FIRMs) for many parts of the country in order for individuals and governments to assess the risk of flooding in specific areas. These maps also indicate what insurance rates property owners may need to pay to develop property in these areas. The current FIRM panels for the Geist Reservoir/Upper Fall Creek Watershed are shown on Exhibit 3. It should be noted that Indiana is in the midst of revising the floodplain maps on a county wide basis through the FEMA Map Modernization program. The floodplain maps will need to be reevaluated during the feasibility phases of implementation projects.

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TITLE: **FEMA Floodplain Map**

PROJECT: **Geist Reservoir/Upper Fall Creek Watershed Management Plan**

BASE LAYER: FEMA Floodplain

CLIENT: Upper White River Watershed Alliance
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Indianapolis, Indiana 46206

| PROJECT NO.: | EXHIBIT: | SHEET: 1 OF: 1 |
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| 09006 | 3 | |
| QUADRANGLE: | DATE: | SCALE: |
| N/A | 09/30/10 | 1" = 16,000' |

There are three flood hazard areas identified within the watershed. Zone A, which is defined as an area inundated by 100-year flooding for which no base flood elevation (BFE) has been established comprises 9,419 acres (6.7% of the watershed). In this zone there is a 1% chance of annual flooding, and a 26% chance that the area will be inundated at sometime during the life of a 30-year mortgage. Zone AE, which is defined as an area inundated by 100-year flooding for which a BFE has been determined, comprises 2,306 acres (1.6% of the watershed). Chance of flooding in Zone AE is the same as in Zone A. However, Zone A floodplain boundaries are based off of approximate methods, and Zone AE floodplain boundaries are based off of detailed hydrologic and hydraulic analyses, establishing BFEs and making the delineation more accurate. Zone X, which is defined as an area that is either determined to be outside the 100-year floodplain but within the 500-year floodplain (0.2% chance of annual flooding) or have a 1% chance of sheet flow flooding where the average depths are less then 1 foot, comprises only 624 acres (0.4% of the watershed). These areas are considered to have a moderate or minimal risk of flooding, and the purchase of flood insurance is available but not required.

The rainfall data used to create these maps is based on Bulletin 71 rainfall depths. Bulletin 71 is a study that relied primarily on data from 275 daily reporting stations of the National Weather Service cooperative network, which had records exceeding 50 years. Based on USGS information, Central Indiana has experienced two 500-year floods in the last 18 years. Teams of USGS hydrographers have traveled to 40 streamflow-gaging stations to keep station instruments operating and to verify streamflow data needed for National Weather Service (NWS) flood forecasts. USGS personnel have worked closely with Federal, state, and local agencies during the flood to provide flood information for emergency managers, the media, and the public.

Identifying the location of floodplain areas within the Geist Reservoir/Upper Fall Creek Watershed allows for targeted areas for floodplain management and/or restoration. Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms and generally include requirements for zoning, and special-purpose floodplain ordinances.

Developments within flood prone areas are regulated by local, state and federal agencies. Depending on the floodplain boundaries depicted on the FEMA FIRM for the area proposed to be developed, floodplain designation (Zone A, AE, etc.), if there is floodway present and how much tributary drainage area (less or more than one square mile) there is to the proposed site, permits from the local municipality, County, IDNR-Division of Water, and FEMA would be required.

In addition to stormwater runoff, flooding can negatively affect water quality as large volumes of water transport contaminants into water bodies and also overload storm and wastewater systems. Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground and ultimately increases during periods of flooding. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, and streams.

**Regulated Drains**

Regulated drains consist of creeks, ditches, tiles (underground pipe systems), and other structures intended to move run-off water. Regulated drains are under the jurisdiction of the local county drainage board and/or the County Surveyor's office. Regulated drains are common throughout the watershed and are mainly tiles and open ditches. Regulated drain locations were obtained from Hamilton, Hancock, and Madison Counties and are shown on Exhibit 4.

Regulated drains are typically maintained by the County Surveyors office. This maintenance includes dredging with large construction equipment, removal of debris, and management of vegetation both within the regulated drains and within the riparian zone associated with the drains. Based on the unpredictable maintenance schedule of regulated drains within the watershed, it is difficult to assign a priority rating to these areas for potential improvement of wildlife habitat, water quality improvement measures, and erosion control measures within the Geist Reservoir/Upper Fall Creek Watershed. However, the selected BMPs and Action Registers include measures and implementation projects that include regulated drains. Coordination with the County Surveyors Office will be necessary during the implementation project evaluation phase.

BMPs within regulated drains in the watershed should be evaluated prior to implementation. If regulated drains are considered for BMP measures (i.e. two-stage ditches, stabilization, etc), the Steering Committee should coordinate with the local County Surveyor's offices of Delaware, Hamilton, Hancock, Henry, Madison, and Marion Counties.

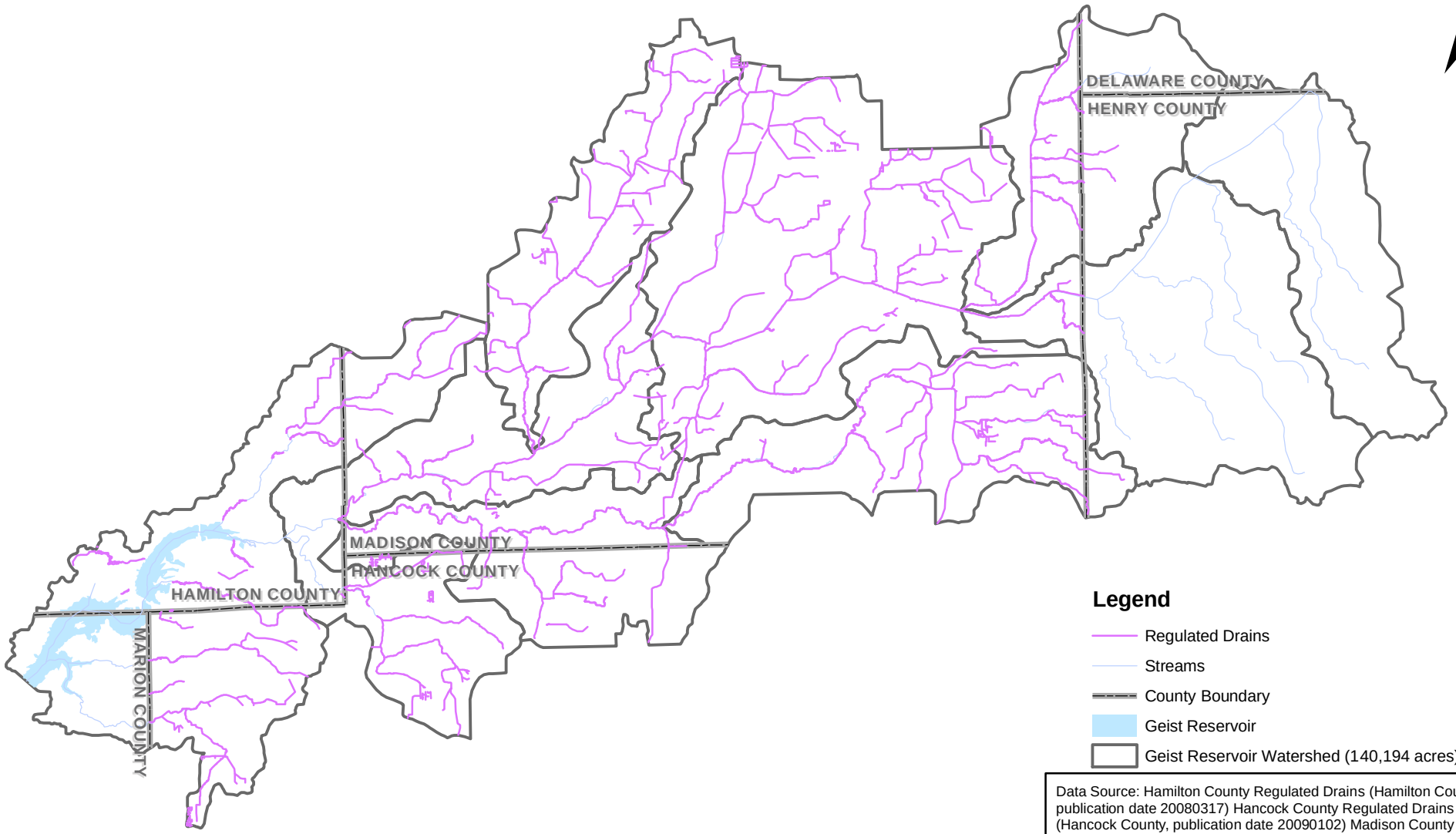
**Wellhead Protection Areas**

The IDEM Ground Water Section administers the Wellhead Protection Program, which is a strategy to protect ground water drinking supplies from pollution. The Safe Drinking Water Act and the Indiana Wellhead Protection Rule (327 IAC 8.4-1) mandates a wellhead program for all Community Public Water Systems. The Wellhead Protection Programs consists of two phases. Phase I involves the delineation of a Wellhead Protection Area (WHPA), identifying potential sources of contamination, and creating management and contingency plans for the WHPA. Phase II involves the implementation of the plan created in Phase I, and communities are required to report to IDEM how they have protected ground water resources.

Information pertaining to wellhead protection and its delineations/restrictions will be important during the implementation phases of the plan. Approved Wellhead Protection Areas are no longer available on-line due to recent legislation classifying this type of information as Confidential.

### Soil Characteristics

There are many different soil types throughout Indiana based on their unique characteristics. Many counties arrange these soil types by like characteristics into groups, or major soil associations. A soil association is a geographic area consisting of landscapes on which soils are formed. Soil associations are groups of soil types that generally share one or more common characteristics; such as parent material or drainage capability. These soil associations provide general characteristics for the specific soil association, and can be used for conceptual locations of best management practices. Information pertaining to the clay




Data Source: Hamilton County Regulated Drains (Hamilton County, publication date 20080317) Hancock County Regulated Drains (Hancock County, publication date 20090102) Madison County Regulated Drains (Madison County, publication date 20090825)

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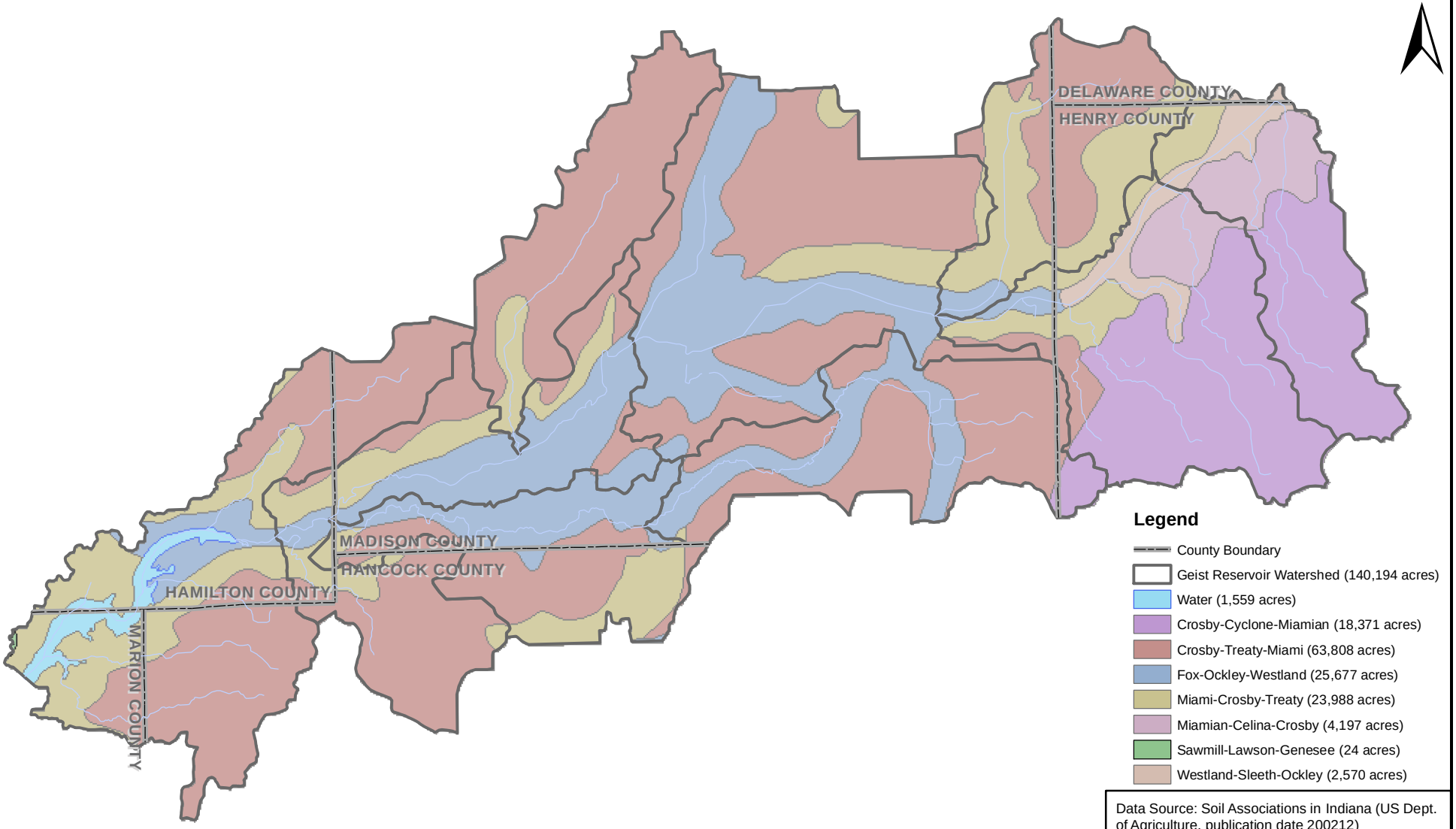
| BASE LAYER: Regulated Drains | | PROJECT NO.: 09006 | EXHIBIT: 4 | SHEET: 1 OF: 1 |
| CLIENT: Upper White River Watershed Alliance<br>P.O. Box 2065<br>Indianapolis, Indiana 46206 | | QUADRANGLE: N/A | DATE: 09/30/10 | SCALE: 1" = 16,000' |

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TITLE: **Soil Associations Map**

PROJECT: **Geist Reservoir/Upper Fall Creek Watershed Management Plan**

BASE LAYER: State Soil Geographic Data Base

CLIENT: Upper White River Watershed Alliance
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Indianapolis, Indiana 46206

| PROJECT NO.: | EXHIBIT: | SHEET: 1 OF: 1 |
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| 09006 | 5 | |
| QUADRANGLE: | DATE: | SCALE: |
| N/A | 09/30/10 | 1" = 16,000' |

content, permeability and even groundwater characteristics are helpful when identifying locations that are feasible for infiltration practices or other best management practices to improve the water quality within the watershed. It should be noted that soil tests in these specific areas should be performed for more project specific detailed information. The major soil associations in the Geist Reservoir/Upper Fall Creek Watershed are shown in Exhibit 5. Table 4 includes the major characteristics of the four soil associations that make up the majority (94%) of the watershed.

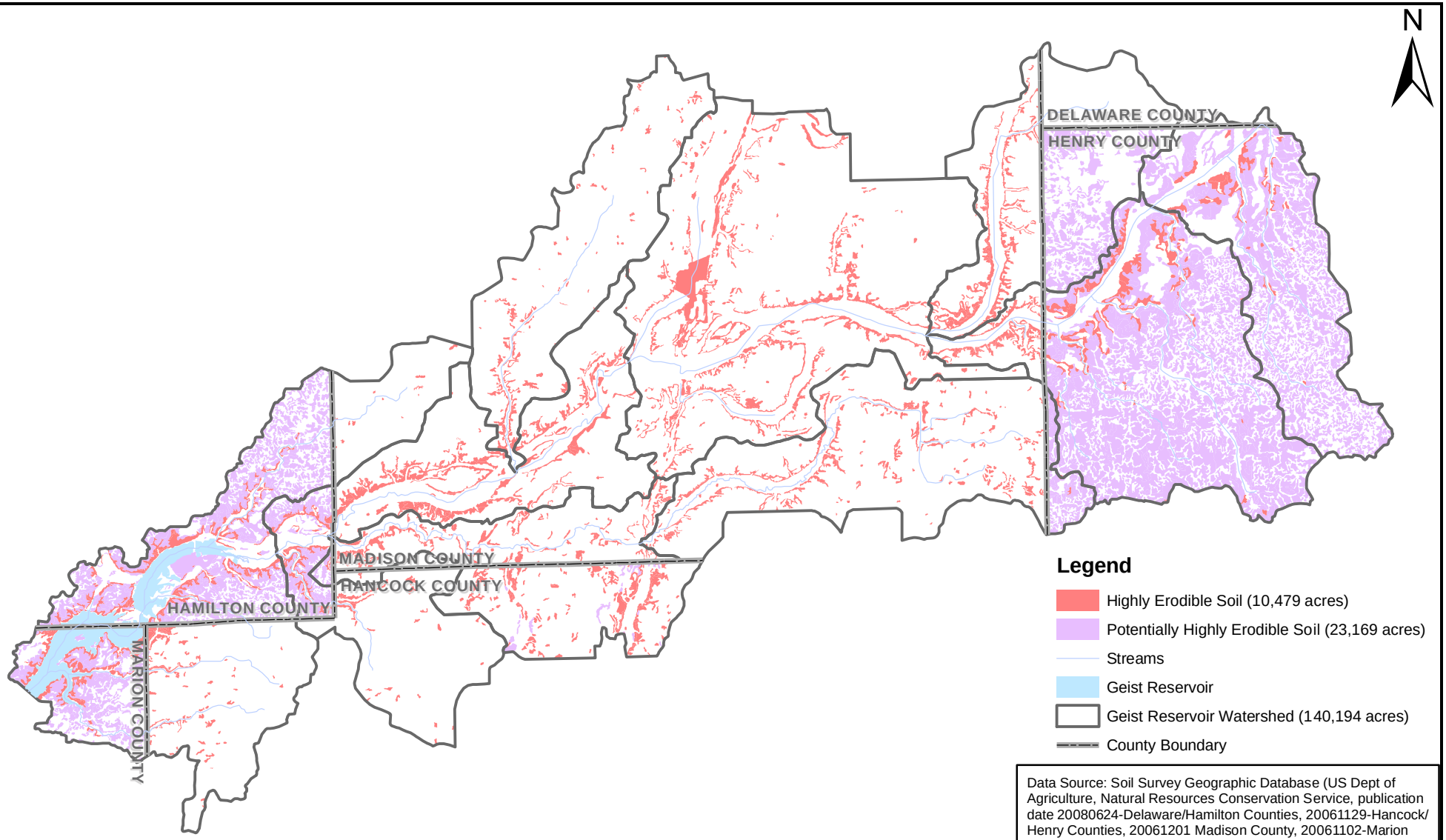
| Table 4: Soil Associations | | |
|---|---|---|
| **Name** | **Characteristics** | **Acres** |
| Crosby-Treaty-Miami | Deep, somewhat poorly to poorly drained soils | 63,808 |
| Fox-Ockley-Westland | Deep, well drained soils | 25,677 |
| Miami-Crosby-Treaty | Deep, moderately well drained to somewhat poorly drained soils | 23,988 |
| Crosby-Cyclone-Miamian | Deep, somewhat poorly to poorly drained soils | 18,371 |

The data source for the Soil Association Map is from the Department of Agriculture Soil Associations in Indiana GIS shapefile with a published date of December 2002. Based on this data and the time it was obtained, the water area is a total of 1,559 acres which includes the reservoir. This could be due to the fluctuation of the draw down period of the reservoir.

**Highly Erodible Land**

Erosion is a natural process within stream ecosystems; however excessive erosion negatively impacts the health of the watershed. Erosion throughout the watershed increases sedimentation of the streambeds which impacts the quality of habitat for fish and other organisms. As water flows over land and enters the stream it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms. Therefore, erosion also impacts water quality as it increases nutrients and decreases water clarity. Highly erodible land (HEL) and potentially highly erodible soils in the Geist Reservoir/Upper Fall Creek Watershed are mapped in Exhibit 6. The data used to create Exhibit 6 is from the USDA-SCS Indiana Technical Guide Section II-C and was collected from the NRCS website for Delaware, Hamilton, Hancock, Henry, Madison, and Marion Counties. A total of approximately 10,479 acres or 7.5% of the watershed is considered highly erodible and 23,169 acres or 16.5% of the watershed is considered potentially highly erodible. It should be noted that the areas of potentially highly erodible soils appear to be significantly greater in Hamilton, Henry, and Marion Counties when compared to Delaware, Hancock, and Madison Counties. This discrepancy can be attributed to the difference in the classification of soils between the counties. For example, Miami soil (MMB2) in Hamilton County is considered potentially highly erodible however the same soil in Madison County is considered not highly erodible. Appendix M contains the USDA-SCS Indiana Technical Guide Section II-C documentation obtained for this analysis.

Highly erodible soils are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another.




Data Source: Soil Survey Geographic Database (US Dept of Agriculture, Natural Resources Conservation Service, publication date 20080624-Delaware/Hamilton Counties, 20061129-Hancock/ Henry Counties, 20061201 Madison County, 20061102-Marion County) USDA-SCS Indiana Technical Guide Section II-11/87

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| TITLE: **Highly Erodible Lands Map** | | PROJECT: **Geist Reservoir/Upper Fall Creek Watershed Management Plan** | |
| BASE LAYER: NRCS Soil Survey | | PROJECT NO.: 09006 | EXHIBIT: 6 | SHEET: 1 OF: 1 |
| CLIENT: Upper White River Watershed Alliance<br>P.O. Box 2065<br>Indianapolis, Indiana 46206 | | QUADRANGLE: N/A | DATE: 09/30/10 | SCALE: 1" = 16,000' |