

The Gallows Run Watershed Restoration and Protection Plan

A Plan of Action for Municipal Officials, Citizens, & Local Students



The Gallows Run Watershed Association

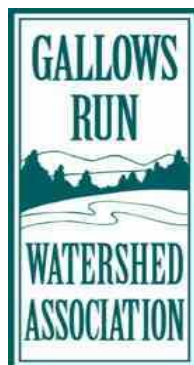


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None of Us Is As Smart As All Of Us!
~ **Ken Blanchard**

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Streaming Wisdom: Watershed Consciousness in the 20th Century

By Peter Warshall

IN OUR TOWNS AND CITIES, two essential sources of life-water to drink and soil to grow food-remain hidden from our eyes. The hills and valleys are coated with asphalt, ancient streams are buried beneath housing, and soil is filler between gas, water and electric piping. Watershed consciousness is, in part, an invitation to peel off (not discard) the layer of industrial and technological activity that hides us from the water and soils of our communities. It is an invitation to reveal where you lie and how your body's plumbing and, in many ways, community hart, are connected to Nature's pathways.

A watershed is a gatherer- a living place that draws the sun and the rain together. Its surface of soils, rocks, and plant life acts as a "commons" for this intermingling of sun and water. Physically, a watershed takes many shapes. It is drawn emblematically in the shape of a teardrop or a cupped leaf or a garden trowel to depict the oblong dish-shape of the valley with its elevated hill slopes, which gather runoff toward a central stream. But most watersheds do not faithfully copy the emblematic drawings. Uplifting or faulting or down warping or layering give them a beautiful individuality. Human influences may distort or, as in city watersheds and strip mining, completely destroy the lay of the land. The bedrock texture of each watershed- its granite or shale, sand or limestone holds (in a sense, cherishes) each watershed's fragile skin of soil. After the sun/water gathering has been accomplished, the watershed lets go: its unused water heading downstream or sky-up; its unabsorbed energy turning to heat or reflecting back through the atmosphere. This seasonal and daily passage of solar fire, water's flow, and the earth's metabolic breathing is unique, in each watershed, as each human on the planet.

For humans, the watershed (and its big cousin, the river basin) is a hydraulic commons-an aquatic contract that has no escape clause. From the forested headwaters to the agricultural midstream volleys to the commercial and industrial centers at the river's mouth, good and bad news travels by way of the water. Did my toilet flushing give downstream swimmers a gastrointestinal disease? Did the headwaters clear cut kill the salmon industry at the rivers mouth? Did a toxic waste dump leak into the groundwater table and poison people in the next county? Watershed consciousness is, in part, a promotional campaign to advertise the mutual concerns and needs that bind upstream and downstream, in stream and off stream peoples together.

This journey is right out your window- among the hills and valleys that surround you. It is the first excursion of thought into the place you live. It is not inner geography- the continuing attempt to feel better by mapping the mysterious struggle to gain perspective of our place on the planet. It focuses on where your water comes from when you turn on the faucet: where it goes when you flush; what soils produce your food; who shares your water supply, including

the fish and nonhuman creatures. The watershed way is a middle way, singing a local song, somewhere close by, between Mind and Planet.

2.0 Executive Summary

The Gallows Run watershed is located in Nockamixon, Springfield and Durham Townships in Northern Bucks County, in Southeastern Pennsylvania. The 8.87 square mile watershed is among one of the most scenic and economically important areas in the region. The seventeen miles of waterway are classified as Cold Water Fishery (CWF) by the Pennsylvania Department of Environmental Protection (PADEP). Many of the natural, cultural, historical and recreational amenities within the Gallows Run watershed are identified in a variety of studies, and are the focus of resource protection efforts. Surface and groundwater resources in the watershed are hydro-geologically connected and watershed residents obtain drinking water from on-site well protection efforts are imperative.

The Gallows Run Watershed Association (GRWA) was initially formed in 2001 in response to a proposed, high-density and high impact land development. Since then, the Gallows Run Watershed Association has successfully completed a variety of projects, planning, policy, and outreach efforts. In 2002, the Gallows Run Watershed Association realized that there were many regional watershed conservation plans; however a specific plan to address and abate prioritized non-point source pollution problem areas was required for the Gallows Run sub watershed.

The Gallows Run Watershed Association successfully secured a Pennsylvania Department of Environmental Protection (PADEP) Growing Greener grant in 2003 to complete the Gallows Run Watershed Restoration and Protection Plan. The goal of the project is to complete the necessary research, fieldwork, public outreach, and scientific analysis to create a prioritized list of restoration and protection measures to maintain and improve water quality within the Gallows Run Watershed. Plan objectives are to create a restoration and protection plan based on sound scientific approaches. The final restoration and protection plan contains a weighted and prioritized list of water quality and water quantity problem areas and specific management recommendations to protect amenity areas and restore problem areas.

One of the most challenging tasks in any environmental study is to obtain adequate information and feedback from the community. Therefore, a variety of public outreach efforts were implemented to obtain input from individuals, agencies, non-profit organizations, businesses, landowners and interested individuals. A technical advisory committee assisted project consultants throughout the study. Other measures to garner public participation included: watershed tours, one-on-one interviews, a questionnaire distributed to over 1000 people (a ten percent response rate to the questionnaire) information booths at community events, two public meetings, press releases, a newsletter devoted entirely to the project, several newsletter articles, volunteer involvement in field work, three watershed workshops, and special projects for local students.

Existing information about the watershed originated from a variety of agencies, academic sources, and completed studies. In fall 2004, the project consultants and a group of trained volunteers completed a comprehensive field assessment. The purpose of the watershed field

assessment was to document water quality amenities, water quality problem areas, and problem area origins. Information was recorded, field checked and placed in Geographic Information System (GIS) format.

A protection and restoration plan resulted from public education, research, fieldwork, data analysis and GIS mapping. Each non-point source problem area site was categorized into three (3) tiers based upon the priority for restoration with tier one (1) being the highest priority for restoration and tier three (3) being the least serious.

The *Gallows Run Watershed Restoration and Protection Plan* contains a weighted list of water quality and water problem areas within the Gallows Run Watershed. Implementing the identified restoration and protection measures will: add protection to watershed amenities; restore impacted problem areas based on need; increase interest in a watershed protection effort, abate nonpoint source pollution, and to sustain and improve water quality. Work on securing funds and the partnerships necessary for plan implementation has already started.

3.0 Introduction to the Gallows Run Watershed

3.1 Project Area

The Gallows Run Watershed is located in southeastern Pennsylvania and in Northern Bucks County. The watershed is located primarily in Nockamixon Township with portions in Durham, and Springfield Townships (See Table 3-1). The Gallows Run is situated south of Cooks Creek, north of the Tohickon and Tinicum Creeks. It flows under the Delaware Canal State Park and into the Lower Delaware Wild and Scenic River. The Gallows Run and its tributaries drain approximately 8.87 square miles of watershed area. The base map for the watershed drainage area illustrates watershed and municipal boundaries, streams, and major roadways (See Figure 3-1).

Table 3-1
Watershed Drainage Area by Municipality

Bucks County		
Municipality	Drainage Area (square miles)	Drainage Area (acres)
Nockamixon	7.23	4627.2
Durham	0.85	544
Springfield	0.80	512
Total Area	8.88	5683.2

Source: GIS Base Map, Borton-Lawson Engineers

Years of pro-active state, regional and local planning and management efforts identified a variety of significant natural, historical, cultural, recreational, and economic *amenities* (e.g., high quality surface and groundwater, healthy aquatic ecosystems, threatened and endangered species,

historic structures and villages, pre-Columbian archeological sites, scenic vistas, preserved open space, parks, and trails) in the Gallows Run Watershed.

The Gallows Run is a Cold Water Fishery (CWF) as classified by the Pennsylvania Department of Environmental Protection (PADEP). Maintaining and enhancing HQ water quality through nonpoint source protection efforts is especially important to the citizens of the Gallows Run Watershed as surface and groundwater resources are hydro-geologically connected, and groundwater is presently the only source of drinking water in the community.

Photograph 3 -1
Scenic Vista, Looking East, Gallows Hill Area



Source: Borton-Lawson Engineers

INSERT FIGURE 3-1 BASE MAP OF WATERSHED AREA

3.2 The Gallows Run Watershed Association & Partnerships

The Gallows Run Watershed Association (GRWA) received non-profit status in 2002. The organization initially formed in 2001 in response to the Kintner Ridge land development proposed on Ealer Hill Road. The original land development proposal called for nearly 40 homes. In a very short period of time, the group raised a significant amount of funding to hire an attorney and an engineer to review local land use planning and regulations, and to provide land development alternatives. The Association's efforts resulted in a 17 home residential development, drinking water well guarantees for neighboring properties, and stormwater Best Management Practices (BMPs) for water quality treatment as well as water volume retention.

In 2002, citizens living in the three municipalities within the Gallows Run Watershed began meeting to discuss stormwater problem areas in the community. A core group of citizens began inviting individuals from local agencies, elected officials, environmental organizations, and community members to local meetings that focused on watershed restoration and protection measures required to address stormwater runoff and other pressing problems in the watershed. A core group began attending municipal meetings to review and comment upon development proposals with potential environmental impacts.

The GRWA has evolved as its understanding about regional environmental issues and its environmental partnerships strengthened. The organization has grown, and several members are now serving on municipal commissions, and advisory bodies. The GRWA has completed a number of environmental education, environmental planning, and public outreach projects. Some members have assisted with formulating municipal policy and strengthening land development ordinances.

Many individuals agreed to join the Plan Advisory Committee for the *Gallows Run Watershed Restoration and Protection Plan*. They represent many organizations including: Lenape Nation of Pennsylvania, Palisades School District, Delaware River Greenway Partnership, Swamps Auto Works, Cooks Creek Watershed Association, Pennsylvania Department of Environmental Protection, Tinicum Conservancy, Tinicum Creek Watershed Association, Bucks County Chapter of Trout Unlimited, Heritage Conservancy, and Bridgeton-Nockamixon-Tinicum Groundwater Committee.

A number of partnering agencies, organizations, and individuals have contributed to this study in the form of research, volunteer fieldwork, and meeting attendance. The groups are now working together on watershed and other plan implementation projects.

3.3 Project Approach & Methodology

The Gallows Run Watershed Restoration and Protection Plan was sponsored and directed by the Gallows Run Watershed Association (GRWA) Board of Directors (Todd Stone, President & Project Director) and the Gallows Run Plan Advisory Committee. Project consultants included Forbes Environmental & Land Use Planning (Suzanne Forbes, AICP, President and Project Manager), Borton-Lawson Engineering (Paul DeBarry, PE, PH) and the Word Forge (Mary Shafer, President). The eighteen (18) month project included the following major tasks: project

administration and research (existing and new), environmental planning, environmental engineering, Geographic Information System (GIS) mapping, public outreach, and technical writing.

During the first study quarter, existing information about the watershed was efficiently gleaned from a variety of sources (e.g., public meeting input, public outreach questionnaire, key person interviews, academic resources, project consultants, and agency and organizational outreach), completed environmental plans and scientific studies (see bibliography). During fall 2004, the project consultants and a group of volunteers completed a comprehensive field assessment. The purpose of the watershed field assessment was to document positive attributes and non-point source problem areas in the watershed (See Sections 6.0 and 7.0).

The consultants began the field assessment phase of the project by creating field data collection sheets and providing an overview of field assessment techniques to perspective volunteers. The field training was presented at two watershed workshops, and at the beginning of each consultant-led field experience. Volunteers assisted by recording the location and extent of *water quality amenities* or natural features that are protective of water quality (e.g., open space, well-vegetated creek corridors, sparsely developed adjoining property, species diversity) and the location of *water quality problem areas* or areas contributing to water quality problems (e.g., flooding, stormwater runoff, streambank erosion, lack of streambank vegetation, farm practices in proximity to creeks, historic landfills, state/federal Superfund Sites).

Photo 3-2
Volunteer Performing Volunteer Field Assessment



Source: Kathy Throckmorton, GRWA Member

Field assessment volunteers took digital photographs and later participated by placing field information in a Geographic Information System (GIS) format and creating an associated informational database (See Appendix B).

The consultants later returned to the watershed to re-check assessment findings, determine the origin of water quality problem areas (e.g., natural stream physiology, inadequate stormwater treatment facilities, dense development with large areas of impermeable surface, inadequate land

development ordinances), and prioritize approximately twenty-four (24) identified problem areas. Each problem area site was categorized into three (3) tiers based upon the priority for restoration. Tier one (1) projects are the highest priority for restoration and tier three (3) projects should be addressed, but are the least serious (See Section 7.0).

From the beginning, the project goal was to create a protection and restoration plan to abate non-point source pollution in the Gallows Run watershed. This restoration and protection plan had to include a weighted and prioritized list of water quality and water quantity problem areas, a map locating those areas, and a management plan with specific recommendations to remediate problem areas.

In pursuit of this goal, a *draft* management plan identified measures to protect and better-manage watershed amenities; restore impacted problem areas based on need; increase interest in a watershed protection efforts, abate nonpoint source pollution, and improve water quality. Comments on this plan were received from the public through a variety of means and incorporated into the final *Gallows Run Watershed Restoration and Protection Plan*. This final plan was presented to the Gallows Run Watershed Association, the citizens of the watershed, and Nockamixon, Durham, and Springfield Townships.

3.4 Public Outreach & Education Efforts

One of the most challenging tasks in the environmental planning process is to obtain adequate information and feedback from the community. Therefore, a variety of public outreach efforts was used to obtain input from individuals, agencies, non-profit organizations, businesses, landowners and interested individuals. A technical advisory committee representing environmental groups, government, business and agency sectors, assisted project consultants throughout the study and met often to provide feedback, comments, and suggestions.

Due to the variety of public education and outreach opportunities, citizens in the watershed had several opportunities to review and comment on the *Gallows Run Watershed Restoration and Protection Plan* and participate in a variety of public outreach and educational opportunities. Participation opportunities included: watershed tours, questionnaires, community events, three public meetings, press releases, one newsletter devoted entirely to the project, newsletter articles, volunteer involvement in field work, and three watershed workshops (See Appendix A).

- **Public Meetings & Work Sessions-** The Plan Advisory Committee contributed numerous hours attending meetings and reviewing watershed study findings. The Gallows Run Watershed Association (GRWA) sponsored a public meeting at project kickoff, where numerous attendees provided input and valuable information. The GRWA, the Bridgeton-Nockamixon-Tinicum Groundwater Committee, and Palisades School District co-sponsored the second public meeting to present the draft plan. The final plan was unveiled to municipal officials, citizens, and others at a third meeting in September 2005.

- **Community Questionnaire-** Often citizens are unable to attend evening meetings or workshops. Therefore, the Gallows Run Watershed created and distributed a community questionnaire. The questionnaire was distributed to over 1000 people via mail and at numerous public events. Ten percent (10%) of the community responded to the questionnaire and responses helped guide the planning process (See Sections 6.0 and 7.0 and Appendix A).
- **Educational Workshops-** Citizen feedback from adults is sometimes under represented. However, the lack of feedback opportunities afforded to younger citizens is often missing entirely. In order to reach young citizens, the GRWA coordinated three workshops for local students, educators, and the general public. Two of the three workshops took place in fall 2004, and one in spring 2005. Students and educators from Palisades and Central Bucks school districts attended, while representatives from partnering organizations worked together to create an interesting, hands-on curriculum. All three workshops attracted landowners and others from the watershed and surrounding region (See Appendix A).

Photograph 3-3
Workshop Attendees Perform Water Quality Sampling



Source: Borton-Lawson Engineers

- **Student Involvement:** The Palisades School District Superintendent supported the PADEP Growing Greener grant application, and the Assistant Superintendent participated on the project advisory committee. In addition, high school science educators and their students were involved for the entire project. Numerous students attended three weekend workshops, joined our consultants on their Thanksgiving break to assist with an extensive watershed field assessment, *and* spent hours of their Christmas vacation creating databases and GIS maps. The same group of Palisades High School students submitted their watershed project report to two awards programs.

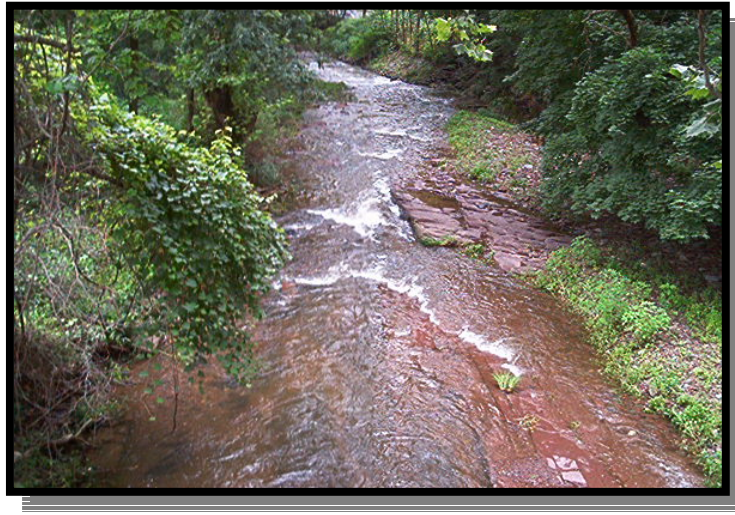
With assistance from our consultants, and science educators, Palisades High School students completed a paper entitled *Documenting a Rural Watershed in Eastern Pennsylvania*. The paper was submitted to the Volvo Adventure Award Program, which is an International competition that rewards environmental action taken by young people, and provides the chance to gain international recognition (United Nations Environmental Program) for local environmental projects. The project was one of ten semi-finalists from the United States. Students will continue working in the Gallows Run Watershed in order to build upon their findings.

3.5 Goals for the Watershed

The *Gallows Run Watershed Protection and Restoration Plan* will add protection to watershed amenities, restore and protect areas based on need, increase interest in a watershed approach to nonpoint source pollution abatement, and improve water quality. The following goals were created by the Plan Advisory Committee, recommended by questionnaire respondents, commented upon by the public, and adopted by the watershed community.

- **Goal One: Water Quality and Water Quantity Protection-** Enhance, protect, and maintain existing water quality and quantity in the Gallows Run, its tributaries and hydro-geologically connected groundwater resources.
- **Goal Two: Restoration and Protection Plan Implementation-** Take a proactive approach to preserve, protect and restore the quality of water in the Gallows Run watershed, and implement Tier 1-Tier 3 prioritized projects listed in the Gallows Run Watershed Plan.
- **Goal Three: Watershed Amenity Protection-** Enhance, protect, preserve and manage natural land resources in the Gallows Run Watershed since they are directly associated with clean and plentiful surface and groundwater resources.
- **Goal Four: Education and Stewardship-** Create and maintain an informed and proactive citizenry knowledgeable of stewardship throughout the Gallows Run watershed.
- **Goal Five: Environmental Partnership-** Maintain and enhance partnerships with adjoining and regional watershed groups and government and non-government organizations.
- **Goal Six: Environmental Planning and Protection-** Enforce existing environmental protection tools and provide additional protection as needed.
- **Goal Seven: Capital Improvements-** Obtain reliable and consistent funding to preserve, restore and manage water resources and natural, cultural, and recreational amenities within the Gallows Run Watershed.

Photograph 3-4
The Main Stem Gallows Run



Source: Borton-Lawson Engineers

4.0 General Description of the Project

4.1 Base Data Acquisition – Topography, Land Cover and Percent Impervious Area

The first step in a watershed assessment is to obtain information illustrating the physical characteristics of the watershed that have the most impact upon hydrologic regime (e.g. soils, geology, topography). The information is then compiled into a Geographic Information System (GIS), which is a computerized mapping system with correlating data or attributes. For instance, soil polygons are displayed on a map and a correlating table illustrates their erodibility, permeability, and runoff potential. The collection and analysis of a variety of data layers was proposed for this Growing Greener initiative, however, due to limited funding a less extensive analysis was selected. The following maps and associated features were obtained and included in the Gallows Run Watershed Restoration and Protection Plan:

- **Base Map:** The GIS data for the Gallows Run Watershed Base Map were obtained from the following agencies: Pennsylvania Department of Transportation (roads and municipal boundaries); Pennsylvania Department of Environmental Protection, streams and watershed boundary; and the United State Fish and Wildlife Service, water bodies (National Wetlands Inventory). The watershed boundary was originally delineated by the PADEP and then refined based on field observations by the Plan Advisory Committee. The contour lines on the base map were obtained from the United State Geologic Survey, Riegelsville Pennsylvania quadrangle (See Base Map Figure 3-1).

- **Topography:** The Gallows Run watershed forms a roughly triangular valley bordered by series of small hills along the east, south and northwest sides of the watershed. The hills range in elevation from 600 to 870 feet above mean sea level (MSL). The elevation at the base of valley ranges from approximately 500 feet MSL to 150 feet MSL where the Gallows Run flows into the Delaware River. As the topographic map shows, the tributaries feeding Gallows Run have cut numerous ravines creating an uneven topography throughout the watershed (See Topography Map Figure 4-1).
- **Digital Elevation Model:** The USGS digital elevation model (DEM) illustrates a three-dimensional topographic model of the land surface. The DEM map shows the Gallows Run Watershed terrain as well as elevation contours and planimetric features such as roads, streams and structures (See DEM Map Figure 4-2).
- **Tax Parcel Database:** Maps containing tax parcels provide a useful “sense of place”. The tax parcel coverage was obtained from the Bucks County Planning Commission. This 1990 coverage, including updated tax parcels and subdivisions, is currently being updated by the Planning Commission.
- **Land Cover:** The land cover is based upon aerial photographs from the year 2000. There has been a limited amount of development during the past four years, however the land cover in the Gallows Run watershed has not changed too dramatically since 2000. As illustrated in Table 4-1, the majority of the watershed contains agricultural and forested areas along the eastern border where the slopes are steeper. Small areas of higher density use are found along Route 611 and at the northern-most portion of the watershed. The land cover / land use categories in table 4-1 can be interpreted from the aerial photograph in Figure 4-3).

Table 4-1
Land Cover, Gallows Run Watershed

Land Cover / Land Class	Area (acres)
Agriculture	1896
Commercial	44.7
Farmstead	11.8
Forest	2389
Industrial	20
Institutional	23.4
Meadow	341.3
Open Space	75.4
Paved	79.6
Residential (1-4 acre)	766.3
Residential (1/3 -1 acre)	19.2
Water	16.5
Total	5683.2

Source: DVRPC & Borton-Lawson Engineers

- **Impervious Surface:** The impervious surfaces map illustrates the relative level of development throughout the Gallows Run watershed. A land cover layer was obtained from the Delaware Valley Regional Planning Commission which was derived from the aerial photograph in Figure 4-3. From this land cover data, impervious surface values within the watershed were assigned to each type of land over. Surface area values within the watershed are based upon the TR-55 land use classifications and an assigned impervious area classification. Pavement and surface water are basically impervious while commercial and industrial areas are the next most impervious. The low density residential areas have less than half the average impervious areas of commercial or industrial properties. The percentage of impervious area is color coded in Figure 4-4.

It should be noted that the map indicates *actual* impervious area (e.g., roofs, pavement, driveways, sidewalks, and water), and agricultural areas (e.g., lawns, meadows and forests) are all averaged at 1% impervious surfaces. It should also be noted that the level of impervious cover is inexorably linked with the municipal zoning districts and the allowable development densities associated with each zoning district. This map should not be confused with a “runoff potential map” where the type of land cover (e.g., grass, residential, commercial) have varying degrees of runoff. The map represents the amount of roofs, pavement, driveways, sidewalks, and water in the Gallows Run watershed (See Percent Impervious Surfaces Map Figure 4-4).

Overall about 5 percent of the surface area of the watershed is impervious, although certain portions of the watersheds have a greater percentage and some areas a lesser percentage. Several studies indicate that watersheds will begin to degrade when they have approximately 10 percent impervious surfaces (FHA, 1999, NWF, 2000). Where zoning and land development ordinances allow for development, the percent impervious surface will most likely increase.

Streams unable to support reproducing trout populations (non-supporting) streams, located in watersheds with greater than 25% impervious cover, become channels for conveying stormwater and are no longer suitable for contact recreation due to high bacterial levels. In these degraded systems, stream organisms are dominated by the most pollution tolerant insects and fish" (NWF, 2000). Municipal land use zoning dictates how dense a tract of land can be developed, which affects the amount of impervious area, and in turn, stream health.

- **Amenities and Problem Areas:** Data was also collected and illustrated on two maps showing both amenities and problem areas. Field survey findings are further described in Section 6 and Section 7 of this plan (See Amenities Map Figure 6-1 and Problem Area Map Figure 7-2).

INSERT Figure 4-1 Topography

INSERT Figure 4-2 DIGITAL ELEVATION MODEL

INSERT Figure 4-3 Land Cover

INSERT Figure 4-4 Percent Impervious

4.2 Regional Planning, Zoning and Water Quality Protection Efforts

The previous section of the Gallows Run Watershed Restoration and Protection plan highlighted important physical resources information associated with the watershed. The following section addresses comprehensive planning and land use regulatory efforts implemented regionally. Subsequent sections provide a necessary overview of current planning, zoning and water quality protection efforts in the three municipalities comprising the Gallows Run Watershed.

For over thirty years, Commonwealth and regional environmental agencies have stressed the importance of environmental protection. Bucks County, and many of its municipalities, has been at the forefront of a variety of environmental protection promulgation efforts. Historically, Northern Bucks County municipalities have been particularly protective of water resources because citizens and businesses are served primarily by on-lot groundwater wells. In addition, surface and groundwater resources are hydrologically connected, groundwater resources are not highly productive, and all water resources are vulnerable to pollution. Therefore, local residents have identified the need to protect open space and other significant natural resources in order to protect water resources from pollutants commonly associated with land development (e.g., erosion, sedimentation, increased stormwater).

4.2.1 Resource Protection and Conservation Management Efforts

An environmentally protective philosophy is illustrated by the myriad of policy, planning and conservation management documents designed to protect the watershed's natural, historical, cultural, recreational, and visual amenities. The following environmental efforts contain information and conservation management strategies designed to assist counties and local municipalities in balancing the rights of individual landowners to develop property with the health and safety benefits derived from protecting water resources and other natural, cultural, historical and recreational amenities:

- The Bucks County Comprehensive Plan (BCPC, 1996)
- The Bucks County Natural Resources Plan (BCPC, 1995)
- The Bucks County Natural Resources Inventory (Rhodes, 1999)
- The Lower Delaware Wild & Scenic Study and Lower Delaware Management Plan (US NPS & DRGP, 1996-98)
- The Middle Delaware Rivers Conservation Plan (Heritage Conservancy, 2003)
- The USGS Groundwater Study (USGS, 1998)
- The Delaware River North (Act 167) Storm water Watershed Plan (BCPC, 2000)
- The Tinicum Creek Rivers Conservation Plan (Tinicum Township EAC& Princeton Hydro, LLC, 1998)
- The Tohickon Creek Rivers Conservation Watershed Plan (Tinicum Conservancy & Princeton Hydro, LLC, 2000)
- The Cooks Creek Watershed Conservation Plan, (Durham Township Environmental Advisory Council/MJE Environmental, 2002)
- The Durham Township Comprehensive Plan, Zoning Ordinance, and Subdivision & Land Development Ordinance (1980-present)

- The Durham Township Open Space Plan (2001)
- The Nockamixon Township Comprehensive Plan, Zoning Ordinance, and Subdivision & Land Development Ordinance (1980-present)
- The Nockamixon Township Natural Resources Plan (1994)
- The Nockamixon Township Open Space Plan (2002)
- The Springfield Township Comprehensive Plan, Zoning Ordinance, and Subdivision & Land Development Ordinance (1980-present)
- The Springfield Township Open Space Plan (2002)

Members of the Gallows Run Watershed Association (GRWA), the Gallows Run Watershed restoration and Protection Plan Technical Advisory Committee, and partnering agencies and organizations were involved first-hand in creating and reviewing the studies and natural resources protection efforts noted in the previous list.

4.2.2 Regional Water Quality Management Efforts

An environmentally protective philosophy at the Commonwealth level is illustrated by two statewide environmental programs. Again, these efforts involved GRWA members, individuals from the Plan Advisory Committee, and partnering entities.

- *The Federal Clean Water Act: Commonwealth of Pennsylvania 303 (D) List*, PADEP, 2003
- *The Environmental Futures Program*, (2D Delaware River, Tohickon Creek) Draft Report, PADEP, June 2001

The Federal Clean Water Act (Section 303 [d]) requires states to provide periodic reports on the quality of surface water resources. The PADEP has an ongoing program to assess the quality of waters in Pennsylvania, and to identify streams and other bodies of water that do not meet water quality standards. Those waterways not supporting uses such as aquatic life, recreation, and drinking water are considered *impaired*.

The field assessments completed by the Pennsylvania Department of Environmental Protection (PADEP) in the Gallows Run region (primarily Tohickon, Tinicum and Cooks Creek Assessments) indicate that the streams in the vicinity are currently meeting aquatic life, human health, and recreational uses. The GRWA's intention for the *Gallows Run Watershed Restoration and Protection Plan*, and with implementing the plan, is to assist the PADEP and the municipalities with maintaining and enhancing the designated uses for the Gallows Run.

The Commonwealth is also required by the Clean Water Act to determine the reasons for identified water quality impairments (point source and nonpoint pollution sources) and to develop a Total Maximum Daily Load (TMDL) for water bodies on the list of impaired streams and lakes. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources.

The Environmental Futures Planning Effort (EFP2) was an effort by PADEP to link state agency teams with local officials, organizations, and interested citizens in watersheds throughout Pennsylvania. The southeast regional office had ten water quality planning teams. The Gallows Run was included in the 2D region, which focused primarily on the Tohickon, Tinicum, and Cooks Creek as well as a section of the Lower Delaware Wild and Scenic River. The intent of this partnership planning effort was to evaluate “baseline” environmental conditions in Pennsylvania’s watersheds, to determine causes for impaired waterways, and to obtain local input to determine nonpoint source pollution reduction objectives. In the 2D watershed there were several causes for concern including:

- Inadequate water quality data.
- Environmental conditions *running the gamut from bucolic(rural) to asphaltic (urban)*,
- Negative impacts from nonpoint source pollution (specific sources were not identified).

The Gallows Run and its tributaries were not studied for the EFP2 effort, however, individuals from Northern Bucks County communities attended and participated in the public meetings preceding the EEP2 report (PADEP, 2000). One important recommendation stressed the importance of correlating the various sources of information, and to making them available to the public. Additional PADEP findings regarding the 2D watershed included the following:

- The negative impacts from non-point sources of pollution are a major problem,
- Nonpoint source pollution problem areas were not completely identified, and further investigation (e.g., field reconnaissance) was recommended,
- Streams in the 2D watershed still require water quality assessments,
- Anthropogenic impacts upon streams in the basin is extensive,
- Few forested sections remain as most of the basin has been cleared for crop fields and residential housing, and
- Nonpoint source pollution sources are most likely from agricultural and residential uses.

Although information on the Delaware, Tohickon, Tinicum, and Cooks Creek are included in the PADEP report, information on the Gallows Run is lacking. Therefore, the GRWA applied EEP2 report findings to the planning process.

4.3 Nonpoint Source Indicators and Impacts

As noted previously, one indicator of water quality is the stream classification given to the Gallows Run, Nockamixon Creek and their tributaries. The Gallows Run subwatershed is a Cold Water Fishery (CWF) and is surrounded by Exceptional Value (EV), High Quality (HQ) streams as well as an abundance of Rare Natural Community Types (Bucks County Natural Resource Inventory, 1999). The Cold Water Fishery (CWF) classification is related to the stream’s ability to support trout. The streams do have favorable physical features (dense to partial shading, light erosion and rubble-gravel substrate) and chemical stability to make them suitable for trout, however additional water quality, water temperature and habitat studies should be completed to fully determine suitability.

In 1982, a study (Mayers, Soldo & Heffly, 1982) by the PA Fish Commission found brown trout from 6 to 15 inches in the lower reaches of the Gallows Run, however, they were not present in numbers great enough to provide a desirable fishery. The report indicates that the absence of fish habitat caused by the stream's shallow nature and low flow limits the sport fish populations, with the fish concentrated mostly in the deep pools. The shallow nature of the stream is from a combination of low baseflow (groundwater recharge) and geomorphic properties. The Fish Commission report indicated that the biota of very lower portion of Gallows Run was influenced by the Delaware River, with warm water species present. They concluded that the closed landfill did not have negative effects on the aquatic life.

The Bridgeton-Nockamixon-Tinicum Groundwater Management Committee (BNT, 2005) has been conducting studies on the response of groundwater to rainfall. These studies conclude that the static water level of some wells is influenced by rainfall amount, but it is not in others. Factors for the difference include local geology and proximity to surrounding wells also is an influence. The focus of these studies to date has been on the impact to groundwater from drinking water withdrawals. However, if impacts of groundwater withdrawal on current and potential fisheries resources are to be determined, additional studies on the impact of well pumping on stream baseflow will need to be conducted. A formal hydrologic budget and stream gauging would enable planners to determine the sustainability of groundwater resources as they relate to the water quantity and quality of the Gallows Run. The adoption of the Act 167 Plan will aid in promoting groundwater recharge in the area.

The Gallows Run is not on the Clean Water Act 303 (d) list, therefore the Pennsylvania Department of Environmental Protection is not conducting or planning to conduct a Total Maximum Daily Load (TMDL) study. These studies are typically performed only on water bodies that already exhibit significant degradation, which fortunately is not the case for Gallows Run. In order to prevent any future degradation, the partnering efforts with local municipalities, regional environmental agencies, water protection organizations, riparian landowners and local citizens initiated by this planning effort will be continued in the future. It is the intent of this planning effort to outline the actions and parties needed to at least maintain, if not enhance the quality of the Gallows Run and its' surrounding watershed for future generations.

An additional step in the restoration and protection process was to organize existing data & information. Several entities had already created maps, compiled water quality/quantity data, and had formulated general goals, objectives, and recommendations. The GRWA did not "*reinvent information*", but quickly applied existing information to this unique watershed. To obtain new information, the GRWA used its own finances and volunteer labor to obtain and install data loggers, rain gauges, and flow monitors which were located based on PA DEP advice. Existing data was augmented with the additional data collected. This information is presented in tabular form and water quality trends are noted. Perceived data trends were linked with recent weather patterns, recent changes in land use, and existing zoning.

The next phase determined whether existing local, state, and federal regulations are adequately protecting nonpoint source amenity areas (e.g., buffers, headwater areas, floodplains, wetlands, low density zoning in proximity to floodplains). The project team used Geographic Information System (GIS) technology to interpret existing landscape changes and how they may negatively

impact identified amenity areas and restoration areas (e.g., zoning, projected land use, percent impermeable surface). GIS technology was also used to prioritize amenity areas based on their importance in sustaining existing water quality, and their susceptibility to development. Areas in need of restoration were prioritized based on extent of problem, contribution to water quality impacts, land ownership, and cost.

The vast array of existing and newly created water resources information was collected in the three previous tasks and was analyzed (See Section 7) and then combined in order to formulate the basis for the Gallows Run Watershed Restoration and Protection Plan (See Section 8).

Photograph 4-1
Flooding and Turbid Stormwater in the Gallows Run Watershed



Source: Gallows Run Watershed Association Archives

5.0 Gallows Run Watershed-Wide Planning & Protection Efforts

The preceding section illustrates that there is a variety of regional water resources and natural resources protection and management efforts. However, in the Commonwealth of Pennsylvania, the power and responsibility for land use and its regulation lie with local government, since the General Assembly delegated planning and land use “police power” to the counties and municipalities through the Pennsylvania Municipal Planning Code (MPC).

The MPC does not demand that municipalities plan or zone, nor that individual municipalities adopt Comprehensive Plans, Zoning Ordinances, and Subdivision and Land Development Ordinances (SALDO). It merely enables local government to shape planning and land use programs. However, northern Bucks County municipalities have a history of strong county-wide and municipal planning and zoning.

Therefore, an overview of land and water resources plans, management policies and ordinances currently in place within the three municipalities within the Gallows Run Watershed was very important for this plan.. Understanding how and whether or not individual, local regulations are adequately addressing the relationship between land development and water resources protection within the Gallows Run Watershed resulted in some of the restoration and management recommendations (See Section 8).

The following subsections provide an overview of existing management and protection efforts in the three municipalities comprising the Gallows Run Watershed (See Appendix C for full planning and zoning overview). In addition, an overview of specific nonpoint source indicators and impacts is provided as a basis for understanding the importance of protecting amenities and addressing problem areas in the Gallows Run Watershed.

5.1 Municipal Environmental Planning & Protection Efforts

5.1.1 The Delaware River (North) Act 167 Stormwater Management Plan

For many years, conservation-minded Townships and Boroughs have attempted to manage and protect water resources and land resources within the confines of municipal boundaries rather than watershed and ecological boundaries. However, many now agree that water resources management can be accomplished more effectively on a watershed basis. The following passage provides a strong case for improved integration of local management and regulation efforts (DeBarry, 2004):

Land and water resources are integrated and are divided by drainage areas, and ground-and surface waters are interconnected. A watershed is a natural resource management unit; therefore, for a sustainable future, land and water resources must be managed on a watershed basis, which includes an understanding and coordination of surface and groundwater system, reservoirs and aquifers, point and nonpoint source pollution, wetlands and uplands, wastewater and drinking water, lakes and streams, and physical, biological, and chemical characteristics of water.

Water resources should be addressed at the watershed level instead of only at the political boundary level. When watersheds cross-political boundaries, land use regulations need to be consistent across borders, to ensure that upstream land and water uses in one jurisdiction do not conflict or adversely impact water quality and quantity in downstream jurisdictions.

An example of legislation managing stormwater runoff and treatment on a watershed wide basis can be found in Pennsylvania's Stormwater Management Act of 1978 (Act 167). The Storm Water Management Act addresses the relationship between new development and the resulting increases in stormwater runoff and non-point source water pollution resulting from new development.

The Act requires Bucks County and all Commonwealth counties to prepare and adopt watershed stormwater plans for designated watersheds. The intent of the act is to address the impacts of development on existing stormwater runoff levels and to recommend measures to control accelerated runoff.

A watershed stormwater plan includes hydrologic and hydraulic evaluation of the drainage basin, consideration of existing drainage problems, existing and proposed flood control projects and their impacts, existing government regulatory mechanisms, and provides recommendations for the control of accelerated runoff as a result of development.

For planning purposes, the Bucks County Planning Commission designated ten stormwater management watersheds in Bucks and adjoining counties. *The Delaware River (North) Act 167 Stormwater Management Plan* contains watershed characteristics information, watershed technical modeling analysis, standards for controlling stormwater, and a model stormwater management ordinance for local adoption consideration. It is the stormwater plan for the Gallows Run Watershed (Bucks County Planning Commission & Pennoni Associates, 2002).

The Delaware River (North) Act 167 Stormwater Management Plan was adopted in 1999 and then revised in 2001 to include additional protection measures. The requested revisions reflect the water resources protection focus of northern Bucks County municipalities, and specifically the importance they place upon protecting surface water *and* ground water resources.

Revisions to the plan require that, along with requirements to manage the rate and volume of stormwater runoff created by new development activities, developers address groundwater recharge and water quality treatment in their required stormwater plans. The major program objectives in The Delaware River (North) Act 167 Stormwater Management Plan, and therefore for the Gallows Run watershed, include the following (BCPC and Pennoni Associates, 2002):

- Manage stormwater runoff created by new development activities taking into account the cumulative basin-wide stormwater impacts from peak runoff rates and runoff volume;
- Preserve existing natural drainage ways and watercourses and provide for proper maintenance of all stormwater management facilities;

- Maintain and/or improve existing water quality, especially in those areas which drain to existing lakes and reservoirs, by preventing additional loading of various stormwater pollutants into stream system;
- Maximize groundwater recharge where feasible and attainable throughout the watershed in an attempt to maintain the existing hydrologic regime;
- Provide sound guidelines and methods for stormwater management for communities in the watershed.

The model ordinance within the Act 167 was adopted by Nockamixon, Durham and Springfield Townships in 2002.

5.1.2 Municipal Conservation Planning and Protection Efforts

In the three municipalities within the Gallows Run Watershed, land development is subject to local land use planning policies (e.g., studies, comprehensive plans, functional plans) and controlled by municipal ordinances (e.g., zoning, subdivision and land development, and stand alone ordinances). There have been a number of successful land use studies and conservation planning efforts completed for the three Gallows Run Watershed townships. Some of these professional efforts include countywide and municipal natural resource inventories, multi-municipal rivers conservation plans, groundwater studies, headwater mapping studies, and municipal open space plans. Since one of the most effective means of stormwater management and water resources protection is through conservation management planning, this is a very positive trend.

Conservation planning can be viewed as non-structural stormwater management, because development is therefore directed to the most suitable land, thereby minimizing impervious areas, stormwater runoff, and groundwater recharge in sensitive areas (e.g., river corridors, floodplains, headwater areas). Therefore, a positive result of successful conservation planning is that resource conservation and protection policies are incorporated into updated municipal comprehensive plans, and protective regulations are included in revised municipal zoning ordinances, subdivision and land development ordinances.

The Municipal Comprehensive Plan ~

The best municipal comprehensive plans are based on sound research and effective public outreach. When soundly researched, a “comp plan” becomes the basis for local zoning and a tool by which local governments may direct growth and change within the community. According to state planning documents, *a comprehensive plan is more than just a document disclosing past and present land use trends with a proposed course of action. A comprehensive plan creates a blueprint for land use patterns of tomorrow* (Pennsylvania Department of Community and Economic Development, 1999). The intent of the comprehensive plan is to protect individual landowner rights, while at the same time, protect the health, safety and welfare of all citizens. All three municipalities have adopted and implemented Municipal Comprehensive Plans with strong conservation management goals, objectives, and recommendations. An overview of each municipal comprehensive plan is included in this plan (See Appendix C) as well as recommendations for improvement (See Section 8.0).

Functional Plans ~

Very often, the recommendations in municipal comprehensive plans suggest further study before local ordinances are strengthened or management programs are implemented. For example, a municipality may require additional information about the location and extent of undeveloped open areas. The municipality may therefore complete a functional plan known as an open space protection plan. Since, open space protection, is one of the most effective means of maintaining the natural hydrologic regime of a watershed, the information in an open space protection plan provides the basis for more pro-active open space acquisition programs as well as zoning and subdivision ordinances designed to protect open space and natural habitat.

All three municipalities have open space plans, have implemented open space acquisition programs and have adopted a number of zoning, subdivision, land development, and stand-alone ordinances to protect open space, water resources, and significant natural resources. An overview of municipal functional plans is included in this plan (See Appendix C) as well as recommendations for open space acquisition (See Section 8.0).

The Municipal Zoning Ordinance ~

The terms *planning* and *zoning* are sometimes used interchangeably, but a distinction should be made between the two. Conservation *planning* involves taking an inventory of significant resources, analyzing the collected data, projecting future development alternatives and degrees of environmental impact, and establishing policies and recommendations that protect land and water resources. While planning is a Community's vision, zoning is one of the tools used to implement the vision.

Zoning is the basic means of land use control employed by local governments in the United States today, and is one method of implementing the policies and recommendations within a conservation plan. Zoning divides the community into districts (zones) and imposes different land-use controls on each district, specifying the allowed uses of land and buildings, the intensity or density of such uses, and the bulk of buildings on the land (DCED, 1999).

Therefore, in theory, a zone allowing for less intense use and density would be assigned to areas containing the most significant land and water resources. Nockamixon, Durham, and Springfield Townships all have zoning ordinances containing resource protection districts as well as other protective measures such as environmental performance standards (e.g., stormwater control regulations, site capacity calculations, floodplain protection regulations, open space provisions, water quality regulations, and resource overlay districts). An overview of each municipal zoning ordinance is included in Appendix C and recommendations for improvement are suggested in Section 8.0.

Subdivision and Land Development Ordinances ~

Subdivision is the creation of new property lines, while *land development* involves construction of public or private improvements (DCED, 1999). The subdivision and land development ordinance (SALDO) is the most commonly used development control method in Pennsylvania, and is considered the most basic of land use regulations. The SALDO requires that all developers provide an adequate amount of information to the municipality regarding the

proposed design of a development, and how the developer plans to minimize site impact based on that proposed design. Common regulations included in the SALDO include traffic impact, erosion and sedimentation control, stormwater management, water resources impacts, and a variety of environmental regulations required by federal, state, and local government. An overview of each municipal subdivision and land development ordinance is included in Appendix C and recommendations for improvement are suggested in Section 8.0.

Stand-Alone Ordinances~

Stand-alone ordinances are often adopted as an interim measure, and later incorporated into the zoning and/or subdivision and land development ordinances when a municipality is ready to complete a full-fledged zoning ordinance and SALDO update. One example is the municipal stormwater control ordinance, adopted by all three municipalities, after the completion of The Delaware River (North) Act 167 Stormwater Management Plan. Each municipality has a stormwater ordinance that works in concert with stormwater management regulations previously included in their zoning and subdivision and land development ordinances. An overview of each municipal stormwater stand-alone ordinance is included in Appendix C and recommendations for improvement are suggested in Section 8.0.

**Photograph 5-1
Riparian Buffer Along Gallows Run**



Source: Borton-Lawson Engineers

6.0 Natural, Cultural, Historical and Recreational Resource Amenities

Natural and man-made processes have negatively impacted surface and groundwater resources since the beginning of time. Groundwater and surface water impacts have magnified as our technology has evolved. The resulting impacts have not gone unnoticed. The following passage illustrates early concerns regarding early deforestation and its impact upon the quality and quantity of water resources:

The amazing difference in the state of cultivated and uncultivated surface of earth, iz demonstrated by the number of small streems of water, which are dried up by clearing away forests. The quantity of water, falling upon the surface may be the same; but when land is covered with trees and leeves, it retains the water; when it iz cleared, the water runs off suddently into the large streems. It iz for this reezon that freshes (floods) in rivers hav becume larger, more frequent, sudden and destructive, than they were formerly.

~ Noh Webster, Late 18th Century (William Cronon, 1983)

In addition to the local, economic value of developed land, it is very important to remember that land also serves a protective role for the quality and quantity of our surface and groundwater resources. For instance, undeveloped forested or grassy meadow areas surrounding our rivers and streams form a protective barrier between developed land and pristine water resources. The more extensive the barrier or *buffer area*, the more protection undeveloped land affords surface and groundwater resources. In light of the value of water to human and ecological system survival, undeveloped land and the features upon it (e.g., forests, meadows, wetlands, ponds) are water quality and water quantity amenities.

The general description portion of this plan (See Section 4.0) provided a land cover map illustrating that the majority of the watershed is agricultural with forested areas along the eastern border where slopes are steeper. Only small areas of the watershed, those areas along Easton Road (Route 611) and the northernmost portion of the watershed are developed at a higher density. A breakdown of land cover and land class along with acreages and a land cover map (See Figure 4-3) are provided for additional information. Section 4.0 also provided an impervious surfaces map (See Figure 4-4) and narrative noting that about 5% of the surface area of the watershed is impervious. Therefore, a significant portion of the Gallows Run Watershed is still undeveloped and a variety of amenities remain relatively intact.

The following section of the *Gallows Run Restoration and Protection Plan* provides an overview of the historic, cultural, recreational, and resources amenities within the Gallows Run Watershed. We will begin with some of the positive economic features associated with undeveloped land, provide recommendations received from the public regarding the value of open space preservation, illustrate the diversity and extent of recreational, cultural, and historic features in the watershed, and finally illustrate the location and extent of these land resource amenities within the Gallows Run Watershed.

It is important to reiterate that the *Gallows Run Watershed Restoration and Protection Plan* was never intended to provide a comprehensive inventory of all resource amenities within the project area. The focus of this study is to identify restoration and protection measures. However, some of the more important amenities are listed in the following section with the primary focus placed on their water quality and water quantity protection values. A secondary focus is placed on those amenities noted in the project questionnaire and those amenities mentioned in public meetings. Problems associated with developing land resource amenities and recommendations for their continued protection are included throughout the plan (See Sections 7 and 8).

6.1 Open Space Amenities and the Local Economy

There are numerous reasons for preserving recreational, cultural, and historical sites in the Gallows Run Watershed. A study completed in 1998 by The Center for Rural Pennsylvania (a legislative agency of the Pennsylvania General Assembly) entitled *Economic Values and Impacts of Sport Fishing, Hunting and Trapping Activities in Pennsylvania* provides an important economic rationale and a useful overview on the importance of recreation to the economic prosperity of areas similar to the Gallows Run Watershed.

Its findings provide a snapshot of how much money these activities bring to the Commonwealth; how much money people are spending to enjoy recreational hobbies; and how these endeavors positively impact employment in rural areas. For instance, the study found that hunters, anglers and fur takers created a \$9.6 billion dollar impact from participating in recreational activities, and that participation resulted in local employment totaling more than 88,000 jobs. The study provides a variety of examples describing the economic and health benefits derived from preserving open areas and providing recreational activities.

More local information supporting the relationship of recreation, economic prosperity, and the importance of maintaining a clean and healthy environment was provided by the Bucks County Conference and Visitors Bureau, the Bucks County Tourist Commission, the Central Bucks Chamber of Commerce and a variety of other county and local entities. All sources agreed that Bucks County continues to be a popular tourist destination and northern Bucks County is increasing in popularity due to development patterns in the Easton-Allentown region to the north and the Philadelphia/Trenton region to the south. Local residents and equestrian businesses (e.g., Bucks County Horse Park) also note the importance of preserving open areas and creating/maintaining recreational trails for horses, hiking, biking and their contribution to healthy living and economic prosperity to this region. Equestrian pursuits are particularly popular in the Gallows Run Watershed and associated equestrian businesses, parks, and recreational events are thriving in the watershed and surrounding region.

Photo 6-1
Bucks County Horse Park



Source: Forbes Environmental & Land Use Planning

Regional eco-tourism research, and other public outreach efforts associated with this plan, provided additional information about recreation in the Gallows Run Watershed area. The Bucks County Conference, Visitors Bureau, Tourist Commission and Chamber of Commerce note the economic benefits derived from fishing, boating, canoeing/tubing, covered bridges, sight –seeing in Bucks County. The Gallows Run Watershed and surrounding immediate region contains all of these recreational, and economically positive amenities as well as horse-back riding parks and trails, scenic roadways, scenic vistas, gamelands, parks, historic villages, and many other amenities. Preservation of these amenities is therefore important to the local economy *and* to the watershed’s ecological health.

6.2 Public Input Regarding Amenities & Threats to Amenities

As noted in the public outreach portion of this plan a variety of public input strategies were implemented for this project: (a public outreach questionnaire, three public workshops, three public meetings, and numerous public events See Section 3). Questionnaire findings formed the basis for research efforts and management recommendations for this plan. The following provides an overview of public input regarding what citizens like to do, and what they value about the Gallows Run Watershed (See Also Appendices A & B).

- **Preferred Recreational Activities-** The top recreational activities included driving the scenic roadways, viewing scenic amenities, and walking.
- **Most Significant Natural Features-** Respondents valued the diversity and extent of natural features and the rural nature of the watershed and surrounding region. The two most valued natural features were the streams and forested areas.
- **Water Resources (Quality)-** The majority of respondents gave an above-average water quality rating for the Gallows Run and its tributaries. However, they also expected that the quality of the Gallows Run and its tributaries will degrade to average in the next ten years.

- **Reasons for Water Quality Degradation-** The top three reasons for water quality degradation included erosion, stormwater runoff, and impacts from hazardous waste (e.g., Boars Head Farm, Hidden Valley Landfill). Respondents noted that water quality would most likely degrade in the future due to continued land development, regional and local political problems, lawns replacing natural vegetation, more frequent flooding, and malfunctioning on-site septic systems.
- **Recommendations For Amenity Protection-** The top amenity protection recommendations provided by the public included implementing more stringent site design regulations and requiring best management practices (e.g., stormwater treatment, erosion and sedimentation control, natural vegetation buffers). The public also suggested the following implementation measures: educate and involve the public, support and endorse open space preservation, reduce the amount of development, enforce existing regional and local land use regulations, adopt more stringent land development ordinances, and repair failing on-site septic systems.

6.3 Research Findings, Amenities

The list of historic, cultural, recreational and natural amenities described in the following subsections is not exhaustive. The list contains amenities located within the Gallows Run Watershed gleaned from regional and local studies and plans combined with mapping, field assessment work, and public input completed for this study.

Some of the amenities listed in the following subsections are not *directly* associated with water quality and quantity protection (e.g., Lenape Native American features, historic mills), but citizen feedback noted their overall importance. In fact historic, cultural and recreational amenities are highly valued attributes within Gallows Run Watershed. This was indicated in the project questionnaire as well as a separate questionnaire circulated for a concurrent project (e.g., The Nockamixon Township Comprehensive Plan, 2005).

Other amenities are *directly* associated with water quantity and quality protection as well as for their recreational worth (e.g., forested buffer areas and open fields within the Bucks County Equestrian Park, State Gamelands #56, and Camp Nockamixon). Additional amenities are valued, because they protect water quality resources, offer recreational opportunities and are historic (e.g., Delaware Canal State Park). Finally, the Gallows Run Watershed contains natural features rich with diverse plants, animals, natural communities and geological and hydrological features. Some of them are prioritized in the Bucks County Natural Areas Inventory (Rhoads & Block, 1999) and are identified due to statewide or countywide significance (e.g., Nockamixon Cliffs, Buckwampum Mountain, Chestnut Hill, and Gallows Run Floodplain).

6.3.1 Historic Amenities

There are a variety of Pre-Columbian (Native American) Amenities in the Gallows Run Watershed and the surrounding Lower Delaware River region. When European explorers, traders, and settlers first arrived in Northern Bucks County, they found it occupied by a highly-developed and thriving Lenape culture- a culture in existence for a thousand or more years *before* their arrival. The Gallows Run Watershed was part of *Lenapehoking* or *land of the*

Lenape. Lenapehoking included an area along the Middle Atlantic Coast from New York Bay to Delaware Bay, and a very large land area nestled between the Hudson and Delaware River Valleys.

One watershed landowner, living at the confluence of the Gallows Run and Nockamixon Creek, came forward during the course of this study to share a variety of Native American artifacts found on their property. Although no conclusions may be made without further investigation, Lenape members serving on the advisory committee noted that the collection was comprised primarily of *points* and *flakes* from the woodland periods (ca. 1000-400 years ago). Points are a finished product, and may be found in any location where game may have existed. However, flakes are stone tools made at the site where they were found. Generally, the more flakes found, the more likely the habitation was year round. Noticeably missing from the collection were grinding and pounding stones, but the collection was from one field in particular and may not be comprehensive.

English settlers arrived in Nockamixon Township around 1735. The Germans arrived sometime prior to the American Revolution. Historic accounts note how Native American culture was quickly replaced by European culture in the region. In 1742, Nockamixon Township was formed by petition and included a 17, 000 acre territory. This acreage diminished in 1890 when Bridgeton Township became a separate township.

Probably the most infamous illustration of how local Europeans expanded their land base, in the Gallows Run Watershed and Bucks County region, was the *Walking Purchase* of 1737. One of many *Walking Purchase* markers is located on Route 412 (Durham Road) and Gallows Hill Road.

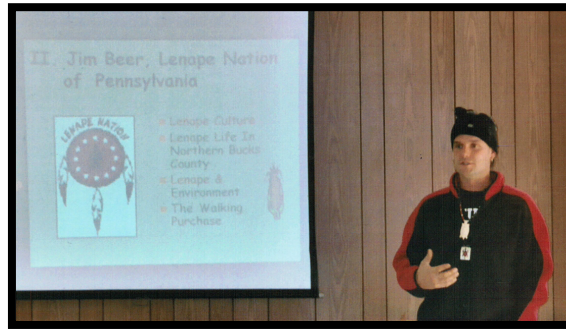
Photo 6-2
Walking Purchase Monument



Source: Forbes Environmental & Land Use Planning

By the mid 1700's, loss of land, warfare, disease, and alcohol had taken its toll on the Lenape culture. Diseases such as small pox, measles, syphilis, scarlet fever and malaria ran rampant, as natural immunities against European diseases did not exist for the Lenape. Loss of land to colonial farmers and timber cutters resulted in the westward migration of Lenape from the Delaware Valley to Ohio and Indiana, and northward to Ontario, Canada. Lenape descendents however, still reside in the region and throughout Pennsylvania and New Jersey, and the project benefited due to Lenape Nation representation on the project advisory committee.

Photo 6-3
Lenape Nation Spokesperson, Jim Beer



Source: Forbes Environmental & Land Use Planning

6.3.2 European Historic Amenities

William Penn was thirty-eight years old when he first stepped into Pennsylvania and Bucks County history. One of Penn's first tasks was to complete a survey of his land grant. He appointed his cousin William Markham to complete the task. Ever since the completion of the Penn Survey, the northern Bucks County region has been physically and economically tied to the Delaware River and the port city of Philadelphia. Eventually Lenape travel corridors became well-traveled stagecoach routes between Philadelphia and Easton (e.g., Easton Road, 611).

Natural resources such as timber, flour, agricultural products, coal/coal dust, and many other commodities have historically flowed freely between the villages located on tributaries like the Gallows Run and the Delaware River. Observable historic links to Philadelphia within the Gallows Run Watershed and surrounding region include roadways, canals, mills, bridges, and villages developed along early transportation corridors.

The following list of historic and cultural amenities in the Gallows Run Watershed was listed in Durham and Springfield, and Nockamixon Township Comprehensive and functional plans:

- **The Ferndale Inn** is located on the Nockamixon Creek at the corner of Church Hill Road and Easton (Route 611) Road. It served as a safe rest stop for travelers, and remains the historical focal point of Ferndale. The Inn dates back to the early 1800's.
- **The Delaware Canal** crosses over the Gallows Run and runs along the Lower Delaware Wild and Scenic River. Completed in 1831, the Delaware Canal has many federal and state historic distinctions, and is indicative of early industry in our region.

- **Saint Luke's Church and Cemetery** is located on Church Hill Road, in the village of Ferndale. The church was originally organized in 1752 as the Nockamixon Union church.
- **Schoolhouses** are located throughout Nockamixon Township and within the Gallows Run Watershed. Two are located in proximity to Gallows Run, and others along its tributaries. Many of the 19th century schoolhouses have been converted to quaint, private residences.
- **Stone Arch bridges** span the Gallows Run in two locations on Old Easton Road. The one pictured in the photograph below was recently renovated, illustrates colonial building techniques, and provides an historical feel highly valued by local residents.

Photo 6-4
Old Easton Road Stone Arch Bridge



Source: Forbes Environmental & Land Use Planning

- **The Village of Ferndale** still remains at the corner of Easton Road (Route 611) and Church Hill Road at the confluence of the Church Hill Road (unnamed) tributary and the Nockamixon Creek. Until 1880, Ferndale was known as *Rum Corner* in reference to a rum distillery once operating in the area. As indicated previously, the Ferndale Inn is still operating, while the wheelwright, blacksmith, creamery and shoe factories are long gone.
- **The Village of Kintnersville** is located in the Gallows Run Valley, on Gallows Run and along Easton Road (Route 611). In 1860 the Village of Kintnersville contained twenty homes, a hotel, general store, lumber mill and large flourmill. The remaining homes, antique shop, post office and commercial shops still exude a small village feel.

6.3.3 Present-Day Recreational Amenities

As noted previously, recreational amenities are valuable for a number of reasons, including their water quality buffering and groundwater recharge capabilities. The following list of recreational resources was obtained from the municipal comprehensive plans, and open space plans for the

three municipalities. The following list contains active and passive recreational amenities located within the Gallows Run Watershed:

- **The Bucks County Equestrian Park** is located on Easton Road (Route 611) on the Nockamixon Creek. The park contains three primary tributaries to the Nockamixon Creek. This 250-acre park is located entirely in the Gallows Run watershed and is augmented by approximately 18 miles of horse trail easements. The trail easements have the potential to form a linear park throughout Nockamixon Township. Equestrian events take place in certain seasons and the trails are used frequently by horse back riders and hikers.
- A portion (approximately 80 acres) of **State Gamelands #56** (just east of Center Hill Road) is located within the headwater areas to several Gallows Run (unnamed) tributaries. Land within the state holding also drains the Tinicum Creek watershed. There are hiking trails within the state gamelands and seasonal, licensed hunting is permitted.
- The **Delaware Canal State Park** was listed in the historic amenity subsection (see 6.3.2), but the towpath serves a recreational purpose as well. Approximately 2, 500 linear feet of canal towpath is located in the Gallows Run Watershed.
- **Camp Nockamixon** is a private overnight camp with a variety of recreational amenities. This 106.6 acre parcel also serves as a buffer to a large portion of the Gallows Run and at least two of its tributaries. The seasonal camp hosts children from urban areas and provides swimming, hiking, peddle boating, fishing, overnight cabins and a variety of required services for long-term visits.

6.3.4 Significant Natural Resource Amenities

The introduction to this section noted a variety of reasons for protecting entire watersheds and the significant resources within them. The Gallows Run Watershed is part of a much larger physiographic and geological region. According to the Natural Areas Inventory of Bucks County, PA, the Bucks County region is naturally diverse (Rhoads & Block, 1999). Further, Bucks County contains a variety of geologic formations, which adds to the habitat diversity of the region. Within the naturally diverse region lies the ecologically-significant Gallows Run Watershed.

The Bucks County Natural Resources Inventory lists a variety of significant natural resource features throughout the County. Ecologically significant sites were prioritized based on four levels of importance. There are four priority areas within the Gallows Run Watershed. Priority one sites (e.g., Nockamixon Cliffs) are those sites having statewide and countywide significance. Priority two sites are those sites having countywide significance, and in some cases statewide importance. Priority three sites (e.g., Buckwampum Mountain and Chestnut Hill) have local or countywide importance. To some degree, priority three sites have somewhat degraded occurrences of state-listed rare species. Priority 4 sites (e.g., Kintnersville, Gallows Run

Floodplains) have localized biological or ecological resources that are important at the local level.

- **Nockamixon Cliffs-** The Nockamixon cliffs are located along River Road (Route 32) at the confluence of the Gallows Run with the Lower Delaware Wild and Scenic River. The north facing cliff community averages 250 feet above the Delaware River. The cliffs are comprised of geologically significant Brunswick shale and they contain mixed hardwood woodlands. Other than their majestic, aesthetic value, the Nockamixon Cliffs have the following notable features: Virginia pine, Sugar maple, sedge, Rosewood sedum, and White heath aster. The site is regarded as one of the most important botanical sites in southeastern Pennsylvania. The Heritage Conservancy holds conservation easements along 24 acres of Nockamixon Cliffs as well as non-binding agreements with owners of 470 acres as part of its Natural Area Registry Program.
- **Buckwampum Mountain-** Buckwampum Mountain is located on Buckwampum Road in the Gallows Run (and Cooks Creek) headwater areas. The geology is Triassic shale and quartzite. The hilltop and forested hillsides contain seeps, wetlands and other notable features including: Red oak-mixed hardwood forest, Red maple-black gum palustrine forest, and 58 bird species including 10 rare breeders. Several parcels on Buckwampum Mountain are privately owned, while 7 parcels on the hilltop are owned by Bucks County.
- **Chestnut Hill-** Chestnut Hill is another Gallows Run (and Cooks Creek) headwater area composed of Triassic shale and quartzite. The extensive woodlands are adjacent to the Monroe Border Fault and contain the following significant features: Red oak mixed hardwood forest, and 63 bird species including 10 rare breeders. Several land owners own parcels on the site.
- **Gallows Run Floodplains (Kintnersville)-** The Gallows Run floodplain is located in the vicinity of the American Grill between Route 611 and the Delaware Canal. The floodplain is noted as it contains extensive floodplain wetlands and backwaters. Notable ecological features include: Blue joint-reed canary grass emergent wetland, Tussock sedge marsh, and Sycamore-River birch-Box-elder floodplain forest. A large portion of the lower stem of the Gallows Run (e.g., the American Grill and surrounding parcels) is therefore considered a natural resource priority area.

In addition to the four priority sites, the Gallows Run Watershed contains preserved and unpreserved open space areas. The land use portion of this plan noted that 1,907 acres of the land area within the Gallows Run Watershed are considered agricultural (See Section 4). However, only 229 acres of this land are preserved through the Bucks County Agricultural Land Preservation Program (BCALPP). The two preserved farms in the watershed include: The 81-acre Clarence and Paul Berger Farmstead (Route 412) and the 148-acre Dorothy and J. Howard Roth Farmstead (Church Road Area).

The land use information noted that approximately 2,387 acres of the watershed are forested, 341 acres are meadow, 75 acres are open space, and 17 acres are water. Only a small percentage of open space is preserved (See Section 4). For instance the Heritage Conservancy has preserved the 137.5 Rufe property (Center Hill Road). One additional parcel noted in the Nockamixon Open Space Plan as “open space” is the Bucks County owned Hidden Valley Landfill. This parcel is further evaluated in Section 7 of this plan, as it is a closed and remediated open space area. The Hidden Valley Landfill site is an 87-acre parcel located on Easton Road (Route 611).

6.4 Corridor Assessment Findings, Amenities

In addition to obtaining information on the features valued by the public, the historic, cultural and natural amenities present in the Gallows Run Watershed, and creating GIS maps showing the extent and location of watershed amenities, the project team also completed research and field work to identify environmental amenities in the river and tributary corridor areas. For this study, the river corridor was identified as land adjoining the creeks and 75 feet from each river bank. The following subsection contains research findings on the extent of riparian buffer, and other amenities found within the river and tributary corridors.

6.4.1 The Riparian Buffer Assessment Project

A riparian buffer is an area of vegetation that is maintained along a stream to stabilize its banks, filter out sediment and pollution, absorb excess nutrients, cool the waters and provide food and cover for wildlife. Before completing the corridor assessment for the Gallows Run and Gallows Run tributaries, a recent riparian buffer assessment project was consulted (Heritage Conservancy, 2003).

The Riparian Buffer Assessment Project (RBAP) was completed using a series of helicopter flights over the main stem and selected tributaries of the Gallows Run and many other creeks in the region. A videotape was used to evaluate stream corridor conditions. Next, a set of benchmarks was established by matching stills from the videotape with photos taken at ground level and the 1"=400' black and white high altitude aerial photographs for known locations. These benchmarks were used as a guide to interpret the full set of aerial photos and classify all the named tributaries in the watershed. A series of computerized Geographic Information Systems (GIS) maps and digitized photos (1":400' scale), show sections of the creek exhibiting healthy riparian buffers and those requiring additional riparian forest buffer.

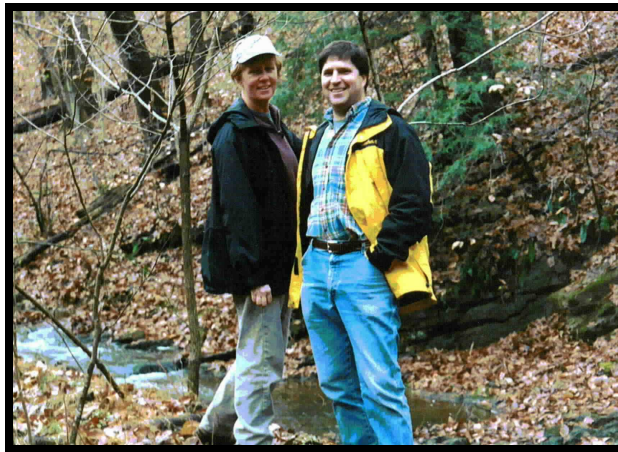
Study maps indicate that riparian buffers throughout the Gallows Run Watershed are relatively intact. However, there are some areas where riparian buffers are lacking. The most notable example is the main stem Gallows Run in vicinity of Old Easton Road and Ealer Hill Road. The RBAP maps indicate that approximately 2000 linear feet would benefit from riparian buffer plantings. The second area is located along the unnamed tributary (T-10 for fieldwork purposes) on approximately 1750 linear feet of non-buffered tributary. The third area is located along Church Hill Road. This unnamed tributary to the Nockamixon Creek (T-11 for fieldwork purposes) contains three areas, each approximately 500 linear feet, lacking adequate riparian buffer. Overall, project fieldwork for the *Gallows Run Watershed Restoration and Protection Plan* confirmed the findings of the RBAB. Recommended best management practices for the

most eroded areas lacking an adequate buffer are noted in the conservation management portion of this study (See Section 7).

6.4.2 Corridor Amenities

The next step involved completing an overview of amenities within the Gallows Run and its tributaries. This phase of the project was completed in the field, from October to December 2004. Project team members had assistance from adult and student watershed volunteers. After obtaining and analyzing research information from existing resources, the project team and community volunteers completed the river corridor field assessment phase. Open space containing undeveloped forest, mixed forest, and grassy meadow areas form a protective barrier between developed land and ground and surface water resources and the areas were documented and noted as resource amenities.

Photograph 6-5
Gallows Run Watershed, Corridor Field Assessment Volunteers



Source: Forbes Environmental & Land Use Planning

The information collected included corridor land ownership (e.g., public, private or other), land use (e.g., residential, agricultural, open space), and terrain (e.g., flat, gently rolling, or steeply sloped). If the corridor area was categorized as open space, field technicians noted whether the open space contained forests, open fields, floodplains, and/or wetlands. Field technicians also noted physical features associated with the creek itself (e.g., width, depth, flow) as well as biological/ecological features (e.g., location and extent of pools and riffles).

The amenities located in the field and within the creek corridor were mapped using the Geographic Information System (GIS). Findings are illustrated on the Amenities map (Figure 6-1). Each amenity is listed on an associated digital database and in the hard copy tables (See Appendix B).

INSERT FIGURE 6-1 AMENITY AREAS MAP

ALSO INSERT CLEAR READABLE TABLE LISTING AMENITIES

Table 6-1
Amenities Key

MAP ID	DESCRIPTION
Community Identified Amenities	
T2-CQ-A2	Conserved Put Property
T2-CQ-A1	Steams Ponds Forest
T1-CQ-A1	Wetlands
T10-CQ-A3	Conserved Put Property
T10-CQ-A1	Old Cemetery
T10-CQ-A2	Forested Land
T6-CQ-A1	Meadow
CQ-A1	Wetlands
T2-CQ-A2	Conserved Put Property
T2-CQ-A1	Steams Ponds Forest
T1-CQ-A1	Wetlands
T10-CQ-A3	Conserved Put Property
T10-CQ-A1	Old Cemetery
T10-CQ-A2	Forested Land
T6-CQ-A1	Meadow
Field Survey Located Amenities	
A-1	Lynn Island
A-2	Confluence
A-3	Delaware Canal
A-4	American Grill Property
A-5	Pond/Floodplain Behind Gristies
A-6	Kintner Road Bridge
A-7	Woodland Buffer
A-8	Woodland Buffer
A-9	Old Easton Bridge
A-10	Old Easton Farmstead
A-11	Traugers Road Farmstead
A-12	Traugers Road Home
A-13	Camp Nockamixon
A-14	Pond
A-16	Camp, residential
A-15	Camp
N-A1	Historical Ferndale Bridge
N-A2	Floodplain
N-A3	NA
T1-A1	Kintner Hill Road
T1-A2	Kintner Hill Road
T2-A1	Kintner Road
T3-A1	Open Space (woodland), residential
T3-A2	Open Space (woodland), residential
T3-A3	Open Space (woodland), residential
T4-A1	Open Space (woodland), residential
T5-A1	Open Space (woodland), residential, commercial
T5-A2	Residential, agricultural, open space (field & wetland)
T6-A1	Camp
T7-A1	Crossing Durham Road
T7-A2	Residential, open space (wetland)
T7-A3	Buckwampum
T8-A1	Commercial, agricultural, open space (field)
T8-A2	Open Space (woodland), residential, agricultural
T9-A1	Open Space (woodland), residential

Note: Complete amenities data is found on Excel table in Appendix B

7.0 Identification of Problem Areas/ Pollution Sources

7.1 Definition of Problem Areas/ Pollution Sources

In order to begin to address watershed restoration initiatives, watershed *problem areas* should be identified and assessed along with the amenities. The following section of the plan describes areas within the Gallows Run Watershed that should be restored.

Problem areas are *stressors*, situations that may cause chemical, biological or physical or habitat degradation of a watershed or hydrologic system (DeBarry, 2004). Stressors are identified disturbances or natural changes to the hydrologic or aquatic system such as increased flooding or poor water quality. Problem areas can be classified into the following major categories, although the type of problem may overlap categories:

- Flooding (regional versus local)
- Erosion (from disturbed construction sites and stream bank erosion) and sedimentation
- Water quality problems
- Pastures

Problem areas may or may not be associated with anthropogenic (man-made) disturbances to the land or hydrologic system such as an increase in impervious area or earth disturbance that contribute to the problem. Both types were recorded for the Gallows Run watershed and are discussed further below.

Flooding

The main stem of the Gallows Run and its tributaries periodically experience flooding conditions. The areas within the watershed immediately adjacent to Gallows Run and various low lying wetland areas are generally subject to minor flooding after rain or thaw conditions. Flooding in the watershed can be classified into two categories: 1) local flooding caused by inadequately sized storm culverts or roadside channels; and 2) flooding caused by the location of structures within the floodplain of the major tributaries. The Delaware River will overflow its banks during longer duration storms, whereas local flooding will occur during shorter duration storms. For instance, the Delaware River backs up the Gallows Run and causes flooding in the vicinity of “The American Grill” near Kintnersville and Route 611. In fact, the River’s backwater during the calculated 100-year flood extends for a distance of 4,570 feet upstream on Gallows Run, or to Fire Line Road. Backwater from the River has flooded the lower portion of Gallows yearly in 1901 to 1904, 1933, and 1936. From 1900 to 1955, 19 major floods occurred on the River. The largest floods on record were the 1955 flood, and the Spring, 2005 flood. Stormwater management in the Gallows Run watershed do little to elevate flooding from the River, however, stormwater management will help alleviate flooding from the shorter duration, higher frequency storms. There is no official list of flooding events in the Gallows Run watershed, however, this information (date, duration, high water marks) should be tallied to better analyze flood event recurrences. In addition, having a recording steam gage located on Gallows Run upstream of the Delaware River backwater influence would aid in quantitatively analyzing the Gallows Run hydrologic budget. This would provide useful information for base flow determination, flood events and indirectly, water quality analyses.

Ealer Hill Road has been a flooding problem due to inadequate roadside swale and driveway culvert capacity and by increased flows and volumes from development in the watershed. Flooding was reported in the Ferndale area. The flooding is caused by steep slopes allowing very little of the rainfall to infiltrate, increased development in the watershed and inadequate roadside swales and culverts. The typical solution involves performing a hydrologic study to determine pipe size and replacing the pipe with a properly-sized unit. Costs are typically borne by the owner of the road. A hydrologic/hydraulic study should be performed and appropriate solutions devised to handle the design flood flows.

Currently, Nockamixon Township is working closely with their Township Engineer and the landowners on Ealer Hill Road to address historic flooding problems. Nockamixon Township is covering the cost of the engineering, permitting, construction, and the majority of materials. The landowners are being asked to cover some materials costs.

Erosion and Sedimentation (E & S)

Erosion can be classified into 1) erosion caused from disturbing the natural vegetation during construction, 2) stream bank erosion caused by removing vegetation from the banks or, 3) man-made features (e.g., obstructions or other measures) that create a change in stream direction or stream flow. Streambank erosion is a natural process that follows the balance of energy resulting from hydrologic regime changes within a given watershed. However, *accelerated streambank erosion* is not natural and may be caused by removal of the vegetation and its root system which held the soil in place, an obstruction or other disturbance along the stream which may redirect the flow towards the streambank, or activities in the up gradient watershed which increase flows and in turn velocities causing erosion, increase in bank width and height, and loss of littoral habitat.

Sedimentation of the eroded soil material results when the velocities slow to a rate that the flows can no longer carry the soil material, and the soil particles drop out of solution and settle. Sedimentation oftentimes occurs where the slopes of the channels flatten or at bridges where the channel has been widened. Gravel deposits within stream beds can restrict waterway openings under bridges. The proposed solution typically involves performing a hydrologic study then increasing the hydraulic capacity underneath the roadway by removing gravel and sediment. Costs are typically borne by the owner of the bridge. Sedimentation of fine grain soil fills in microhabitats between cobbles and gravel in streambeds, significantly decreasing the benthic community diversity and spawning areas, often resulting in reduction or loss of fisheries.

Streambank erosion is a problem in the Gallows Run Watershed, and as more development occurs, more erosion and sedimentation can be expected. The Bucks County Conservation District is responsible for administering Title 25, Chapter 102 (Erosion Control Regulations). These regulations address accelerated erosion and the resulting sedimentation from earthmoving activities. Enforcement of erosion and sedimentation regulations, and the permanent stabilization of exposed areas and proper stabilization of channels of conveyance will reduce erosion problems.

Water Quality Problems

The Hidden Valley Landfill has also been found to be contributing pollutants to the Nockamixon Branch of the Gallows Run. The Palisades High School wastewater treatment also contributes contaminants to the Nockamixon Branch. Although pollution levels are lower than in the past, they could still cause a stress on aquatic organisms. These are discussed in more detail later in this section of the plan (See Section 7.5.4).

Pastures

Pastures have been placed in their own category since they contribute to erosion, sedimentation, flooding and water quality problems identified above. There are a number of horse and cow pastures in the Gallows Run Watershed. The typical pasture encountered ran right up to the stream banks that are devoid of vegetation. This has two effects, the root structure, which prevents stream bank erosion, is missing, and the stormwater runoff from the pasture is quickly transported to the stream. The compaction of the soil from horses or cows prevents rain water infiltration and increases runoff which in turn can increase localized and downstream flooding. The sediment in the stormwater carries with it silt, nutrients, pathogens and bacteria, all pollutants commonly associated with eroding and compacted pastures.

7.2 The Importance of Clean Water

Clean water is perhaps the most pressing environmental and cultural issue facing humans today. Less than one tenth of one percent of water on the planet is considered suitable and accessible for drinking. Maintaining clean water for drinking, swimming, boating, aquatic life, and industry is imperative to sustain the quality of all life. Our water resources are holistically connected through the hydrologic budget. The hydrologic budget can be defined as:

$$P = RO + Re + ET + S \quad \text{Where:}$$

P = Precipitation

RO = Surface Runoff

Re = Recharge

ET = Evapotranspiration

S = Storage

Precipitation includes rain, snow, sleet and hail. Surface runoff is the portion of the rainwater that hits the ground, and then flows overland to the streams. Recharge is that portion of rainfall that infiltrates in the soil and eventually reaches the groundwater table. This water flows through the subsurface system and either contributes to the aquifer or replenishes the stream base flow. Evapotranspiration is evaporation from respiration of plants. Storage is temporary storage of water in aquifers, streams and reservoirs. This water eventually comes out of storage and exits the system via ground or surface water flow. As can be seen by the descriptions above, the entire hydrologic system is interconnected, therefore if one portion of the hydrologic system is affected, whether water quality or water quantity, it affects the other components. It is therefore imperative to maintain, improve, or restore our water resources.

7.3 Public Input Regarding Problem Areas

Information on drainage problems and proposed solutions was solicited from each citizen within the Gallows Run watershed by providing questionnaires to each watershed group member, and citizens in the watershed early in the study. In addition, trained watershed association members, students and citizens performed a field survey. This data was recorded on forms and placed into the GIS. Problem areas were also discussed and commented upon at advisory committee, watershed association, and public meetings (See Appendix B).

7.4 Corridor Assessment Findings, Problem Areas

Association partners, volunteers and the consultants obtained, reviewed, and quickly applied existing land use, zoning, water quality, water quantity, nonpoint source pollution, and other related information (policy & data) to this unique sub watershed.

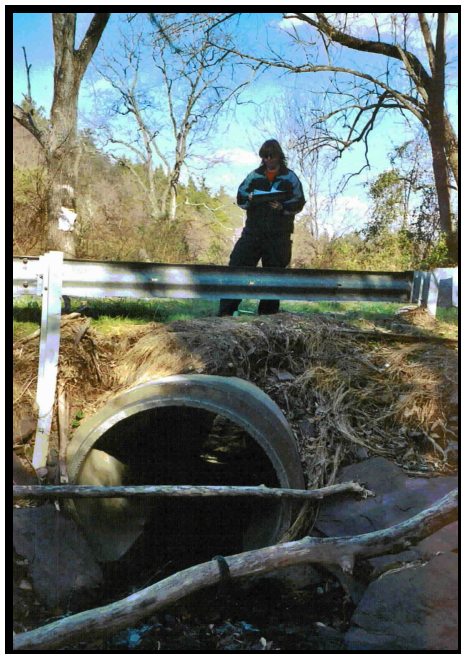
With regard to the field assessment, Forbes and Borton-Lawson were hired to train volunteers to identify those areas in need of restoration and additional protection. Volunteers toured the watershed with the consultants. Volunteers did not begin the field assessment until they fully understood the information to be obtained. The GRWA worked with PADEP and other local agencies to create a standardized field assessment form. Since a good number of volunteers were high school and middle school students and teachers from Central Bucks and Palisades School Districts, two field assessment workshops were provided for students and one workshop for students and adults. Therefore, the volunteers were asked to attend three workshops.

Once the volunteers were adequately trained, they began completing the restoration and protection field assessment. The focus of the assessment was to identify nonpoint source pollution problem areas. The location of nonpoint source problem areas as well as amenities protecting the water resources from nonpoint source pollution were recorded. Volunteers collected stream geomorphologic information, and mapped the location of problem areas (e.g., excessive stormwater runoff, flooding problems, excessive erosion) and amenities. All information collected in the field assessment was placed on existing geographic information system (GIS) maps provided by the previously identified partners (See Figure 7-3).

The problem area map depicts the location of problem areas relative to the surface water in the watershed. The problem areas identified through the community survey are shown on the map using a dark cranberry colored triangle while the problems identified through consultant-led observations are shown using filled, cranberry colored circles. The location of the Hidden Valley Landfill is also shown on the map.

In numerous locations more than one type of problem was identified. A graduated symbol was used on the map to show where multiple problems are present. A small symbol indicates a single problem in an area while larger symbols indicate multiple problems in an area. The size of the symbol is proportional to the number of problems identified for the particular area. The USGS topographic map is used as a base for the problem areas map.

Photograph 7-1
Problem Area Field Assessment



Source: Forbes Environmental & Land Use Planning

INSERT Figure 7-1 PROBLEM AREAS MAP

PLEASE ALSO INSERT READABLE TABLE LISTING PROBLEM AREAS

**Table 7-1
Problem Areas Key**

MAP ID	DESCRIPTION
Community Identified Problem Areas	
CQ-P1	Flooding
N-CQ-P1	Ferndale Flooding
N-CQ-P2	Erosion on Center Hill Tributary
N-CQ-P7	Cabot Site
T2-CQ-P1	Forest Harvesting too close to stream
T2-CQ-P2	Malfunctioning Basin/ Water Quality
N-CQ-P4	Erosion, Lack of Buffer
N-CQ-P4	Public Septic (?)
N-CQ-P3	Fairhill Road Flooding
T11-CQ-P1	Well Running Dry
N-CQ-P6	Vets Field Flooding
CQ-P1	Flooding
N-CQ-P1	Ferndale Flooding
N-CQ-P2	Erosion on Center Hill Tributary
Field Survey Located Problem Areas	
P-1	Stormwater Outfall-4'
P-2	Stormwater Outfall-2'
P-3	Obstruction/ Invasives
P-4	Streambank Stabilization Efforts
P-5	611/32 Bridge
P-6	Riverbend Furniture
P-7	Route 611 Erosion
P-8	Old Easton Road Bridge
P-9	Ealer Hill Road Flooding
P-10	Old Easton Road Bridge
P-11	Trauger's Road Crossing
P-12	Trauger Family Rd Property
P-13	Camp Nockamixon
P-14	Lack of vegetation buffer
P-15	Storm water control
P-16	Horses
P-17	Cows
N-P1	Pumping Station
N-P2	Home
N-P3	Old Easton, Church Hill Road
N-P4	Swamps, auto use
N-P5	Driveway Crossing
T1-P1	Kintner crossing
T1-P2	Outfall
T1-P3	Accelerated erosion
T1-P4	Porch
T2-P1	Horse Pasture
T2-P3	Runoff from tributary, sedimentation Kintner Ridge
T2-P2	Erosion at bridge, close to road
T3-P1	Two culverts on either side
T3-P2	2 culverts on both sides of stream, backup of water
T3-P3	Rechanneled stream
T3-P4	Deepest gully in streambed
T3-P5	Ealer Hill Road Flooding
T4-P1	Bridge under 611
T6-P1	Erosion at confluence
T6-P2	Undersized pipe
T6-P3	Roadway crossing and large underground pipe

MAP ID	DESCRIPTION
T7-P1	Privy
T7-P2	Bank eroding with pooling
T7-P3	Use by ATUS (in H2O possibly)
T8-P1	Animals close to stream
T9-P1	Farm on hill, tilled right up to stream
T10-P1	Steep bank and slope
T10-P2	Erosion/ trib course
T10-P3	Natural erosion
T10-P4	Metal dumped in around tributary, limited buffer on right
T10-P5	Buffer compromised, debris carried downstream from site
T10-P6	Pooling below bridge
T10-P7	Natural erosion
T11-P1	Church Hill Road along Trib 11
T11-P2	#521 and #515 Church Road
T11-P3	Nockamixon road
T11-P4	No buffer
T11-P5	Groundwater, water pollution
T11-P6	Accelerated erosion, sedimentation, water pollution
T12-P1	Horse Park

Note: Complete problem areas data is found on Excel table in Appendix B

7.5 Research Findings, Problem Areas

7.5.1 Measurement and Attainment of Groundwater Quantity and Quality

Based upon data collected by the Bridgeton-Nockamixon-Tinicum Groundwater Management Committee within the Gallows Run watershed, the groundwater supply within the watershed appears locally sufficient to meet current needs, although highly susceptible to over-exploitation. Two of the wells monitored by the study are located within the Gallows Run watershed and several of the monitored wells are located around the perimeter of the watershed boundary. The groundwater table, and its response, varies throughout the watershed. In addition to precipitation events, the groundwater table is also subject to withdrawal. Monitoring of the water table in the northern and western portions of the watershed suggest that the water table is immediately impacted by groundwater extraction from wells in these areas. This observation suggests that either there is a limited amount of water in the aquifer or (more likely) that the transmissivity of the geological formation is low. In either case, this makes the aquifer highly sensitive to excess withdrawal. On the other hand, the groundwater table as measured in monitored wells within the south and eastern portions is not significantly impacted by extraction from wells in this area. This suggests that there is either a relatively large amount of water in this aquifer, or that the transmissivity is significantly greater than the northern aquifer. This aquifer is much less sensitive to withdrawal. It is important to note that this type of study does NOT allow us to draw conclusions regarding the development potential of either aquifer, nor does it provide insight into the groundwater-surface water connectivity.

There have been reports of drinking water testing for suspected well contamination on Kintner Road (by Countryside Road), Fireline/Lehnenberg Road, Route 202, and Chestnut Hill. Understandably, there is a hesitancy to release any additional information on specific problem areas for fear of a decrease in property value. The Bucks County Health Department, logs in bacteriological sampling information but does not provide findings to the general public. A

potential source of contamination of these wells may be malfunctioning septic systems. There have been anecdotal reports of malfunctioning septic systems in the Ferndale area, however formal confirmation was not received from the Bucks County Department of Health. The Townships should update their Act 537 Plans and catalogue malfunctioning septic systems so that they can be repaired.

Figure 7-1 shows the status of Act 537 Plans by Township in the Gallows Run watershed and surrounds. Act 537 Plans are official sewage plans that municipalities must prepare. These plans look at a survey of failing septic systems and plans for the future of wastewater disposal in the Township. A potential criteria for waste disposal options is their groundwater recharge potential and the export of water from the watershed. These options need to be reviewed and reprioritized when the Act 537 plans are updated. According to Figure 7-3, Nockamixon and Durham Township's plans are over 20 years old and should be updated. In addition, Springfield Township's plan is at least 5 years old. In the interim, the Watershed Association should make people aware of proper maintenance of septic systems and how to spot malfunctions.

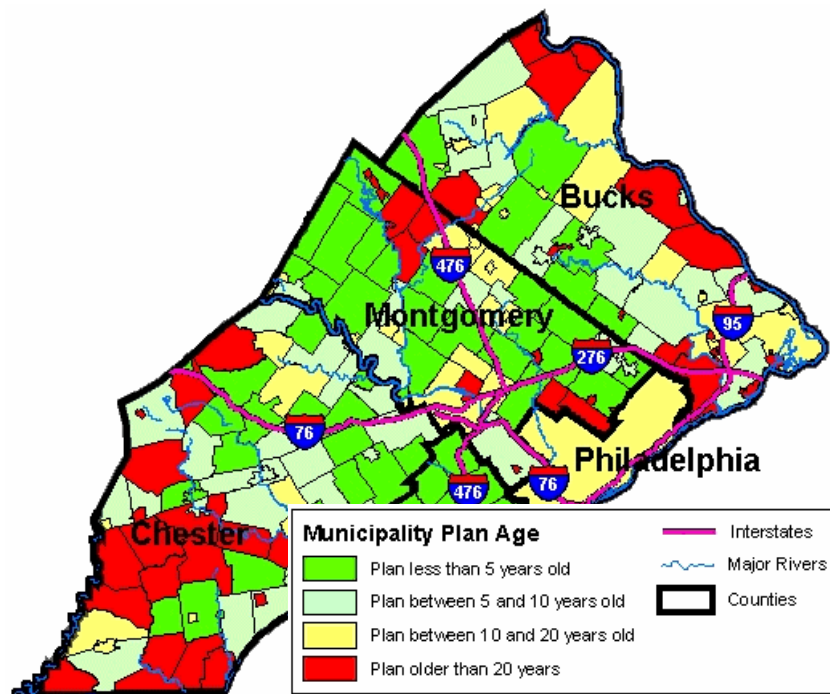


Figure 7-2 – Status of Act 537 Plans in Buck County

7.5.2 Measurement and Attainment of Surface Water Quality

The water quality of the Nockamixon Branch of the Gallows Run and downstream section of the Gallows Run, below the confluence of the Nockamixon Creek, were seriously impaired several decades ago from leachate discharged into the stream from the Hidden Valley landfill site. Hidden Valley Landfill site is located on Route 611, next to the Bucks County Horse Park and across from Laurel Hill Road. There are still concrete lagoons (former treatment system along with spray irrigation) and buildings on the site. It was operational until the late 1970's. The facility was purchased by Bucks County and a leachate collection system was installed to treat

leachate from the landfill. Five treatment wells were in place after closure due to evidence of surface leachate at the backside of the landfill. Levels of leachate were and continue to be low. The Bucks County Department of Health still monitors the discharge once per year.

The Palisades high school wastewater treatment plant is a secondary treatment facility with a 21,500 gal/day maximum design flow rate. The discharge is located on the Nockamixon Branch at Ferndale. The average flow rate for the facility is 17,000 gal/day. Secondary treatment design includes 1) grinder, 2) equalization tank, 3) large aeration compartment, 4) 2 holding tanks, 5) 2 section clarifier, 6) chlorine contact, and 7) discharge to Nockamixon Creek. The equalization tank added on in the 1980's to handle increased student population.

The existing permit expires in July 05; therefore a renewal application should be in process (PADEP) at the present time. Nutrient requirements includes:

- Ammonia as nitrate requirements (winter: 13 mg/l and max of 26 mg/l & summer: 20 mg/l and max of 40 mg/l).
- Mass loading limits or Ammonia as Nitrogen limit requirements (winter 3.6 lbs/day & summer 2.3 lbs/day).

Two recent notice of violations (NOVs) included 1) violations for submitting discharge monitoring reports late and 2) high ammonia levels during June, July and September 2004 as follows:

- June/July/September monthly average concentration limits exceeded.
- June/July/September monthly mass loading limits exceeded.
- Minor fecal limit average in July exceeded (minor exceedences).

The September exceedences were most likely due to flooding (Hurricane Ivan). The June & July exceedences were most likely due to operational problems. The facility has remained in compliance since then.

Several water quality assessments completed since the closure of the Hidden Valley Landfill system suggest a significant improvement in the water quality of the Gallows Run. The most recent assessment of the surface water quality of the Gallows Run is based upon 2001 biological data collected by the Pennsylvania Department of Environmental Protection for its Surface Water Assessment Program. As part of this program the state assessed the water quality of the Gallows Run at six evaluation points dispersed throughout the watershed as shown in Figure 7-2. The first station assessed is located near the mouth of the Gallows Run. The next station is situated within the first upstream unnamed tributary flowing into the Gallows Run from the south. Two additional stations the assessment examined were located in the Nockamixon Creek and two others upstream within the Gallows Run main stem above the confluence of the Nockamixon Creek.

INSERT Figure 7-3 PADEP SAMPLING LOCATION - BIOLOGICAL

The investigation found stoneflies at every location and an abundance of mayflies and caddisflies at all stations except for the two study points located within the Nockamixon Creek. Typically these species are indicators of good water quality within the watershed as they are relatively intolerant to pollution and rapidly respond to the presence or absence of pollution. The absence of mayflies and caddisflies, or a slightly less diverse biotic community within the Nockamixon Creek, suggests that water quality in the Nockamixon Creek may be slightly reduced or the habitat slightly less desirable than the rest of the watershed.

The aforementioned analysis is underscored by the biotic index ratings included in the 2001 surface water assessment. These ratings included in the assessment are based upon the Hilsenhoff Biotic Index (HBI). Generally the HBI is the measure of the sensitivity of organisms to existing water quality. Organisms are assigned values depending on their tolerance to organic compounds. The less tolerant an organism is to water quality impairments, the lower the Hilsenhoff value. HBI is calculated by multiplying the tolerance value by the percentage of individuals in the community. This yields an HBI value of between 0 and 10 which correlates to the degree of impairment of the water. Table 7.1 lists the typical correlation between HBI and water impairment (Reif, 2002a).

Table 7-2 Hilsenhoff Biotic Index

HILSENHOFF BIOTIC INDEX	
Value	Water Impairment
0-4.5	None
4.51-6.0	Slightly
6.51-8.5	Moderately
8.51-10.0	Severely

Generally speaking the presence of a diverse ecosystem of organisms with a lower tolerance to organic pollutants will result in a higher HBI and a high water quality. Conversely, the absence of diversity and/or presence of organisms with a high tolerance to pollutants produces a higher HBI which is indicative of lower water quality.

A very cursory biotic assessment was completed during the course of this study by others. Within the Gallows Run watershed all of the stations investigated contained four or more families with an HBI of 3 or less and six or more families with an HBI of 4 or less. Only those stations within the Gallows Run, both above and below the confluence with the Nockamixon Creek, contained a dominant family with a Hilsenhoff rating of 4 or less. The others sites contained a dominant family with a Hilsenhoff rating of greater than 5. All stations examined, except for the uppermost station in the Nockamixon Creek near the former Hidden Valley Land Fill site, contained biotic communities dominated by families with a HBI of 5 or less, providing another indicator of good water quality within the watershed.

The HBI analysis was performed independently of this assessment. In the future, biological assessments should be coordinated with habitat and fisheries studies and several biological indices such as the EPA Rapid Bioassessment Protocol (RBP) and Brillouin's Diversity Index (BDI) obtained to compare results with the HBI.

Thus, both the diversity and species of organisms found within the Gallows Run Watershed are indicative of the generally good quality of its surface water. The data appear to further indicate that although the water quality is good throughout the watershed, the water quality in the Nockamixon Creek is of slightly lesser quality than that of the rest of the watershed. Within Nockamixon Creek itself, the lower reaches are of somewhat better quality than the upper Pollutant Loading Estimate.

7.5.3 Pollutant Loading Estimate

Pollution entering our streams comes from point (pipe) sources and nonpoint (stormwater runoff/atmospheric) sources. The National Pollution Discharge and Elimination System (NPDES) Phase I program established under the Federal Clean Water Act targeted point sources of pollution and had a big effect on cleaning up these sources of pollution (industry, sewage treatment plants, etc.) However, on the average, eighty percent of the current pollution to our Nation's waterways comes from stormwater runoff. Pollutants accumulate on impervious surfaces from atmospheric deposition, land use, automobile exhausts, etc. In addition, agricultural and land development practices expose the soil to washoff. Typical nonpoint source pollutants include nitrogen, phosphorus, fecal coliform, hydrocarbons, and by far the biggest pollutant, sediment (suspended solids). These pollutants get washed off the various land surfaces and enter the waterways via stormwater runoff. The more impervious surface an area has, generally, the more pollutants associated with it. This amount of pollutant that is washed off from the various land surfaces is called the pollutant load. This pollutant load can be determined through nonpoint source pollution assessments.

The ultimate goal of nonpoint source (NPS) pollution assessment is the identification of critical loadings so that best management practices (BMPs) can be incorporated into stormwater controls in those areas where it is critical to reduce NPS loads. This is particularly important where streams and reservoirs in watersheds serve as municipal water supplies, and to meet the more stringent requirements for drinking water supplies imposed by the 1986 Federal Safe Drinking Water Act. In addition, if streams within the watershed are classified as "high quality waters" or "exceptional value waters," it is best to determine where pollutants are originating in order to properly manage land use and resultant pollutant loads from NPS runoff. Uncontrolled future development within the watershed could jeopardize water supplies, impoundment quality, and coldwater fisheries.

NPS pollutant loadings can readily be calculated by categorizing the watershed by land use, and multiplying the total land area for each classification by typical NPS pollutant loadings shown in Table 7-3.

Table 7-3. Nonpoint Source Pollution Loads for Watersheds in Eastern Pennsylvania (DeBarry, 2004).

NONPOINT SOURCE POLLUTION LOADING FACTORS

LAND USE	TOTAL - NITROGEN (LBS/AC/YR)				TOTAL - PHOSPHORUS (LBS/AC/YR)			
	HYDROLOGIC SOIL GROUP				HYDROLOGIC SOIL GROUP			
	A	B	C	D	A	B	C	D
Open Space	0.60	0.60	0.60	0.60	0.08	0.08	0.08	0.08
Meadow	0.06	0.60	0.60	0.60	0.08	0.08	0.08	0.08
Newly Graded	---	---	---	---	3.10	4.70	5.60	6.60
Forest	0.60	0.60	0.60	0.60	0.08	0.08	0.08	0.08
Commercial	13.20	13.20	13.20	13.20	1.60	1.60	1.60	1.60
Industrial	11.20	11.30	11.20	11.00	1.30	1.35	1.35	1.30
Residential								
1/8 ac or less	11.70	12.90	13.20	12.00	1.60	1.60	1.70	1.75
1/4 - 1/3 ac	7.90	8.80	8.80	8.60	0.90	1.10	1.10	1.10
1/2 - 1 ac	6.40	7.35	7.30	7.20	0.70	0.90	0.95	0.95
2 - 4 ac	3.30	3.80	3.55	3.55	0.24	0.33	0.33	0.33
Smooth Surface	11.60	11.60	11.60	11.60	2.00	2.00	2.00	2.00

LAND USE	TSS (LBS/AC/YR)	BOD (LBS/AC/YR)	FECAL COLIFORMS (MPN/AC/YR)
Open Space	3	2.1	14.22
Meadow	3	2.1	0.07
Newly Graded	59,600	40	100
Forest	140	2.1	0.07
Commercial	754	33.9	0.82
Industrial	1504	29	2.64
Residential			
1/8 ac or less	952	24.6	32.9
1/4 - 1/3 ac	900	15.1	20
1/2 - 1 ac	851	11.4	1.65
2 - 4 ac	800	7.7	1.0
Smooth Surface	400	39.2	40.0

Forest as described above includes unharvested, undeveloped woodlands typical of the Gallows Run watershed. Table 7-4 itemizes the annual non-point source pollutant loading originating from within the Gallows Run watershed. BOD is not a pollutant, in particular, but is an indicator of the amount of organic material (chemicals or organic matter) being washed into the waterways. This pollutant loading is produced by normal everyday activities associated with the

various land uses/classes within the watershed and is not attributable to a single discrete source. The aggregate sum of this non-point source pollution upon the Gallows Run and subsequent downstream watercourses such as the Delaware River is substantial. Even though approximately 75% of the watershed is undeveloped (either agriculture or wooded), a significant amount of non-point source pollution is created from these two land use classifications. Conversely, although the amount of paved area within the watershed is relatively small, approximately 1.4% of the watershed, the impact of the runoff from this relatively small area is significant. Therefore it is essential that land use practices within the Gallows Run Watershed be managed efficiently to minimize the amount of non-point source pollution entering the watercourse.

Table 7-4 – Summary of Annual Pollutant Loads by Land Use in the Gallows Run, determined by the Mass Balance Approach.

Annual Pollutant Loading Estimate						
Land Cover / Land Class	Area (acres)	Total Suspended Solids (lbs.)	Biochemical Oxygen Demand (lbs.)	Nitrogen (lbs.)	Phosphorous (lbs.)	Fecal Coliforms (MPN*)
Agriculture	1894.56	112,915,480	75,782	n/a	9,473	189,456
Commercial	44.71	33,711	1,516	590	72	37
Farmstead	11.77	9,415	91	42	4	12
Forest	2387.16	334,203	5,013	1,432	191	167
Industrial	19.96	30,017	579	224	27	53
Institutional	23.35	17,606	792	308	37	19
Meadow	341.16	1,023	716	205	27	24
Open Space	75.41	226	158	45	6	1,072
Paved	79.57	31,828	3,119	923	159	3,183
Residential (1-4 acre)	765.88	612,702	5,897	2,719	253	766
Residential (1/3 -1 acre)	19.23	16,362	219	136	18	32
Water	16.52	0	0	0	0	0
Total	5679.28	114,002,574	93,882	6,624	10,267	194,820

n/a=not available

* = Most Probable Number

These results are preliminary and show relative areas of concern, however, this is essentially the same process that DEP utilizes to establish TMDL's for the watershed. A balance of the water quality parameters with the nonpoint source pollution loadings would establish if and where nonpoint source pollution controls are required to maintain the designated water quality use. This analysis is beyond the scope of this assessment, but could be pursued if the Association wants to establish the creeks as trout waters. As can be seen from Table 7-3, suspended solids (sediment) from agriculture is the biggest concern. This would include the pasture areas. Phosphorus attaches itself to soil particles, therefore where there are high suspended solids, the phosphorus concentration is also high. Another source of the sediment would be streambank erosion, which is the reason for the restoration recommendations in this report.

Water quality in the watershed is generally good and currently is not an impediment to is designated use. The diversity of fish and other aquatic organisms indicate good water quality. These analyses are taken during low or normal flow. However, as with all watersheds, existing problem areas and development pressures can quickly change this scenario if a watershed protection plan is put into place. However, there are inadequate samples taken during storm events making it difficult to determine the extent of sediment loading. Samples of suspended sediment during storm events should be conducted above and below the highly eroded sites to establish streambank loadings. A detailed watershed wide water quality monitoring plan is not recommended at this time. However, monitoring water quality in problem areas prior, during and following restoration or implementation of management options is recommended to track the influence these solutions have on water quality

7.5.4 Categorization and Prioritization of Problem Areas

As indicated below, various problems identified in the watershed are contributing to flooding or water quality problems. To maintain good water quality, these problems should be corrected. Correcting problem areas in headwater tributaries has potential benefits for the whole Gallows Run Watershed and, eventually, on the entire Delaware River Watershed. Due to funding program structure the watershed “system” must be managed/restored by correcting/restoring individual problems as funds become available. Therefore, this report establishes a systematic approach to restoring the watershed through a series of prioritized problem area correction measures.

As discussed previously, problem areas are stressors, and are classified into four categories (e.g., flooding, erosion, water quality problems and pastures). Each of the four problems was encountered somewhere in the Gallows Run Watershed. Each problem area identified was evaluated against seven categories or criteria for the possibility for retrofitting. Retrofitting involves modifying an existing condition to improve the quality of stormwater runoff through such means as adding a forebay, diversions, wetlands planting, etc. The criteria with the highest priority are listed first. The sites with the highest priority for restoration or retrofit measures are shown in Figure 7-4.

Criteria & Prioritization

- **Water Quality Benefits** – Areas receiving water pollution from up-gradient sites were categorized as high priority. Priority was also given to areas where reported water quality problems were presented, or could be prevented.
- **Benefit / Cost Ratio** – Those sites with the highest benefit / cost ratio, or *biggest bang for the buck* were categorized as high priority.
- **Flooding / Safety** – Flooding is a safety issue and also results in significant economic impact. Areas with historic flooding problems were therefore categorized as high priority. Safety is also a factor where erosion is taking place along frequently-traveled roadways. These areas were also categorized as a high priority.

- **Ratio of Catchment Area Draining to a Pond (PCDA): Total Catchment Drainage Area (CDA)** – The PCDA is the area upgradient of the BMP that actually flows into the BMP whereas the CDA is the total area of the land development, some of which may not enter or bypass the BMP. The more the BMP captures, the more beneficial it can be at removing pollutants. The Ponds with a high PCDA: CDA ratio were considered high priority compared with those with a lower ratio. This is because stormwater ponds that treat a higher percentage of the total catchment drainage area (CDA) are considered to have greater potential for protecting/restoring downstream erosion and water quality problems. Problem areas with high PCDA: CDA ratios were therefore categorized as priority areas.
- **Stream order** – A stormwater pond that drains to a smaller (lower order) receiving stream was considered a higher priority than a pond discharging to a larger (higher order) receiving stream. This is because low order streams are generally more sensitive to a change in the flow regime. Stormwater ponds draining to lower order streams were categorized as a priority.
- **Ownership** –Generally, implementation projects on public properties are easier to coordinate and provide a broader public benefit. However, in some cases property owners expressed a willingness to participate in future efforts. Higher priorities were provided in these instances.
- **Ease of Access, Ease of implementation, Educational Impact** – Areas were given priority if the parcel was easy to access or easy to implement. This is because access restrictions drive up costs. Priority was given to sites that are highly visible from major roadways or not obstructed by trees. Highly visible areas provide an educational opportunity and encourage broader participation.

Tiering & Prioritization

Subsequent evaluation focused on the feasibility of restoring or retrofitting each problem area including the ability to expand storage volume, affects from adjacent land uses, safety, access, etc. Each prioritized site was then also classified into three tiers based upon the magnitude of the problem and the greatest impact restoration or management measures would have on water quality and/or flooding. The three tiers are discussed below:

- **Tier 1 (Highest Magnitude and Most Benefit/Cost):** Sites that were classified into Tier 1 were those that would have the largest environmental benefit for the least amount of money/effort. In other words, they would have the highest benefit /cost ratio as far as water quality improvement and/or flood prevention is concerned.
- **Tier 2 (Moderate Magnitude and Moderate Benefit/Cost):** The next tier of projects would still have significant water quality improvement, however, would not have as high a potential as Tier 1 and/or have a lower benefit / cost ratio.

- **Tier 3 (Lower magnitude and Lower benefit/cost):** Projects on this tier have the lowest cost/benefit ratio, would be difficult to implement, or have a low probability of significant improvement to water quality. In other words, restoration of these areas are relatively expensive for the benefit they provide. These projects should still be viewed as high priority problems.

Streambank erosion projects were further classified into three tiers. The magnitude of restoration depends upon magnitude of the problem and the up gradient watershed conditions (e.g., existing development, potential development, land use and pollutants associated with land use). The three erosion tiers are described below:

- **Tier 1 (Highest Magnitude and Most Benefit/Cost):** The erosion problem area with the highest magnitude would require stream realignment or a structural engineering solution (e.g., embankment regrading, rip-rap, gabions, weirs) or a combination of engineering solutions.
- **Tier 2 (Moderate Magnitude and Moderate Benefit/Cost):** The next order of magnitude would be eroded areas where damage is repairable using natural stream channel techniques (e.g., log revetments, log plantings).
- **Tier 3 (Lower Magnitude and Lower Benefit/Cost):** Tier 3 erosion areas are those that are least expensive to restore. Restoration of these areas might include buffer reestablishment to stabilize eroded banks. This approach is only successful where stormwater management regulations designed to address smaller storms are in place.

7.5.5 Individual Problem Areas

The problem area information collected during the field assessment were screened by the consultants and narrowed down to approximately two dozen sites. The consultants returned to the field to prioritize the sites and to establish a “short list” of the highest priority problem areas. Each site was subject to the seven criteria and then categorized into one of three (3) tiers. A number of sites involved streambank erosion. Each site is described below along with the magnitude classification of repairs it may require. All sites are illustrated on the Problem Area Map (See Figure 7-4), with photographs (Source: Borton-Lawson Engineers) and further summarized in the following subsections:

Tier 1 Problem Areas

Photograph 7-2

Route 611 (Easton Road) Problem Area



Problem: Erosion from a site such as this can lead to water quality degradation, not only immediately downstream of the site, but continually downstream and into the Delaware Bay. The larger particles settle first, but the smaller particles can be carried miles away. The sediment from an eroded streambank contributes phosphorus, deposits under bridges reducing their hydraulic capacity, smothers fish eggs, etc., a compounding effect. There is severe streambank erosion on Gallows Run adjacent to Route 611 (Easton Road). Route 611 is a State-owned and maintained

road. Erosion is extensive and has migrated to the guide rail and roadway shoulder. Sedimentation is obvious and extensive and the area is also a safety concern. The project team noted that it is only a matter of time before portions of the road get washed away and this roadway will need to be closed for repairs.

Recommended Solutions: Engineered and structural streambank stabilization (e.g., rip-rap, gabions, deflectors) combined with natural stream channel design in the transition zones (See Figure 7-4, Point P-7). Working with the Pennsylvania Department of Transportation on moving the stream away from the road, using natural stream channel design methods is also recommended.

Photograph 7-3

Ealer Hill Road Problem Area



Problem: Ealer Hill Road has a history of flooding caused by localized development and construction of a road and residences in a natural drainage pattern. Problems like this can exacerbate downstream problems as shown in Figure 7-5. Nockamixon Township is currently implementing a solution. The Township engineer is increasing pipe and roadside swale capacities to better channel the water.

Additional Solution: Regional stormwater detention and treatment basin(s) on Upper Ealer Hill Road are recommended as well as vegetative buffer plantings. The location of the potential regional basins is shown in Figure 7-5. A Growing Greener Program grant application was submitted in spring 2005 for the feasibility of the basin on Ealer Hill Road. The Act 537 sewage plan should be updated. (See Figure 7-4 Site

T3-P5)

Photograph 7-4
Camp Nockamixon Problem Area



Problem: There is severe streambank erosion at the confluence of Gallows Run with Tributary 6. Recent storms have exacerbated the problem causing severe damage. The stream bank is now serving as a berm for the pond, and the potential for failure exists. Safety is therefore an issue as well.

Solution: The berm should be inspected by a registered professional engineer. A streambank restoration plan should be submitted to PADEP for the next fiscal year round of Growing Greener funds to restore this stretch of stream. Lengths include approximately 500 feet downstream of the

confluence and 500 feet upstream of the confluence (See Figure 7-4, Site P-13).

Photograph 7- 5
Farm on Gallows Hill Road



Problems: Several agricultural pastures were identified as problem areas and grouped into one category. Erosion, lack of stream buffer and potential water quality problems are noted.

Solutions: Fence off a minimum 20-foot buffer surrounding the streams. Replant buffers with native plant species. One animal water source location should be provided in a non-erosive area. Prevent pollutant-laden runoff from entering the channels with a stormwater bioretention area. (See Figure 7-4, Sites T2-P1, P14, P15, P17)

Photograph 7-6
Traugers Road Problem Area



Problem: Approximately 100 linear feet of streambank erosion along Nockamixon Creek.

Solution: The 1% gradual slope allows for riparian buffer plantings for approximately 300 linear feet. This would stabilize transition slopes. Inexpensive plantings (protected with deer fencing) within the buffer should suffice rather than expensive restoration measures. Results should be monitored over the years and stabilization documented. (See Figure 7-4, Site P-12).

Tier 2 Problem Areas

Photograph 7-7
Lower Gallows Run Problem Area



Problem: There are streambank erosion problems upstream and downstream of Route 611. Erodible soils, sharp bends, heavy rains and man-made obstructions have caused natural and accelerated erosion.

Solution: Install upstream management measures to reduce flows and bedload. Work with the current landowner to replace temporary solutions with streambank restoration measures that will last. (See Figure 7-4, Site P-4- P-6)

Photograph 7-8
Kintner Hill Road Problem Areas



Problem: Moderate streambank erosion (approximately 50 linear feet) along Kintner Hill Road. The landowner has constructed a porch enclosure over the stream, therefore eroded sediment eventually deposits elsewhere in the channel and driveway and roadway problems are evident.

Solution: Since the erosion is minor and the slope is steep, rip-rap placed on the eroding areas would work here. (See Figure 7-4, Sites T1-P3 and T1-P4)

Photograph 7-9
Church Hill Road Problem Areas



Problem: Church Hill Road (Tributary 11) has several streambank erosion problem areas that are particularly evident at driveway crossings.

Solution: Due to the gradient of the stream (approximately 3 percent) natural stream channel restoration measures would work on the eroded areas. (See Figure 7-4, Sites T-11-P3 and T-11-P6)

Tier 3 Problem Areas

It should be noted that even the Tier 3 problems should be corrected, and are more important than the ones not in the priority list, however, their benefit/cost is lower than the previous two tiers.

- **Easton Road-**

Problem: The field surveys indicated an accumulation of litter and commercial waste behind Swamp's Auto garage. Although not directly related to water pollution, the potential exists for runoff and seepage to contribute pollutants to the stream.

Solution: If possible, determine what debris and commercial waste might need to be removed from the site. Such cases would include containers or tanks that contain fluids such as gas, oil, hydraulic fluids and anti-freeze. (See Figure 7-4, Site N-P4)

- **Village of Ferndale-**

Problem: Based upon the surveys and input during meetings, there are localized stormwater and flooding problems in the Village of Ferndale as a result of historical land development patterns and inadequately sized roadside swales and culverts. Some concern has also been expressed about the possibility of failing, on-lot septic systems.

Solutions: Structural solutions including widening of roadside channels, replacement of undersized culverts. Unfortunately, the topography and location of the existing roadways precludes the installation of a regional stormwater management facility (See Figure 7-4, Site Ferndale). The Act 537 sewage plan should be updated.

INSERT Figure 7-4 PRIORITY AREAS

INSERT Figure 7-5 EALER HILL MAP

8.0 Management Measures Required to Maintain / Achieve Goals

Previous sections of the *Gallows Run Watershed Restoration and Protection Plan* provide an overview of the watershed area, public outreach efforts and findings, existing planning and water resource protection efforts in the three watershed municipalities, and the location of amenities and problem areas. This section will identify regulatory and non-regulatory management measures recommended for restoration and continued protection of identified watershed resources. As the primary focus of this study effort was water quality, the recommendations in this section concentrate upon maintenance, and enhancement of existing water quality.

After reviewing the preceding information, the consulting team, Gallows Run Watershed Association, and Project Advisory Committee adopted seven goals in order to restore and protect the Gallows Run Watershed. All seven goals were reviewed by the public and are incorporated in the recommendations included in this section. The seven goals include:

- **Goal One: Water Quality and Water Quantity Protection-** Enhance, protect, and maintain existing water quality and quantity in the Gallows Run, its' tributaries and hydro-geologically connected groundwater resources.
- **Goal Two: Restoration and Protection Plan Implementation-** Implement a proactive approach to preserve, protect and restore the quality of water in the Gallows Run watershed, and implement Tier 1-Tier 3 prioritized projects listed in the Gallows Run Watershed Plan.
- **Goal Three: Watershed Amenity Protection-** Enhance, protect, preserve and manage natural land resources in the Gallows Run Watershed because they are directly associated with clean and plentiful surface and groundwater resources.
- **Goal Four: Education and Stewardship-** Create and maintain an informed and proactive citizen stewardship of the Gallows Run watershed.
- **Goal Five: Environmental Partnership-** Maintain and enhance partnerships with adjoining and regional watershed groups and government and non-government organizations.
- **Goal Six: Environmental Planning and Protection-** Enforce existing environmental protection tools and provide additional protection as needed.
- **Goal Seven: Capital Improvements-** Secure reliable and consistent funding to preserve, restore and manage water resources and natural, cultural, and recreational amenities within the Gallows Run Watershed.

8.1 An Introduction to Best Management Practices (BMPs)

Best Management Practices (BMPs) are structural or nonstructural stormwater management measures which promote infiltration and improve the quality of stormwater runoff. Restoration

and protection measures may include the following ***nonstructural*** best management practices (BMPs): preservation of environmentally sensitive areas, streambank planting/restoration, strengthened or enforced ordinances (floodplain, floodway, stormwater, wetland, wetland buffer, stream buffer, open space, water quantity etc.), as well as continued educational efforts. Restoration and protection measures may include the following ***structural*** best management practices (BMPs): dam/obstruction removal, flood control structures (e.g., cross vane structures), wetland creation, structural stormwater management measures (wet basins, constructed wetlands, infiltration trenches or basins, bioretention areas, dry wells, rain barrels, etc.) (DeBarry, 2004) The Gallows Run watershed was assessed to determine where and if various BMPs might be appropriate. Most stormwater detention basins in the past were not designed to improve water quality, but were simply designed to reduce the peak rate of outflow in the hope that this would alleviate destructive downstream flows.

There are two stormwater detention basins located in the Kintner Hill development. They are located in the Kintner Ridge Development on Ealer Hill Road. One basin (see Photograph 8-1) is located at the development's entrance, while the other is located on lot #7. Neighbors have noted operational and maintenance issues related to the basins. For instance, the Bucks Conservation District submitted a "notice of violation" for the basin located on lot #7. Municipal waste and debris are sometimes present as well. These basins were visited to determine if it would be feasible to retrofit these basins to improve the quality of the water exiting the basins.

8.2 Recommended *Structural* Best Management Practices (BMPs)

The aforementioned basins were evaluated as to their ability to act as a BMP, and whether or not they could be "retrofitted" to improve the quality of runoff exiting the basins. Retrofitting typically involves modifying the basins to include a permanent pool of water with wetland plants, modifying the outlet structure to retain more water, providing a forebay to trap sediment, providing baffles to force the stormwater to travel a longer path in the basin allowing for more pollutant removal time, and possibly reconfiguring or deepening the basin to provide for more storage volume.

The basin at the entrance to the Kintner Ridge development actually had a 6 inch pool of water in its base allowing sediment and sediment-bound pollutants to settle. Vegetation was also observed, providing another potential route for pollutant and nutrient retention, as well as providing habitat for amphibians. It was determined that trying to improve on functionality for either water or pollutant retention would not be cost effective.

Photograph 8-1
Stormwater Detention Basin (Ealer Hill Road)



Source: Borton-Lawson Engineering

Both basins on the top of Ealer Hill. had good water quality treatment features with about a six inch pool of water, wetland plants and signs of amphibian life (bullfrogs).

It was concluded that these are functioning well as water quality BMPs already and a retrofit would not be cost effective.

The structural BMPs described for the twelve prioritized problem areas (See Section 7.5 Categorization and Prioritization of Problem Areas) should be implemented as soon as possible. Implementation of recommended BMPs should be consistent with the seven previously listed management plan goals. Periodic maintenance of the two existing basins should be required.

8.3 Areas Requiring Additional BMPs

The areas requiring additional BMPs are those identified in the Prioritized Sites Section of this report, Section 7.5.2. The BMP solution is described within the section describing the problem.

8.4 Selected BMPs (regulatory and non-regulatory)

The selected BMPs are described in the Prioritized Sites Section of this report, Section 7.5.2. The BMP solution is described within the section describing the problem. The Townships that have land within the Gallows Run Watershed have adopted and should consistently implement and enforce the Delaware River (North) Watershed Act 167 Stormwater Management Ordinance. Ordinance enforcement is imperative as it contains requirements for new development to implement structural and nonstructural BMPs to improve the quality of runoff from any new development that may occur in the watershed.

8.5 Recommended *Non-Structural* Best Management Practices (BMPs)

Non-structural best management practices (BMPs) may be regulatory or non-regulatory. The following section contains non-structural planning, regulatory, public outreach recommendations consistent with the seven previously listed management goals.

8.5.1 Planning and Local Land Use Findings

Planning and zoning feedback received during the course of this study indicated that the public valued the rural feel of the watershed area as well as the natural, cultural and recreational amenities within the watershed. Additional community feedback data obtained for the draft Nockamixon Township Comprehensive Plan (BCPC, 2005) indicated similar findings. Citizens noted that future planning priority items should address groundwater protection, protection of natural resources and open space, and regulation of future growth. Citizens expressed apprehension about land development and noted the need for enforcement of existing land use regulations.

Research for the Gallows Run Watershed Restoration and Protection Plan revealed a comprehensive array of existing land use regulations in the three municipalities (See Section 5.0 and Appendix C). For instance, comprehensive plans in all three municipalities contain goals and objectives that are very protective of water and land resources. The plans clearly demonstrate an understanding of the important link between land development approaches and water quality and quantity impacts. Other municipal plans and studies (e.g., open space plans, natural resource plans) have also been completed in the municipalities. The districts throughout the watershed contain, for the most part, large lot zoning. Zoning in the headwater areas is protective of existing agricultural land use. Zoning ordinances for all three municipalities contain performance standards intended to protect watercourses, floodplains, and woodlands. Subdivision and land development ordinances require significant review by the Planning Commission, and in the case of Nockamixon, Durham and Springfield Townships, the respective Environmental Advisory Councils as well.

In addition, The Delaware River (North) Act 167 Stormwater Management Plan was recently adopted (BCPC & Pennoni Associates, 2004). Each municipality has adopted the Act 167 stormwater ordinance, which contains stormwater flow and stormwater treatment provisions. The ordinance contains requirements that new development implement structural and nonstructural best management practices to improve the quality of runoff from any new development that may occur in the watershed.

Future planning and land use regulatory efforts should be based on a rationale that takes into consideration the following:

Land Use Trends

- **Regional Development Influences-** Although northern Bucks County municipalities have adopted strong resource protection strategies, and are less developed than other communities; the three municipalities are still concerned that higher density development is slowly encroaching from surrounding areas (e.g., Allentown, Easton, Philadelphia and Lower Bucks).
- **Existing Development Patterns-** All major transportation routes and development patterns in the Gallows Run Watershed follow the stream and tributary valleys. Higher density developments within the watershed are very close to stream and tributary

corridors. In addition, recent land use data analysis (e.g., Nockamixon Township Comprehensive Plan) indicates a loss in agricultural land and an increase in single-family residential uses. Most construction has taken place on previously vacant or agricultural parcels.

- **Land Use, Water Supply and Wastewater Disposal-** Most of the developed land within the watershed exists as farmsteads and single-family developments. These are served by on-site wells and on-lot sewage disposal systems. The water supply for homes and other developed land is obtained entirely from groundwater in all three townships. Township functional plans note that the majority of the watershed is considered “unsuitable” for conventional or on-site sand mound wastewater treatment facilities. Studies completed by the USGS have noted that groundwater & surface water sources are hydrogeologically connected, groundwater capacity and recharge are limited, and there are a variety of land development constraints in this watershed.
- **Soils & Steep Slopes-** Soils throughout the watershed are highly erodible and many are impervious. Impervious soils and shallow bedrock formations results in rapid stormwater runoff and “flashy” stream flow behavior. Some of the regions most fertile soils are located in the headwater areas of the watershed. The steepest slopes are located along stream corridors and along the Route 611 corridor linking Ferndale and Kintnersville.

Resource Protection

- **Open Space Protection and Water Resources Protection-** There is a direct link between open space protection and the quality and quantity of water resources. Therefore, protecting significant resources (e.g., open space, woodlands, meadows, stream buffers, wetlands) will protect surface and groundwater resources.
- **The Relationship of Land Development and Water Resources-** The extent of land development has a direct impact upon both the availability and quality of our surface and groundwater resources. Therefore, the way we develop land (e.g., density, extent of impermeable surfaces) and treat land once it is developed (e.g., storage and use of chemicals, maintenance of sewage systems, landscaping) is inexorably linked to the quality and quantity of local water resources.
- **Municipal Land Use Protection-** In the Commonwealth of Pennsylvania, land use regulations and land use development police powers are in the hands of individual municipalities and their elected and appointed officials (e.g., Supervisors, Zoning Hearing Board, Planning Commissions, Environmental Advisory Committees). If the Gallows Run Watershed is to be effectively protected, all three municipalities should adopt, and enforce consistent land use regulations (e.g. water supply, wastewater, stormwater management and open space protection regulations).

- **Watershed Protection-** At the present time, the most effective *multi-municipal* regulatory tool to protect ground water and surface water resources is The Delaware River (North) Act 167 Stormwater Management Plan.
- **Municipal Regulations & Relationship to Water Resources Management–** Municipal zoning ordinances, subdivision and land development ordinances, and Act 167 Stormwater Plan are meant to protect watershed resources. Therefore enforcement of existing regulations is imperative and adoption of more protective regulations is vital to water resource conservation.

8.5.2 Water Resources Protection Recommendations

All three municipalities (and their elected and appointed officials) should adopt and/or enforce protective and constitutional zoning and land use regulations. Regulations should be based on sound methodology and appropriate planning processes. It should be realized that watershed protection, without watershed-wide legislature or regulations must be achieved utilizing a combination of existing programs and regulations. Some of these are watershed based i.e. act 167; some are not, i.e. the MPC. However, by utilizing the sum of the parts approach, land use practices can be managed for sustainable water resources on a watershed basis. Based on feedback from the citizens of the watershed, goals adopted for this plan, key points noted in Subsection 8.3.1, and the planning and zoning information obtained for this study (See Appendix C) our recommendations are as follows:

Planning, Zoning and Land Development Recommendations **(Regulatory Best Management Practices)**

The recommendations noted in the following subsections are based on research completed for this study. Planning, zoning and subdivision and land development recommendations are based on the research completed and included in Appendix C of this document.

- **Watershed Resources Protection Regulations-** Nockamixon, Durham and Springfield Townships should *comprehensively and consistently* protect Gallows Run Watershed resources by adopting and enforcing regulations designed to: protect existing and future water supply; ensure adequate wastewater treatment and wastewater discharge; control stormwater volume; treat stormwater discharge; require groundwater recharge; protect surface water quality, preserve open space resources; protect significant natural resources; and limit the type and density of development in environmentally-sensitive areas.
- **Groundwater Protection Regulations -** The three municipalities should adopt and/or enforce *consistent* regulatory approaches for groundwater protection. Municipalities should require groundwater resource impact studies for new developments. The water resources studies should substantiate that there will be no impact to groundwater supply for adjoining homes and businesses, and the water supply serving the proposed is adequate, reliable and potable. The three municipalities should work together in a

manner similar to that of the Bridgeton-Nockamixon-Tinicum Township Groundwater Committee.

- **Stormwater Regulations-** The municipalities should adopt and/or enforce *consistent* volume, treatment and recharge regulations recommended in The Delaware River (North) Act 167 Stormwater Management Plan (e.g., stormwater modeling, selected BMP design methods to control the volume, quality and recharge of stormwater). This may be accomplished by having the three municipalities meet periodically to discuss stormwater ordinance enforcement issues and consistent regulatory and non-regulatory approaches.
- **Sewage Treatment Regulations-** Nockamixon, Durham and Springfield Townships should update and/or enforce *consistent* municipal sewage facilities (Act 537) plans that require selection and construction of proper wastewater treatment technology based on site natural resource constraints and release of adequately treated wastewater based on water quality regulations and at or near the source of water supply.
- **Land Development Regulations-** The three municipalities should *consistently* adopt and enforce low impact development (LID) approaches to environmental resources protection, whereby development density should not exceed natural resources carrying capacity. The municipalities should continually consider more protective resource protection approaches such as stricter performance standards (e.g., stream buffers, wetland buffers); overlay districts (e.g., stream corridor, groundwater recharge areas) or other accepted methods especially in stream corridor areas.
- **Open Space and Significant Resource Protection Regulations-** The municipalities should update and adopt *consistent* open space, natural resources protection functional plans that build upon updated comprehensive plans and serve as the basis for resource protection ordinances.

Zoning and subdivision ordinances should adopt *consistent* performance standards or other effective land use planning regulations that protect open space and significant natural/cultural/historical/recreational resources (e.g., lakes, ponds, woodlands, trees, wetlands, wetland buffers, stream, riparian buffers, floodplains, soils, scenic vistas, historic districts, historic structures, recreational facilities).

The recommendations for consistency among township ordinances and regulations, though desirable, should not preclude one community's enactment of more strongly protective ordinances, even in the absence of such action by other communities.

Environmental Planning, Education, Public Outreach and Fiscal Planning Recommendations (Non-Regulatory Best Management Practices)

- **Planning Education & Land Development Review Training-** As new officials are appointed and elected in Nockamixon, Durham and Springfield Townships, consistent planning and land development review training should be required to strengthen land and water resources protection and land development proposal review (e.g., Pennsylvania Municipal Planning Education Institute, PMPEI). Likewise, citizens living in the Gallows Run Watershed should attend planning commission meetings in order to take part in the land development review process. The municipalities should involve appointed commissions (e.g., Environmental Advisory Commission/Councils, Parks and Open Space Boards) in land development reviews.
- **Water Monitoring-** Flooding was one of the most noted problems in this watershed. Protection of the existing water quality was one of the most noted comments received from the citizen survey. Additional statistical data is necessary to predict and plan for stormwater flood events. It is also necessary to determine biota quality and to quantify the limits of groundwater capacity. Therefore, the Gallows Run Watershed Association and its partners should initiate a comprehensive water monitoring program (e.g., ground and surface water) as sufficient groundwater and surface water data is lacking. The program should include a quality assurance and quality control component, selection of monitoring locations, equipment purchase (e.g. staff gauges, data loggers) and the collection of physical, chemical, and biological data. The installation of stream gauges is critical to developing a data base to determine base and stormwater flow, and a water budget for the Gallows Run aquifer.
- **Environmental Studies-** The three municipalities should work together on the research, field studies, and agency coordination necessary to support stricter resource protection regulations. One example is to complete the field studies necessary for Gallows Run to qualify for High Quality (HQ) or possibly Exceptional Value (EV) anti-degradation protection (e.g., Title 25/Chapters 93 & 96 Environmental Protection regulations, Commonwealth of Pennsylvania Code). The study should take place in three phases. The first phase would include data screening to determine additional testing parameters and stream monitoring locations required. The second phase would include partnering with Pennsylvania Department of Environmental Protection (PADEP) to obtain additional information. The third phase includes a full-fledged biological assessment. The final phase involves a formal request to PADEP to consider HQ or EV anti-degradation protection. Additional environmental study examples include headwater and tributary mapping studies, multi-municipal groundwater quality and quantity studies, trout habitat/temperature studies, and natural resources identification and diversity studies. Many useful studies have been completed by the Bridgeton-Nockamixon-Tinicum Groundwater Committee (e.g., stream and wetlands identification, wetlands recharge) and should also be expanded into the Gallows Run Watershed (e.g., Durham and Springfield Townships).

- **Environmental Projects-** The completion of prioritized, structural best management practices recommendations for the twelve prioritized problem areas was previously discussed (See Sections 7.5 and Section 8.) Additional restoration and protection project areas are noted on both the amenities and problem areas maps (See Figures 6-1 and 7-1).

With regard to the amenities map (A1-A-4), watershed partners should work with private landowners (e.g., American Grill Property [A1-A-4], Camp Nockamixon [A-13], the Bucks County Horse Park) and others on a variety of recreational, natural resource and public outreach projects. In particular, the American Grill site would benefit from protective easements, a passive recreational trail, and Gallows Run and Delaware River access areas. Work is underway on this project as is the cultivation of the necessary relationships with other landowners within the watershed (e.g., horse trails, workshops, and voluntary agricultural and resource conservation) to protect amenities.

- **Environmental Outreach & Public Education** – Consistent and continuous public outreach is required to attain the seven goals adopted for the *Gallows Run Watershed Restoration and Protection Plan* (See Section 8.0). In order to build upon the successful outreach efforts implemented during the last two years, the Gallows Run Watershed Association (GRWA) should continue working with their partners on the following public education approaches:
 - **Upper Bucks Futures-** Continue to educate citizens in the watershed by publishing the Upper Bucks Futures newsletter. Articles should continue to focus upon water resources protection, land use protection, landowner outreach, project updates, meeting and workshop updates, and the impacts of land development proposals upon the Gallows Run Watershed.
 - **Regional Environmental Advisory Council/Commission (EAC)-** Initiate the formation of a multi-municipal, regional EAC. The EAC should meet frequently to discuss development trends and other issues impacting individual municipalities, the Gallows Run Watershed and adjoining watersheds.
 - **Special Events-** Continue to participate in Nockamixon and Durham Days as well as events sponsored by adjoining watershed associations (e.g., Cooks Creek, Tinicum Creek, Delaware River Greenway Partnership), because a significant amount of positive public outreach and partnership building takes place at these events.
 - **Palisades School District Partnership-** Continue to develop, as noted in Section 3.4, the successful partnership between the GRWA and Palisades School District administrators, educators, students, and local Scout groups formed due to the *Gallows Run Watershed Restoration and Protection Plan* effort. Proactive involvement will assist educators with meeting the environment and education

curriculum standards and will provide students with a hands-on educational and community service experience.

- **EAC Recommendation-** Initiate the formation of a multi-municipal, regional EAC. The EAC should meet frequently to discuss development trends and other issues impacting indirect municipal ties, the Gallows Run Watershed, and adjoining watersheds.
- **Watershed Workshops-** The three municipalities, the GRWA, and other organizations (e.g., Tinicum Conservancy, Bridgeton-Nockamixon-Tinicum Groundwater Committee, Cooks Creek Watershed Association) should continue working together on special topic workshops such as recent headwater mapping and land development review workshops.
- **Press Releases-** Continue working with the local media through periodic press releases and coverage addressing restoration project implementation, special events, workshops, and successful grant proposals.

In order to initiate new partnerships and educate additional audiences, the Gallows Run Watershed Association (GRWA) should consider the following public education recommendations:

- **Watershed Association Membership Drive-** The Gallows Run Watershed Association has been very successful within a very short period of time. However, existing members should be informed about recent successes. Existing members of GRWA should be informed about the many recent successes of the organization. They should be approached for donations, and new members should be cultivated to expand the volunteer base and further watershed education in the Townships.
- **Landowner Stewardship Brochure-** Most developed land in the Gallows Run Watershed is owned and maintained by private landowners. The GRWA should consider creating an eye-catching brochure to encourage membership in the GRWA, to build interest in watershed protection, and to provide advice on individual landowner stewardship of watershed resources.
- **Stream Owners Manual-** Most developed land directly adjoining the Gallows Run and its tributaries is owned and maintained by private landowners. Landowners in the Gallows Run corridor are also stream owners. Some of them may have amenities that they may not know about (e.g., significant natural resources) and others may be experiencing problems (e.g., streambank erosion) or may be negatively impacting the stream (e.g., removing riparian buffers, mowing lawns to the streambank). The GRWA should consider creating a stream owners manual with specific tips to protect streams and tributaries in the Gallows Run Watershed.

- **Stream Cleanup-** The Gallows Run Watershed Association should coordinate, along with partners and landowners, an annual stream cleanup day. The initial focus should be to remove stream and bridge obstructions (e.g., trash, large trees, etc.) Sediment is a much bigger problem that needs to be addressed on a watershed scale. Removing sediment is only a temporary solution, and areas where sediment deposits will most likely accumulate sediment again if the watershed's issues (improper stormwater management, streambank erosion) are not addressed.

8.6 Financial Needs to Implement Suggested Best Management Practices (BMPS)

Implementing the regulatory and non-regulatory best management practices (BMPs) noted throughout this plan will be expensive and fiscal planning is needed. The following list of government and non-government grant funding sources contained in Table 8-1 is suggested from which to provide reliable and consistent funding.

The list contained in Table 8-1 is neither exhaustive nor comprehensive, and further research (e.g., eligibility and criteria) is recommended. In addition, a combination of government and non-government funding sources should be concurrently pursued. The largest source of funding comes from private individual donations, a fact of which most non-profit groups are not aware. Therefore, it is important to focus also on increasing membership, identifying potential donors and cultivating them as well as pursuing grant applications.

Table 8-1
Recommended Grant & Local Foundation Programs

Fiscal Source	Projects
<i>Government Grants, Federal</i>	<i>Identified Amenity Protection & Problem Area Studies and Restoration Projects</i>
US Fish and Wildlife, Partners for Fish and Wildlife	Habitat restoration, natural resources management education (12 prioritized structural BMP problem areas/eroded riparian buffers, workshops, newsletters, Palisades student and educator projects, landowner manual, watershed brochure)
US Department of the Interior, National Park Service, Land and Water Conservation Fund, Cooperative Conservation Grants	A variety of cultural, conservation and recreational grants (American Grill trail and river access project, Bucks County Horse Park equestrian trail projects, workshops, newsletters, Palisades student and educator projects, landowner manual, watershed brochure)
US Department of the Interior, Natural Resources Conservation Service, Resource Conservation and Development, Watershed Protection and Flood Prevention, Watershed Rehabilitation	Habitat restoration, natural resources management education (Prioritized structural BMP problem areas on agricultural land, landowners manual for agricultural uses, agricultural easements)
US Department of Agriculture, Forest Service (State and Private Forestry Program)	Woodland habitat restoration (forested riparian buffer enhancement)
<i>Government Grants, State</i>	
PADEP, Growing Greener Program, Watershed and Technical Assistance, and Innovative	Watershed restoration and education (12 prioritized structural BMP problem areas/eroded riparian buffers,

Fiscal Source	Projects
Project, Environmental Education Programs	workshops, newsletters, Palisades student and educator projects, landowner manual, watershed brochure)
PADCNR, Community Conservation Partnerships Program, Recreation & Conservation Grants	Watershed and river corridor restoration (Preserve identified open space and easements, American Grill trail and river access project, Bucks County Horse Park equestrian trail projects, workshops, newsletters, Palisades student and educator projects, landowner manual, watershed brochure)
<i>Grants, Other</i>	
Delaware River Greenway Partnership, Riverkeeper Municipal & Non-Profit Incentives Grant Programs	Planning, Restoration, Enhancement and Public Education Projects (All projects listed would qualify)
League of Women Voters, Water Resources Education Network (WREN)	Watershed Education and Surface Water Protection (workshops, newsletters, Palisades student and educator projects, landowner manual, watershed brochure)
<i>Foundation Funding</i>	
Heinz Foundation, Heinz Endowments, Environmental Grants Program	Protect watersheds and ecosystems (All projects could qualify).
William Penn Foundation, Environment and Communities Program	<i>Promoting vital communities within a healthy regional ecosystem. (All projects could qualify).</i>

Fiscal planning can be a full-time job. Therefore, the Gallows Run Watershed Association should attempt to appoint several volunteer members to identify additional funding opportunities, keep track of grant cycles and application submissions dates, and obtain the necessary support from local partners. Eventually, successful funding efforts should be used to pay for full or part-time professional assistance.

It is also recommended that the GRWA continue working towards building membership and participating in special events. In addition, time should be spent on implementing a donation drive, and sponsoring special events geared toward raising money (e.g., art shows, paddling trips).

8.7 Implementation of Prioritized Measures

The *Gallows Run Watershed Restoration and Protection Plan* was developed to serve as a blueprint or plan of action for maintaining and restoring water resources within the watershed. Even as the Plan was in draft stage, the Association applied for a Growing Greener grant in 2005 to formulate a comprehensive approach to manage the increased flows and resultant flooding and water quality problems in the Ealer Road area. The Association will continue to look for funds to correct problems based upon the prioritization list, beginning with Tier 1. The Gallows Run Watershed Association and their partners (e.g., municipalities, PADEP, PADCNR etc.) should act now to begin developing a scope of work and cost estimate to correct all identified problems based on a systematic approach. The following table lists the tasks previously described, the partners that are involved with completing each task, and an approximate schedule for task completion.

Table 8.2 Implementation of Gallows Run Watershed Management and Recommendations

Task	Partners	Schedule for Implementation
<i>Structural BMPs</i>		
Ealer Hill	GRWA, Nockamixon Township, PADEP, Conservation District	February, 2005 G2 Grant Application-Already submitted
Route 611 Streambank Stabilization	GRWA, PennDOT, Nockamixon Township	February, 2006 G2 Application-Begin application process now.
Camp Nockamixon Streambank Stabilization	GRWA, Camp Nockamixon, PennDOT, Nockamixon Township, Conservation District	February, 2007 G2 Application-Begin application process early.
Pastures	GRWA, private Landowners, Nockamixon Township, USDA/NRCS, Conservation District	February, 2008 G2 Application-Begin application process early.
Traugers	GRWA, Private Landowners, Nockamixon Township	February, 2009 G2 Application-Begin application process early.
<i>Non-Structural BMPs</i>		
American Grill Trail	GRWA, Landowner, Nockamixon Township, Delaware River Greenway Partnership, PADCNr	PADCNR and other trails grants available in 2005-06
Membership Drive	GRWA	Begin Letter Campaign in Early 2006.
Homeowners Brochure	GRWA, Nockamixon Township, and Landowners	Obtain membership funding and implement in 2006-2007.
Stream owners Manual	GRWA, Nockamixon Township, and Landowners	Obtain membership funding and implement by 2007-2008
Planning and Local Regulatory Efforts	GRWA, Nockamixon Township, Nockamixon Township Planning Commission & EAC, and Citizens	Updating plans and ordinances based on plans should be an on-going process beginning 2006.
Additional Land Use and Watershed Study	GRWA, Nockamixon Township, B-N-T Groundwater Committee, DRGP	Scientific study is the basis for sound regulatory and non-regulatory measures. On-going process beginning 2006

8.8 Technical & Financial Assistance Required

Implementing a watershed protection and restoration Plan is not inexpensive. The proactive planning measures, such as ordinance adoption, are the least expensive to implement and have long term benefits by preventing future problems. Restoration measures, such as streambank stabilization, are expensive on a linear foot basis and the benefit/costs should be weighed carefully.

9.0 Conclusions

The *Gallows Run Watershed Restoration and Protection Plan* effort has confirmed that this watershed is among one of the most scenic and economically important areas in the region. The Gallows Run Watershed Association has completed many successful projects in the short time it has existed, is expected to flourish, and will assist municipal government and the citizens with ensuring that the land and water resources within the watershed remain scenic, rural, and pristine for future generations.

The completion of this plan is an important step toward realizing that goal. However, completing the plan is only an initial step. The GRWA and its partners must now implement the recommendations within the restoration and protection plan. Implementation is no small task, however it is obvious the partnership in this watershed is a strong, and the significant natural, cultural, and recreational resources within the watershed are worthy of protection.

***It's Amazing How Much You Can Accomplish
When It Doesn't Matter Who Gets the Credit!
~ Source Unknown***

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