FOREST COUNTY

ACT 167 PHASE 2 – May 2011

STORMWATER MANAGEMENT PLAN

Picture of The Nebraska Bridge during Stormwater Event March 2011

This illustrates the impact of Stormwater upon the Tionesta Creek Watershed in Forest County.

(Top picture is Top of Nebraska Bridge barely above floodwaters on March 8, 2011, 2nd Picture is March 20, 2011, 3rd picture is March 25, 2011)

FOREST COUNTY WATERSHED PLANNING ADVISORY COMMITTEE (WPAC)

WPAC Member	Organization
Doug Carlson	Forest County Planning Department
Donna Zofcin	Forest County Planning Department
Scott Henry	Forest County Office of Community & Economic Development
	Boroughs
Lois Lackey	Tionesta
	Townships
Todd Boyer	Barnett Township
Mark Woodside	Green Township
Derrick Beach	Harmony Township
George Oliver	Hickory Township
Robert A. Summers	Howe Township
Greg D. Geyer	Jenks Township
Quay Y. Brady	Kingsley Township
Todd A. Allio	Tionesta Township
	Agencies and Stakeholders
Tim Bruno	PADEP
Tom Minnich	PennDOT Engineering District 1-0
Ty Ryen	PA DCNR
Rob Fallon	USDA Forest Service

PREPARED FOR:

FOREST COUNTY
526 Elm Street
Tionesta, PA 16353

PREPARED BY:

FOREST COUNTY
PLANNING COMMISSION
526 Elm Street
Tionesta, PA 16353

CONSULTANT:

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415 Moon Clinton Road
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RESOLUTION

WHEREAS, the Stormwater Management Act 167 of 1978 provides for the regulation of land and water use for flood control and stormwater management, requires the Pennsylvania Department of Environmental Protection to designate watersheds, and provides for grants to be appropriated and administered by the Department for plan preparation and implementation costs, and provides that each county will prepare and adopt a watershed stormwater management plan for each designated watershed; and

WHEREAS, the Forest County Commissioners entered into a reimbursement agreement with the Pennsylvania Department of Environmental Protection to develop a county-wide watershed Stormwater Management Plan; and

WHEREAS, the purpose of the Stormwater Management Plan is to protect public health and safety and to prevent or mitigate the adverse impacts related to the conveyance of excessive rates and volumes of stormwater runoff by providing for the management of stormwater runoff and control of erosion and sedimentation; and

WHEREAS, design criteria and standards of stormwater management systems and facilities within the County shall utilize the criteria and standards as found in the Stormwater Management Plan;

NOW, THEREFORE, BE IT RESOLVED that the Forest County Commissioners hereby adopt the Stormwater Management Plan, including all volumes, figures, appendices, and Model Ordinance, and forward the Plan to the Stormwater Management Section of the Pennsylvania Department of Environmental Protection for approval.

This Resolution is hereby adopted this _____day of _____, 2011 by:

FOREST COUNTY COMMISSIONERS

R. James Parrett, Chairman

Robert J. Snyder, Jr.

Basil D. Huffman

CONTENTS

FOREWORD

Forest County is a unique county within the Commonwealth of Pennsylvania. Considered to be 100% rural by both Federal and State agencies, 94% of the County's land surface is covered by forest. Approximately 50% of the County's land area is under ownership of a federal or state government agency and a majority of the privately owned land is owned by large landholders primarily engaged in timber management and harvesting.

With only a fraction of the County being available for development, land development within Forest County is limited due to several factors, including slopes, soil conditions, and the lack of public infrastructure. All nine municipalities within Forest County are subject to the Forest County Subdivision and Land Development Ordinance and only Tionesta Borough has enacted a Zoning Ordinance. During the past twenty years, only two major subdivisions (greater than ten lots) have been proposed and approved.

The County's residential population is below 5,000 persons and they are dispersed at a density of only 10 persons per square mile. Population estimates indicate that most areas of the County have seen a population decline over the past ten years (the notable exception being Jenks Township, where the inmate population of SCI-Forest depicts a population explosion). Projections indicate that Forest County's municipalities may suffer a population loss of nearly 20% upon release of the 2010 census data.

Clean water, fresh air, abundant foliage, and few people – this typifies the majority of Forest County. With two segments of designated "Wild and Scenic Rivers", only a portion of one stream within the County is listed as "impaired" in the PA Water Atlas.

In order to consider the impacts of stormwater on our land and in our streams, Forest County has prepared the following Stormwater Management Plan. Utilizing a consultant and working closely with PaDEP, the County has strived to assure that Pennsylvania Act 167 (of 1978) is being addressed in a proper manner. This Plan is an attempt to recognize the uniqueness of Forest County and to provide a basis for decision-makers in assessing possible impacts new development may have upon the County's general pristine nature.

SECTION I INTRODUCTION

A. Introduction

The purpose of an Act 167 Plan is to assess the current and future runoff conditions within a designated watershed(s) and develop stormwater management standards, criteria and other ordinance provisions for adoption by the municipalities within the watershed to minimize adverse impacts from stormwater runoff associated with new or future development.

This County-wide Plan has been prepared by the Forest County Department of Planning and includes all designated watersheds within the County. This Plan will assist in achieving the effective and efficient stormwater management of all major watersheds within Forest County and provide a single technical source for stormwater management across Forest County.

The need for this Act 167 Plan is to reach compliance with the Pennsylvania Stormwater Management Act of 1978 (Act 167). One of the primary objectives of Forest County's Act 167 planning process is to provide a county-wide comprehensive program to assist in the planning and management of stormwater. With coordination from the nine (9) municipalities in Forest County, the resulting stormwater management ordinance will address severe and ongoing stormwater related problems in critical areas throughout the County. Furthermore, cooperating member municipalities will be able to adopt stormwater management controls that collectively will have a beneficial impact on the waters of Forest County and those "problem" areas that presently remain unmanaged.

Forest County lies entirely within the Ohio River drainage basin, and is drained by the Allegheny River and its tributaries. The main stem of the Allegheny River drains an area of 118 mi^2 within the county, and its two major tributaries, the Clarion River and Tionesta Creek, drain 105 mi2 and 209 mi^2 respectively.

1. Allegheny River

   The Allegheny River is approximately 325 miles long, and drains a rural dissected plateau of 11,580 mi^2 in the northern Allegheny Plateau, providing the northeastern most drainage in the watershed of the Mississippi River. In 1992, the U.S. Congress granted three sections of the Allegheny River, totaling 86.6 miles, the designation of Wild and Scenic River. These sections are classified as Recreational to reflect the relatively high level of accessibility and development relative to other rivers in the Wild and Scenic Rivers System. The Allegheny River Landscape Conservation Area captures the approximately forty-seven (47) mile segment from the Buckaloons Recreation Area at Irvine to the southern end of Alcorn Island at Oil City. The seven Allegheny Wilderness Islands also lie within this section of the Allegheny River. This section of the Allegheny continues to support a rich diversity of fish and mussel species. Currently, sixty-eight (68) species of fish - nine of which are considered species of special concern in PA - occur within this stretch of river. Twenty-four species of freshwater mussels have also been documented, thirteen of which are of special concern in Pennsylvania. Of those thirteen species, two species are listed as Federally Endangered, and two species are Candidates for Federal listing.

2. Clarion River

   The Clarion River flows 101 miles through Forest, Jefferson, and Clarion Counties, discharging into the Allegheny River near Parker, PA. Over half the river was granted Wild and Scenic River status by Congress in 1996, and this entire area is encompassed by the Landscape Conservation Area. The free-flowing character of the River supports a rich diversity of fish, odonates, and recovering freshwater mussel fauna. The River is free flowing and relatively slow moving with meanders and a generally steep valley with little floodplain. Major tributaries to the River include Wolf Run, Spring Creek, and East Branch Millstone Creek.

3. Tionesta Creek

   Tionesta Creek is a tributary of the Allegheny River that flows through Forest, Clarion, Warren, McKean, and Forest Counties. Tionesta Creek is 61.9 miles long, and its watershed is 480 mi2 in area. The Tionesta Creek Landscape Conservation Area includes the main stem of the Tionesta Creek roughly from its confluence with Jake Run upstream to Lynch, plus Bluejay Creek and the tributaries flowing into these sections of Tionesta Creek and Bluejay Creek. Forty-one fish species and five freshwater mussel species inhabit Tionesta Creek.

Forest County has five watersheds designated by the DEP under the Act 167 Program, however only three of these watersheds contain any appreciable area within the County. These designated watersheds are shown in Figure I-1.

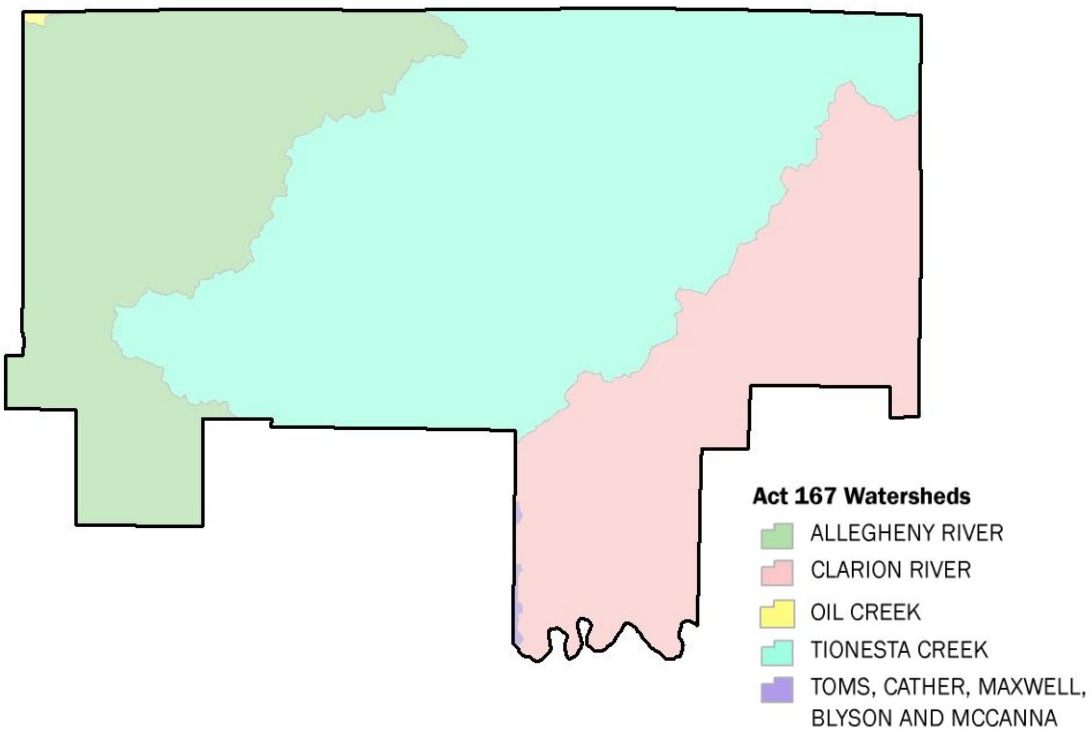


Figure I-1

This Act 167 Plan was prepared taking into account selected sub-watershed areas within the designated watersheds identified above and based on specific selection criteria in the Phase 1 Scope of Study; thereby meeting the requirements of the Act 167 planning process for Forest County and associated watersheds.

Upon final approval of this Plan by the Forest County Commissioners, and final submission PaDEP, each of the County's nine municipalities will need to adopt local regulations governing stormwater or officially designate the Forest County Stormwater Management Ordinance as the prevailing regulation.

As a requirement of the development of this Plan, a model municipal ordinance has been developed and is included herein as an Appendix. The model ordinance can then be used by municipalities in the development of their own local ordinance, which must at a minimum, adhere to and be no less stringent than the adopted model ordinance. Each municipality, at their own discretion, may develop an ordinance that augments additional or more restrictive requirements and regulations that must be followed within their respective municipality.

An alternative to each municipality enacting their own stormwater management regulations and devoting resources to administering such programs, Forest County officials have proposed the creation of a County-wide Stormwater Management Ordinance. Similar to the Forest County Subdivision & Land Development Ordinance, the entire process will largely by administered by the Forest County Conservation District & Planning Commission on behalf of those municipalities who wish to participate. This will not only conserve valuable resources at the local level, but will provide a more consistent and comprehensive approach to stormwater management – an approach that has proven effective with administration of subdivisions and land developments.

Unlike the protocols outlined in the Pennsylvania Municipalities' Planning Code governing subdivision ordinances, wherein the lack of a municipal ordinance automatically places jurisdiction with the County planning agency – Act 167 appears to require enactment of stormwater regulations at the municipal level. Thus, municipalities within Forest County will have an option of (a) developing and administering their own stormwater regulations (based on the model ordinance), or (b) formally designating the Forest County Stormwater Management Ordinance as the local regulation and placing administrative power with the County Conservation District & Planning Commission.

At a minimum, it is suggested that the Plan be reviewed and revised every five years in order to incorporate newer regulations and technical procedures that should be part of the most current Plan version.

B. Stormwater Management

The water that runs off the land into surface waters of the Commonwealth during and immediately following a rainfall event is referred to as stormwater. In a watershed undergoing land use conversion or urban expansion, the volume of stormwater resulting from a particular rainfall event increases because of the reduction in pervious land area (i.e., natural land cover being changed to pavement, concrete, buildings, or unmanaged cropland). These surface changes can also substantially degrade stormwater runoff quality, increasing the pollutant load to the rivers and streams. The alteration of natural land cover and land contours to residential, commercial, industrial, and crop land uses results in decreased infiltration of rainfall, an increased rate and volume of runoff, and increased pollutant loadings to surface watercourses.

As the population of an area increases, land development is inevitable. As land disturbance and development has increases, so does the problem of dealing with the increased quantity and decreased quality of stormwater runoff. Failure to properly manage this runoff results in greater flooding, stream channel erosion and siltation, degraded water quality, as well as reduced groundwater recharge. The cumulative effects of development in some areas of a watershed can result in flooding of natural watercourses with associated costly property damages. These impacts can be minimized if the land use and development incorporates appropriate runoff and stormwater management systems and designs.

Individual land disturbance/development projects have historically been viewed as independent or discrete events or impacts, rather than as part of a larger watershed process. This has also been the case when the individual land development projects are scattered throughout a watershed (and in many different municipalities). However, it is now being observed and verified that the cumulative nature of individual land surface changes dramatically affects runoff and flooding conditions. These cumulative effects of development and land disturbance in some areas have resulted in flooding of both small and large streams with associated property damages and even causing loss of life.

Therefore, given the distributed and cumulative nature of the land alteration process, a comprehensive approach must be taken if a reasonable and practical management and implementation approach or strategy is to be successful.

C. Stormwater Management Plan Objectives

This Plan has been prepared in order to produce a countywide model ordinance that will serve as a means of effectively implementing the results of the Plan and providing measures that address technical, legal, and governmental issues.

The final objectives for this Plan were developed based on a review of the objectives within Section 3 of Act 167, a review of water quality impairments in the County, and a review of stormwater management problems identified by the WPAC and through the municipal survey process. Through analysis of the survey results, L.R. Kimball and County staff determined that the three primary stormwater problems within the County are stream corridor flooding, street flooding, and property flooding.

The original Plan objectives included the following:

1. Encourage planning and management of storm water runoff in each watershed which is consistent with sound water and land use practices (Act 167, Section 3).
2. Establish a comprehensive program of storm water management policy to help preserve and restore stream flood carrying capacity, to help preserve as much as possible the natural storm water runoff regimes and natural course, current and cross-section of waters of the Commonwealth; and to protect and conserve ground waters and ground-water recharge areas (Act 167, Section 3).
3. Establish local administration and management of storm water (Act 167, Section 3).
4. Prepare detailed hydrologic analyses of the following watersheds in order to develop comprehensive approaches to stormwater management controls (as outlined in Table I-1)

Table I-1

Designated Watershed	Rationale	Focus of Modeling Effort
Oil Creek	Majority of watershed lies outside of Forest County	
Toms / Cather / Maxwell / Blyson / McCanna	Majority of watershed lies outside of Forest County	
Allegheny River	Recurrent street flooding and Growth Priority Area	Tributaries in Tionesta Borough
	Frequent property flooding due to runoff stream obstructions and encroachments	Prather Run
Tionesta Creek	Recurrent street and property flooding	Section of Upper Tionesta Creek at Mayburg in the vicinity of the common boundary between Kingsley/Howe Townships
Clarion River	Recurrent property flooding due to runoff increase	Cherry Run

These original Plan objectives were determined using the process summarized in Figure I-2.

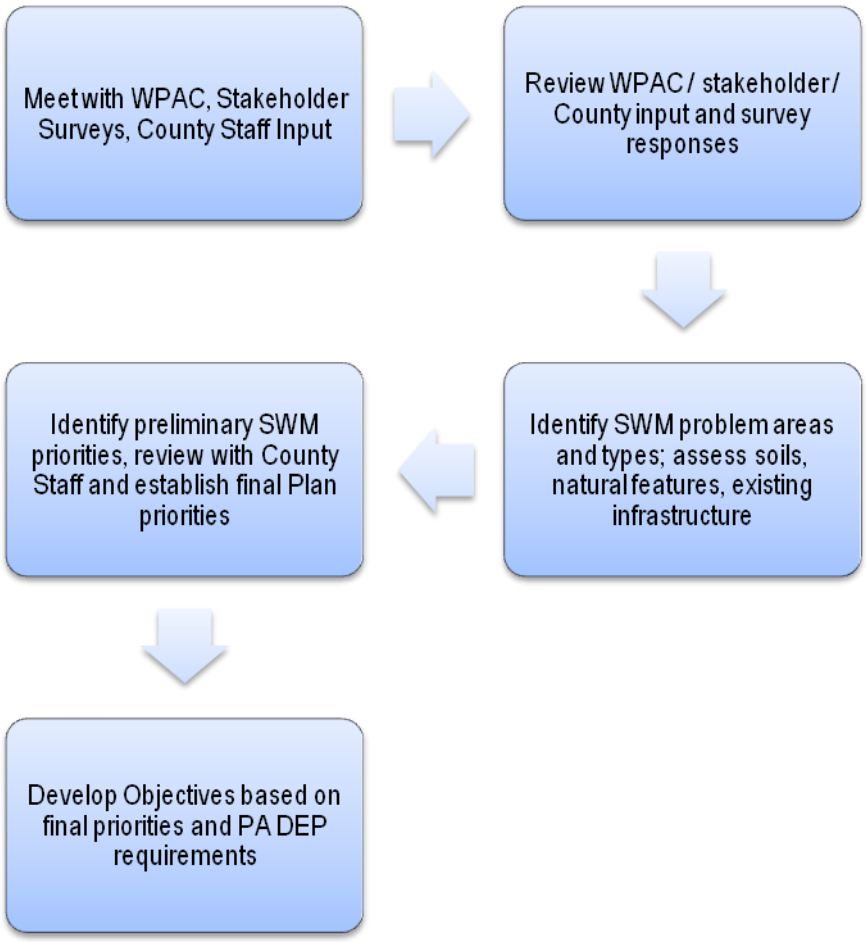


Figure I-2 Original Plan Objectives Setting Process

The final Plan objectives for the current planning cycle take into account the Act 167 Program budget cuts and consequent cuts in funding for the Forest County Plan. These final objectives are based on the reduced funds available as well as the accelerated Plan completion deadline. These changes forced a re-evaluation of the objectives for the current planning cycle, and the final Plan objectives include the following:

1. Encourage planning and management of storm water runoff in each watershed which is consistent with sound water and land use practices (Act 167, Section 3).
2. Establish a comprehensive program of storm water management policy to help preserve and restore stream flood carrying capacity, to help preserve as much as possible the natural storm water runoff regimes and natural course, current and cross-section of waters of the Commonwealth; and to protect and conserve ground waters and ground-water recharge areas (Act 167, Section 3).

   Establish local administration and management of storm water (Act 167, Section 3).

As noted above, these final Plan objectives were determined by the County based on the amount of funding available for this planning project and based on an anticipated Plan approval deadline of May 31, 2011.

D. Stormwater Management Plan Strategy

Preferred Strategies:

1. Administrative / Policy
    a. Adoption of Forest County Stormwater Management Ordinance and subsequent designation of the Forest County Stormwater Management Ordinance as the prevailing regulation and thus placing administrative power with the County Conservation District & Planning Commission.
    b. Municipal adoption of the Model Ordinance language within this Plan.

       Municipalities may adopt a stand-alone ordinance, or may choose to incorporate the language within the Model Ordinance into their existing ordinances
    c. Municipal implementation and enforcement of the requirements of the Model Ordinance within this Plan. Specific implementation strategies are described in Section VII.
2. Technical (refer to technical discussion in Sections IV and V).
    a. Maintain groundwater recharge
    b. Maintain water quality
    c. Reduce channel erosion
    d. Manage overbank events
    e. Manage extreme flood events

Alternative Strategies:

1. Administrative / Policy
    a. Municipal encouragement of clustered design practices to reduce overall development footprints
    b. Municipal or County support and funding of SWM BMP pilot projects for technical analysis as well as public education
    c. Public incentive programs related to Municipal-sponsored education activities
        i. Rain barrel programs
        ii. Public handbooks and technical guidance detailing residential BMP implementation
    d. The development of strategic partnerships between adjacent municipalities, key stakeholders and community interest groups.
2. Technical (refer to technical discussion in Sections IV and V).
    a. Correction of existing drainage problems – Individual problem corrections not addressed in the current Plan due to additional technical analysis required. Refer to Section V for general discussion of non-achievable goals.
    b. Culvert retrofits – Individual retrofits not addressed in the current Plan due to additional technical analysis required. Refer to Section V and the model ordinance for additional discussion of retrofits.

c. Stormwater management basin retrofits - Individual retrofits not addressed in the current Plan due to additional technical analysis required. Refer to Section V and the model ordinance for additional discussion of retrofits.
    i. Modification of outlet structures for additional outflow control
    ii. Combination of existing basin with new SWM BMPs
    iii. Addition of sediment forebays
    iv. Soil amendments for water quality
    v. Regrading/reshaping basin for more effective management and control of runoff
    vi. Incorporation of existing basins into surrounding landscaping to serve dual function of SWM practice and provide positive aesthetic and environmental habitat benefits

d. Retrofit of existing landscaping and site design features - Individual retrofits not addressed in the current Plan due to additional site investigation and technical analysis required. Refer to Section V and the model ordinance for additional discussion of retrofits.
    i. Modification of parking islands into bioretention areas
    ii. Replacement of impervious pavement/concrete with permeable paving and concrete
    iii. Modification of overflow parking areas into infiltration areas
    iv. Replacement of traditional tree planters to environmentally beneficial tree planter boxes in streetscape applications

e. Agricultural BMP implementation
    i. Animal waste management
        1. Curbing animal confinement areas
        2. Grassed filter strips
        3. Waste storage
            a. Lagoons and ponds (higher moisture wastes/slurry)
            b. Synthetic covers (drier wastes)
            c. Digestion tanks
    ii. Land management practices
        1. Isolation of livestock from waterways
        2. Rotation of pasture/grazing areas
        3. Cleaning solids from waterway swales
        4. Crop rotation
        5. Crop terracing practices
        6. Nutrient management plans

SECTION II ACT 167

A. Stormwater Management Act 167

Recognizing the need to address the serious and growing problem of inadequate stormwater management, the Pennsylvania General Assembly enacted Act 167 of 1978. The statement of legislative findings at the beginning of the Pennsylvania Storm Water Management Act (Act 167) sums up the critical interrelationship among land development, accelerated runoff, and floodplain management. Specifically, this statement of legislative findings points out that:

1. Inadequate management of accelerated runoff of stormwater resulting from development throughout a watershed increases flood flows and velocity, contributes to erosion and sedimentation, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities to carry and control stormwater, undermines floodplain management and floodplain control efforts in downstream communities, reduces groundwater recharge, and threatens public health and safety.
2. A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety, and welfare and the protection of the people of the Commonwealth, their resources, and their environment.

Until the enactment of Act 167, stormwater management had been oriented primarily towards addressing the increase in peak runoff rates discharging from individual land development sites to protect property immediately downstream. Management of stormwater throughout the state paid minimal attention to the effects on locations further downstream (frequently because they were located in another municipality) or to designing stormwater controls within the context of the entire watershed.

B. Purpose of the Study

Stormwater management has typically been regulated at the municipal level, with little or no design consistency (concerning the types or degree of storm runoff control to be practiced) between adjoining municipalities in the same watershed. Act 167 changed this approach by instituting a comprehensive program of watershed stormwater management planning. The Act requires Pennsylvania counties to prepare and adopt stormwater management plans for each designated watershed within the county; and recent changes in PADEP Act 167 policy now provide for Act 167 planning efforts on a countywide basis. Perhaps most significantly, Act 167 plans are to be prepared in consultation with municipalities located in the county, working through a Watershed Plan Advisory Committee (WPAC). Comprehensive, consistent, and practical implementation of the Plan will be facilitated through a single administrative agency.

Preparation of an Act 167 plan provides an opportunity for municipalities to retrofit existing sites to improve existing water quality impairments or existing sources of flooding problems. The types and degree of controls that are prescribed in the stormwater management Plan must be based on the expected development pattern and hydrologic characteristics of each individual watershed. The standards and criteria contained within the Plan are to be developed from the technical evaluations performed in the planning process in order to respond to the “cause and effect” nature of existing and potential storm runoff impacts in the watershed. The final product of the Act 167 watershed planning process is to be a comprehensive and practical implementation Plan, developed with a firm sensitivity to the overall needs (e.g., financial, legal, political, technical, etc.) of the municipalities within Forest County. Due to funding limitations, many of the factors unique to Forest County were not utilized in a significant manner so as to provide proper guidance in development of both this Plan and the model stormwater ordinance provided by the Department of Environmental Protection. Recognizing local involvement needed to go beyond surveys, County staff developed alternatives that will better serve the interests of both Forest County and of Act 167 in Forest County.

SECTION III GENERAL DESCRIPTION OF WATERSHEDS

A. General County Description

Forest County covers 275,000 acres and, according to the 2000 census, has a population of 4,946. The most populous municipality in Forest County is Jenks Township with a population of 1,261. Tionesta Borough and Tionesta Township follow with populations of 615 and 610, respectively.

B. Political Jurisdictions

The County is comprised of nine (9) municipalities. The political jurisdictions include eight (8) townships and one borough. All nine (9) of the municipalities also participate in the National Flood Insurance Program.

Table III-1

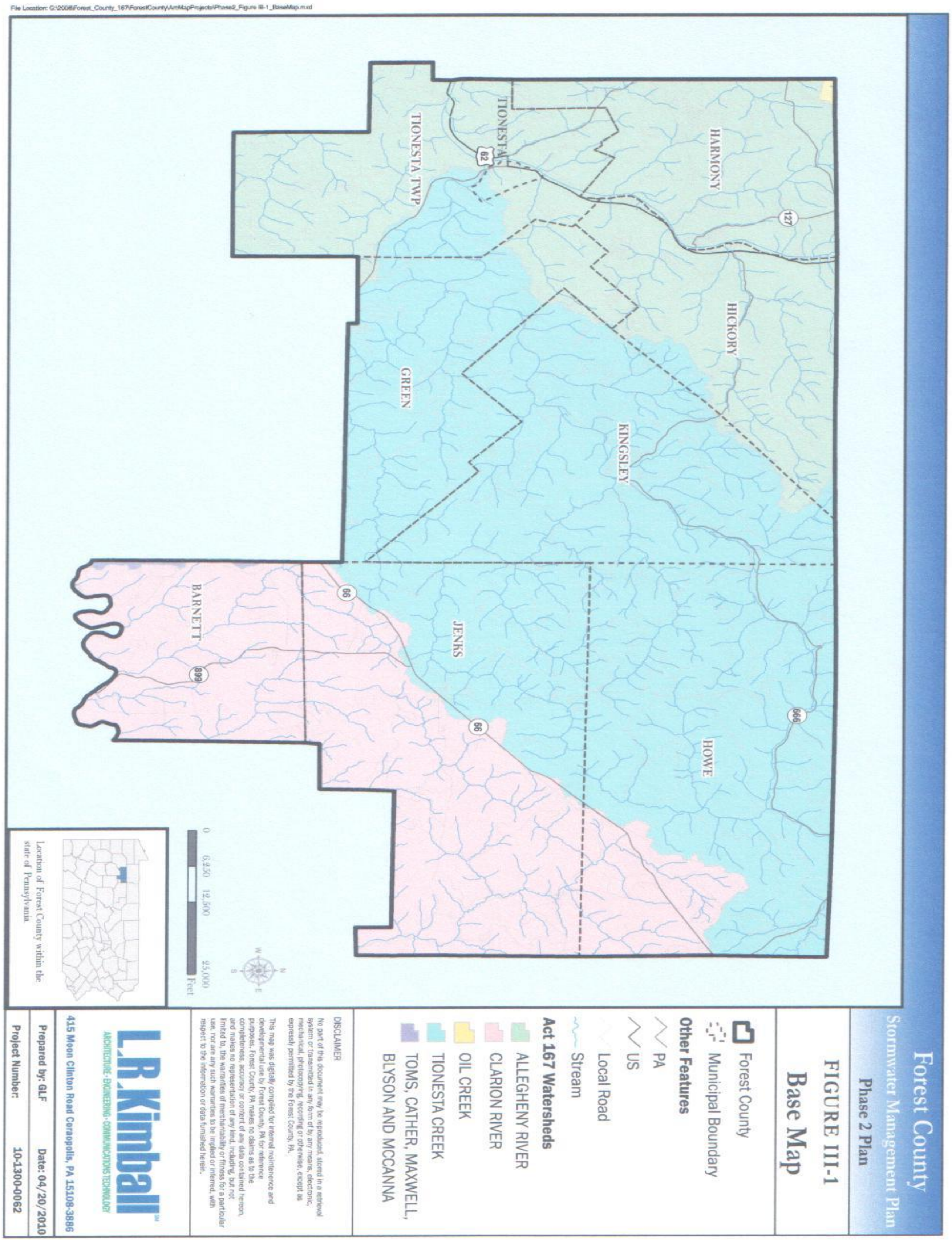
County Political Jurisdictions

Townships	Boroughs
Barnett	Tionesta
Green	
Harmony	
Hickory	
Howe	
Jenks	
Kingsley	
Tionesta	

Refer to Figure III-1 for a Base Map of Forest County.

C. NPDES Phase II Involvement

No municipalities in Forest County are included in an Urbanized Area (UA) as designated by the U.S. Census 2000. Therefore, no municipalities are required to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II requirements for operators of municipal separate storm sewer systems (MS4s). Oddly enough, some of the communities designated as MS4s have impervious surface exemptions of 10,000 square feet before comprehensive stormwater management plans are required. MS4s are typically, communities within municipalities with several times the population as all of Forest County and within municipalities far smaller than Forest County.



File Location: G:\2008\Forest_County_167\ForestCounty\ArcMapProjects\Phase2_Figure III-1_BaseMap.mxd
Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-1
Base Map
Forest County
Municipal Boundary
Other Features
PA
US
Local Road
Stream
Act 167 Watersheds
ALLEGHENY RIVER
CLARION RIVER
OIL CREEK
TIONESTA CREEK
TOMS, CATHER, MAXWELL, BLYSON AND MCCANNA
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Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
127
666
62
66
899
0
6,250
12,500
25,000
Feet
N
S
E
W
Location of Forest County within the state of Pennsylvania

D. Data Collection

In order to evaluate hydrologic responses of the watersheds, data was collected on the physical features of the watersheds. Data collection typically varies depending on whether a hydrologic or a detailed watershed model is to be developed and analyzed for a particular watershed. Because of limited funding, no target watersheds in Forest County were modeled during the current planning cycle. Without detailed data collection, target criteria for base values of required measures in the model stormwater management ordinance are apt to be invalid. Non-specificity to local conditions creates a gross or holistic approach with limited validity and consequently of limited value. A comparison of those criteria used in other localities provided some guidance for the base values utilized in the Forest County Stormwater Management Ordinance.

1. Base Map: The base map was created using data from a variety of sources:

Data	Source
Designated watershed boundaries	PA DEP
USGS 1:24,000 Quadrangle Maps	USGS
Roads	The Pennsylvania Department of Transportation
Municipal and County Boundaries	The Pennsylvania Department of Transportation
Networked Streams	The Pennsylvania State University/Environmental Resources Research Institute

Data were reviewed against available aerial mapping and each other to check for consistency. Other various datasets were used for compilation of the GIS and stormwater models for analysis, and are listed below.

2. Topography: USGS digital raster graphic (DRG) formatted topographic maps (1:24,000, 7.5 minute quadrangles) were used to create a watershed-wide DRG. Corresponding 7.5-minute digital elevation models (DEM) were used to create a watershed-wide digital elevation model.
3. Soils: All soil data was obtained from the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) in digital format. Generalized soils were obtained from the State Soil Geographic Database (STATSGO). STATSGO maps are statewide soil maps made by generalizing the detailed soil survey data. Soil mapping units with similar characteristics are grouped together. Data on hydrologic soil groups (HSG) was derived from the detailed Soil Survey Geographic Database (SSURGO) data. The spatial component of SSURGO data (the soil map) is provided as a GIS data layer. The attribute data (soil information) is provided as a relational Access database. Together the spatial data and relational database are referred to as National Soil Information System (NASIS) data. The NASIS data were processed to extract HSG classifications for the surface horizon of the soil-mapping units within the watershed.
4. Geology: The geology for the watershed was extracted from the statewide bedrock geology coverage produced by Pennsylvania Bureau of Topographic and Geologic Survey, Department of Conservation and Natural Resources (DCNR). The dataset obtained from the DCNR are not intended to be used at any scale finer than 1:250,000. The geology data are displayed for the watershed at a scale larger than 1:250,000. The geology information is provided for illustrative and general information only.

5. Land Cover: The land cover data was derived from digitized data provided by Forest County. This data is intended to provide a general overview of the watershed and to model stormwater runoff characteristics.
6. Wetlands: Wetlands were obtained from the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) in digital format and incorporated into the overall GIS. NWI maps are compiled from photo interpreted aerial photography from the National Aerial Photography Program (NAPP) 1:40,000 Scale, and the National High Altitude Photography Program (NHAP) 1:58,000 or 1:80,000 Scale. Source dates range from the 1970's to the present. The minimum mapping unit for treeless areas is 1/4 acres, 1 to 3 acres in general. The wetlands data is incorporated into the GIS dataset for illustrative purposes. Other wetland areas likely exist in the watershed that are not depicted on NWI maps.
7. Development in Floodplains: 100-year floodplain data, or special flood hazard areas, for Forest County was derived from the September 1996 Federal Emergency Management Agency (FEMA) National Flood Insurance Program Q3 Flood Data. The existing land cover was then clipped to these areas to depict the development in floodplains.
8. Obstructions: Bridges, culverts and pipes that convey streams and tributaries under roads, railroads and other similar infrastructure are referred to as obstructions. The obstruction locations and attribute information (size and shape) were determined from Stakeholder Survey information.
9. Problem Areas: Stormwater problems include flooding, erosion, sedimentation, landslides, groundwater impacts, pollution and other potential issues. Data on the location of these problems in the watershed were collected from surveys sent to each municipality within the watersheds and incorporated into the watershed geodatabase. The municipalities were provided a topographic map of their township or borough and a collection of forms. They identified and plotted the locations of the known problem areas on paper maps or in digital format and completed the forms that describe the problems at each location
10. Stormwater Management Facilities: Stormwater management facilities may include detention/retention basins, underground storage and constructed wetlands. These types of facilities were also identified, plotted and described on forms by the municipalities.
11. Stormwater Sewer System Outfalls: Municipalities in urban areas (as defined by the US Census Bureau) are required to map the location of storm sewer outfalls as part of the PA DEP Municipal Separate Storm Sewer System (MS4) program. Due to the fact that no municipalities within Forest County fall within the MS4 requirements, specific outfall information is not included as a part of this Plan.

E. General Development Patterns

Historically, Forest County has had a volatile economy, which has led to periods of both growth and decline. The present population consists of rural and small-town residents, many of whom are retired, which will likely result in future population decline. According to the information provided in the Pennsylvania Water Atlas of the State Water Plan, a static population or population decline is expected. Due to the presence of the prison in Marienville (SCI Forest) census numbers for Jenks and Howe Township appear to show a growth in population. Inmates however do not build homes, businesses, or contribute to stormwater increases. Inclusion of those persons on the census rolls creates an illusion of growth that simply is not there. Marienville did have a modest growth in business construction (two or three business structures were constructed) as a result of the building of the prison facility. Forest County has very few light manufacturing businesses,so employment which would help to drive growth does not exist. Recreational homes represent another sector of the population that could impact stormwater management in Forest County. However, this sector is economy dependant. In the current economic climate, recreational home building in Forest County is at an all time low. Even though the current Comprehensive Plan notes that population growth will be more dependent upon immigration than natural increase, and therefore projects only modest future growth, that Plan is dated and is currently being revised to reflect current conditions.

To address the need for economic diversity and modest growth the County identified Growth Priority Areas in their Comprehensive Plan to encourage infrastructure development, focus marketing efforts and create development incentives for communities or property owners. Growth Priority Areas are located along the Route 66 corridor, north and south of Marienville in Jenks Township, and along the Route 36 corridor, south of Tionesta in Tionesta Township.

The Comprehensive Plan also noted that much of Forest County's future business base will need to come from within, and that the business base has traditionally been concentrated in small downtown areas such as Marienville and Tionesta. The County plans for public expenditures to continue to support historic investment in these areas.

There is also a need for revitalization of agricultural areas, as much farmland has been lost to State and Federal acquisition and simple abandonment. The Comprehensive Plan identifies these as Revitalization Areas and has defined a Public Land Growth Boundary where areas outside this boundary, such as prime farmlands, should not be acquired by state or federal agencies. Given the impact that public land ownership has in Forest County, future development can be expected, but it will be modest since less land is available for that use.

F. Physiography and Geology

Forest County lies entirely within the High Plateau Section of the Unglaciated Appalachian Plateau (or Allegheny Plateau) Physiographic Province. Broad, rounded to flat uplands with deep, angular valleys characterize the High Plateau Section. The stream drainage pattern of the Unglaciated Allegheny Plateau is dendritic, resembling the branching of trees.

The bedrock geology in Forest County was formed during the Pennsylvanian, Mississippian, and Devonian Periods of the Paleozoic Era. During that span of time, repeated sea advances and retreats deposited sands, silts, clays and coals, which in turn formed the sequence of sedimentary rocks that are found in the County today. Minor uplift occurring about 200 million years ago, caused in part by the Allegheny Orogeny (mountain building event), added to the present bedrock structure. Since that time, streams have eroded and dissected the plateau, exposing the younger rock at the higher elevations and the successively older rock of the valley walls and bottoms. The surficial geology of the county is dominated by sandstone, shale, siltstone, and conglomerates, with coal and limestone found in lower or older strata.

The geology and geomorphology of Forest County also affects projected development growth trends. Due to the dendritic stream patterns and the youthful landscape (from a geomorphologic perspective) valley walls are steep in slope which limits future land development growth projections on a sizable percentage of land surfaces in Forest County.

Refer to Figure III-2 for a general geology map of Forest County.

G. Climate

The climate in Forest County is humid and temperate. Based on temperature and precipitation data recorded at Tionesta, the mean annual temperature for the region is 46°F. In winter, the mean temperature is 32.2°F, with an average daily minimum temperature of 22°F. In summer, the mean temperature is 60°F and the average daily maximum temperature is 72°F. The growing season ranges from approximately 126 to 165 days, depending on aspect and elevation. Precipitation is evenly distributed throughout the year, but is significantly heavier on the windward, west facing slopes than in the valleys. The average annual precipitation is 43 in., while the average snowfall is 74 in.

H. Soils

Soil properties influence the runoff generation process. The USDA, Natural Resources Conservation Service (NRCS) has established a criterion determining how soils will affect runoff by placing all surface horizon soils into four Hydrologic Soil Groups (HSGs) – A through D, based on infiltration rate and depth. Hydrologic soil group A is characterized as having high infiltration rates and therefore low runoff potential. Group B is characterized as having moderate infiltration rates, and it consists primarily of moderately deep to deep, moderately well to well drained soils that exhibit a moderate rate of water transmission. Group C soils have slow infiltration rates when thoroughly wetted and contain fragipans, a layer that impedes downward movement of water and produces a slow rate of water transmission. Hydrologic Soil Group D soils are tight, low permeable soils with high runoff potential and are typically clay soils.

The soils of Forest County are primarily derived from siltstone, shale, and sandstone, and tend to be acidic in nature. On a gross scale, the soils of the county are gray-brown podzolic soils that typically underlie mixed northern conifer-hardwood forest. On a finer scale, the county's fifty-three soil types have been grouped into six associations based on similarities in climatic or physiographic factors and soil parent materials.

Hazleton-Cookport-Cavode soils are deep, well drained, through somewhat poorly drained, mainly sloping and moderately steep soils that formed in materials weathered dominantly from acid sandstone and shale.

Cavode-Ernest-Gilpin are deep and moderately deep soils that are somewhat poorly drained through well drained, mainly sloping and moderately steep soils that formed in materials weathered dominantly from acid shale and sandstone.

Ernest-Wharton-Gilpin are deep and moderately deep soils, moderately well drained to well drained and mainly sloping to moderately steep soils that formed in materials weathered from acid shale, siltstone and sandstone.

Gilpin-Cavode-Ernest are moderately deep and deep, well drained through somewhat poorly drained soils, mainly sloping to very steep soils that formed in materials weathered from acid shale and sandstone.

Hazleton-Gilpin-Ernest are moderately deep and deep, well drained, mainly sloping, steep and very steep soils that formed in materials weathered from acid shale and sandstone.

Cookport-Hazleton-Ernest are deep, moderately well drained and well drained, mainly gently sloping soils that formed in materials weathered from acid sandstone and shale.

Hanover-Alvira-Shelmadine are deep well drained through poorly drained, mainly gently sloping and sloping soils that formed in pre-Wisconsin glacial till.

More descriptive breakdowns of each soil in the series can be found below.

Hazelton Series: The soils of the Hazelton series consists of deep and very deep, well drained soils formed in residuum of acid gray, brown or red sandstone on uplands. Slope ranges from 0 to 80 percent. Permeability is moderately rapid to rapid. Mean annual precipitation is about 48 inches. Mean annual air temperature is about 51 degrees F.

Hanover Series: The Hanover series consists of deep, moderately well drained and well drained soils formed in weathered Illinoian glacial till with a thin mantle of loess in some areas. These soils are on uplands and have slopes ranging from 0 to 40 percent. Permeability is moderate above the fragipan and slow in the fragipan. Mean annual precipitation is about 38 inches, and mean annual temperature is about 50 degrees F.

Cookport Series: The Cookport series consists of deep and very deep, moderately well drained soils formed in residuum weathered primarily from sandstone but includes some materials from shale and siltstone. Permeability is moderate above the fragipan and slow in the fragipan. Slope ranges from 0 to 25 percent. Mean annual precipitation is about 50 inches, and mean annual temperature is about 52 degrees F.

Alvira Series: The Alvira series consists of very deep, somewhat poorly drained soils formed in loamy pre-Wisconsin glacial till derived from sandstone, siltstone, shale, and some quartzite. The soils are on glaciated uplands. Slopes are dominantly 0 to 15 percent. Permeability is slow. Mean annual precipitation is 42 inches. Mean annual temperature is 53 degrees F.

Wharton Series: The Wharton series consists of deep and very deep, moderately well drained soils formed in residuum from interbedded clay shale, siltstone, and fine-grained sandstone. They are on uplands. Slopes range from 0 to 35 percent. Permeability is slow or moderately slow. Mean annual precipitation is 42 inches. Mean annual temperature is about 51 degrees F.

Ernest Series: The soils of the Ernest series are very deep, moderately well or somewhat poorly drained soils formed from colluvium derived from acid shale, siltstone and sandstone.Permeability is moderately low. Slope range is 0 to 50 percent. Mean annual precipitation is 43 inches. Mean annual air temperature is 48 degrees F.

Gilpin Series: The Gilpin series consists of moderately deep, well drained soils formed in residuum of nearly horizontal interbedded shale, siltstone, and some sandstone of the Allegheny Plateau. They are on gently sloping to steep, convex, dissected uplands. Slope ranges from 0 to 70 percent. Permeability is moderate. Mean annual precipitation is 43 inches, and mean annual air temperature is 51 degrees F.

Cavode Series: The Cavode series consists of deep and very deep, somewhat poorly drained upland soils formed in residuum weathered from gray and yellow acid shale interbedded with siltstone and sandstone. Permeability is moderate to moderately slow in the surface layer and upper subsoil and slow in the lower subsoil and substratum. Slope ranges from 0 to 25 percent. Mean annual precipitation is about 42 inches and the mean annual air temperature is about 51 degrees F.

Shelmadine Series: The Shelmadine series consists of very deep, poorly drained soils formed in glacial or periglacial material. Slopes range from 0 to 15 percent. Permeability is slow. Mean annual precipitation is 41 inches. Mean annual temperature is 49 degrees F.

Many of the soils in Forest County affect the likelihood of future development since the majority of the County depends on on-lot sewage systems to serve home owners. The population centers of Marienville and Tionesta have municipal sewage systems, but the majority of the County does not. Soils determine not only the type of on-lot sewage system which can be used, but also influence the costs associated with instillation of such systems. Very few of the soils found in Forest County are considered excellent for in ground sewage systems. The marginal soils depend upon expensive systems to manage sewage. Therefore, there is a natural limitation to land development due to natural soil conditions in Forest County. The soils also impact and limit the types of stormwater mitigation techniques available to land developers. Infiltration systems should be limited due to the presence of unsuitable soils common to the County. If stormwater management techniques are required due to the size of impervious surfaces being created, water retention systems should be considered as the most likely to provide desired affects.

County soils are shown in Figure III-3.

I. Water Resources

Forest County lies entirely within the Ohio River drainage basin, and is drained by the Allegheny River and its tributaries. The main stem of the Allegheny River drains an area of 118 mi^2 within the county, and its two major tributaries, the Clarion River and Tionesta Creek, drain 105 mi^2 and 209 mi^2 respectively.

Allegheny River Watersheds: The Allegheny River is approximately 325 miles long, and drains a rural dissected plateau of 11,580 mi^2 in the northern Allegheny Plateau, providing the northeastern most drainage in the watershed of the Mississippi River. In 1992, the U.S. Congress granted three sections of the Allegheny River, totaling 86.6 miles, the designation of Wild and Scenic River. These sections are classified as Recreational to reflect the relatively high level of accessibility and development relative to other rivers in the Wild and Scenic Rivers System.

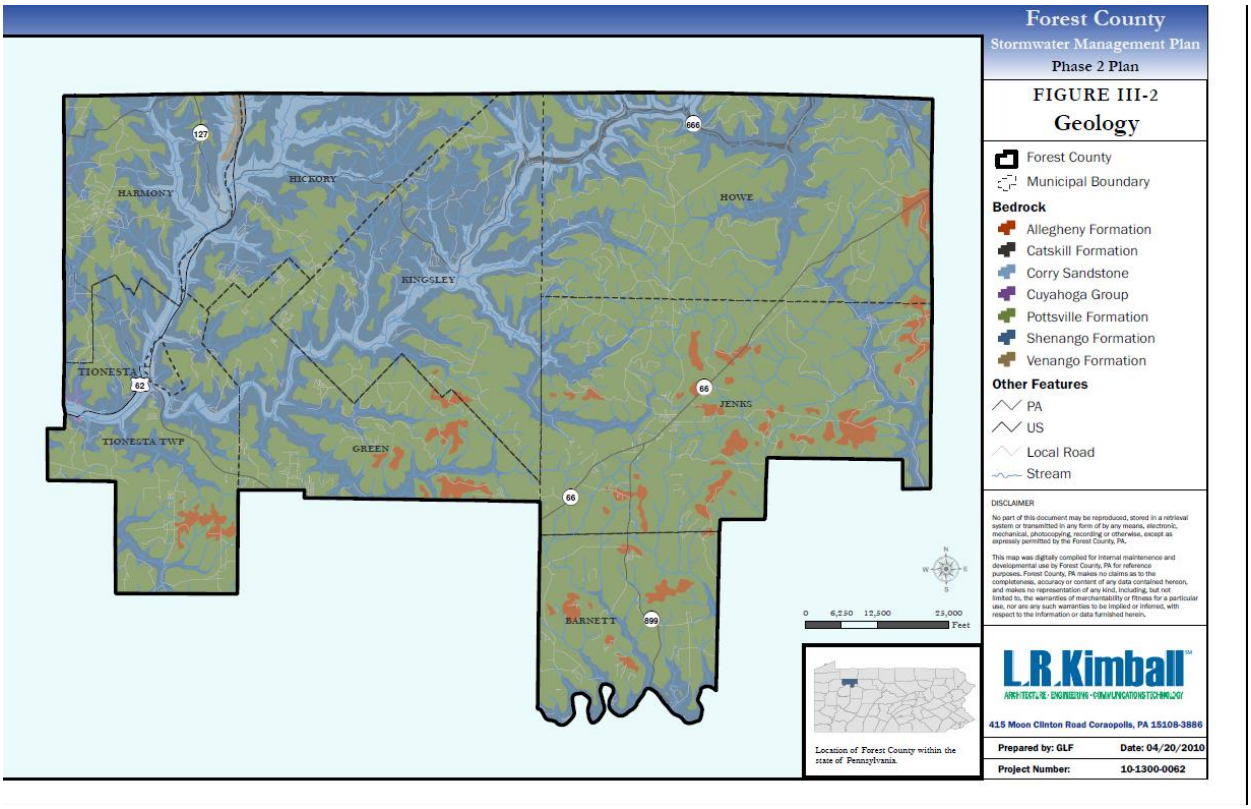
The Allegheny River Landscape Conservation Area captures the approximately forty-seven mile segment from the Buckaloons Recreation Area at Irvine to the southern end of Alcorn Island at Oil City. The seven Allegheny Wilderness Islands also lie within this section of the Allegheny River. This section of the Allegheny continues to support a rich diversity of fish and mussel species. Currently, sixty-eight species of fish - nine of which are considered species of special concern in PA - occur within this stretch of river. Twenty-four species of freshwater mussels have also been documented, thirteen of which are of special concern in Pennsylvania. Of those thirteen species, two species are listed as Federally Endangered, and two species are Candidates for Federal listing.

Clarion River Watersheds: The Clarion River flows 101 miles through Forest, Jefferson, and Clarion Counties, discharging into the Allegheny River near Parker, PA. Over half the river was granted Wild and Scenic River status by Congress in 1996, and this entire area is encompassed by the Landscape Conservation Area. The free-flowing character of the River supports a rich diversity of fish, odonates, and recovering freshwater mussel fauna.

The River is free flowing and relatively slow moving with meanders and a generally steep valley with little floodplain. Major tributaries to the River include Wolf Run, Spring Creek, and East Branch Millstone Creek.

Tionesta Creek Watersheds: Tionesta Creek is a tributary of the Allegheny River that flows through Forest, Clarion, Warren, McKean, and Elk Counties. Tionesta Creek is 61.9 miles long, and its watershed is 480 mi^2 in area. The Tionesta Creek Landscape Conservation Area includes the main stem of the Tionesta Creek roughly from its confluence with Jake Run upstream to Lynch, plus Bluejay Creek and the tributaries flowing into these sections of Tionesta Creek and Bluejay Creek. Forty-one fish species and five freshwater mussel species inhabit Tionesta Creek.

Figure III-2


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-2
Geology
Forest County
Municipal Boundary
Bedrock
Allegheny Formation
Catskill Formation
Corry Sandstone
Cuyahoga Group
Pottsville Formation
Shenango Formation
Venango Formation
Other Features
PA
US
Local Road
Stream
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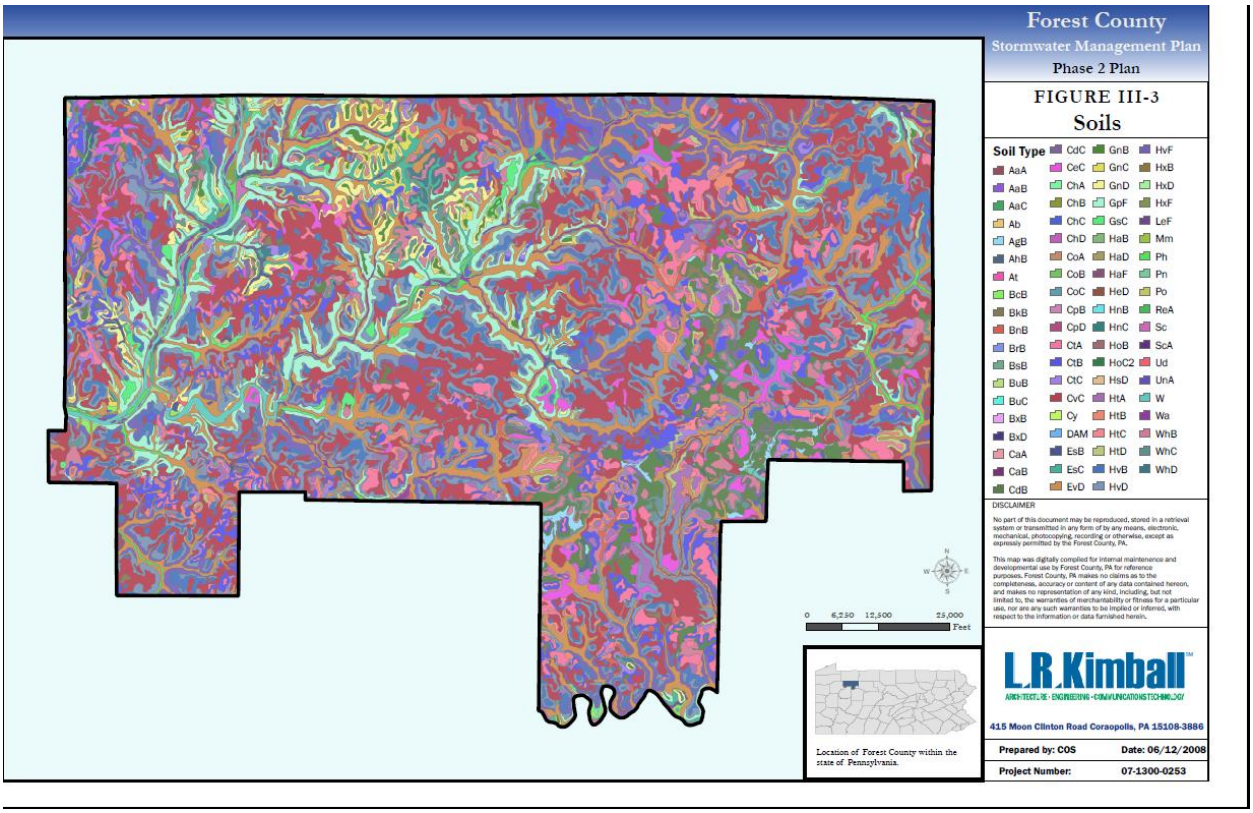
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
127
666
62
66
899
0 6,250 12,500 23,000
Feet
Location of Forest County within the state of Pennsylvania.
L.R.Kimball
415 Moon Clinton Road Coraopolis, PA 15108-3886
Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062

Figure III-3


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-3
Soils
Soil Type
AaA AaB AaC Ab AgB AhB At BcB BkB BnB BrB BsB BuB BuC BxB BxD CaA CaB CdB
CdC CeC ChA ChB ChC ChD CoA CoB CoC CpB CpD CtA CtB CtC CvC Cy DAM EsB EsC EvD
GnB GnC GnD GpF GsC HaB HaD HaF HeD HnB HnC HoB HoC2 HsD HtA HtB HtC HtD HvB HvD
HvF HxB HxD HxF LeF Mm Ph Pn Po ReA Sc ScA Ud UnA W Wa WhB WhC WhD
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N
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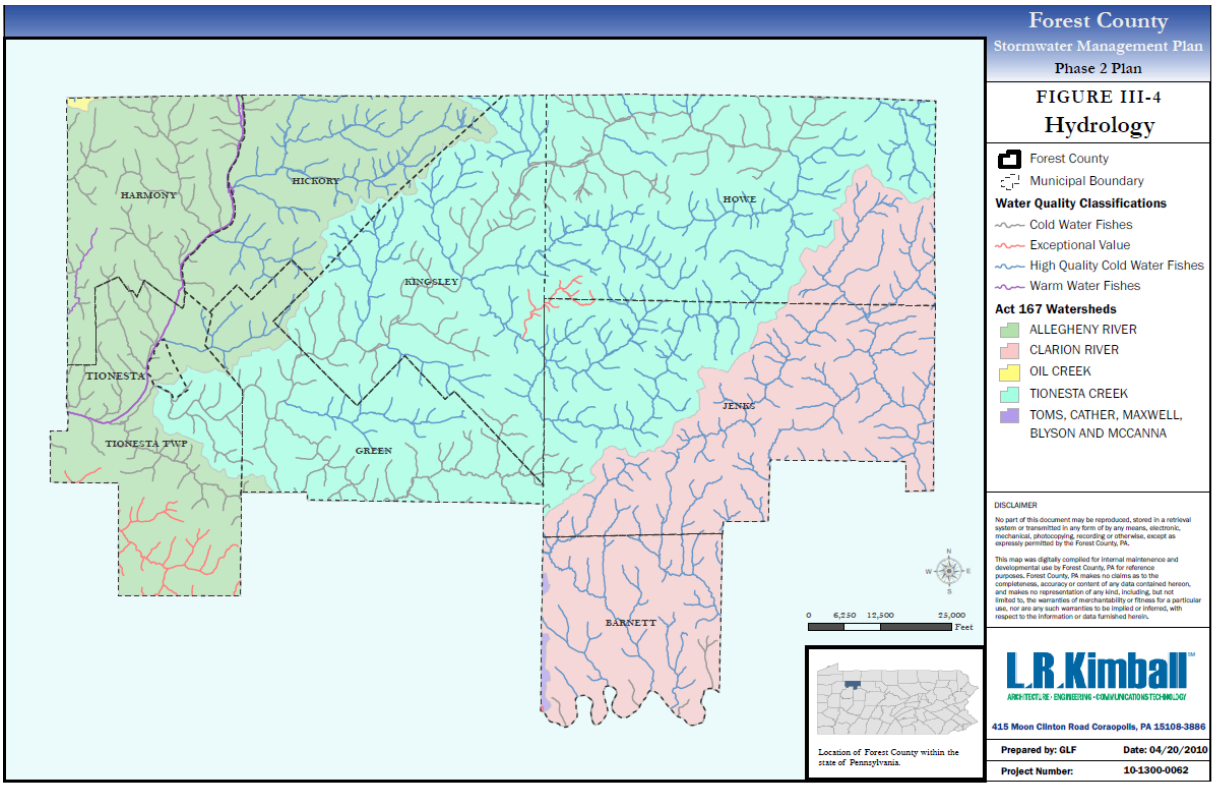
Feet
Location of Forest County within the state of Pennsylvania.
L.R.Kimball
ARCHITECTURE · ENGINEERING · COMMUNICATIONS TECHNOLOGY
415 Moon Clinton Road Coraopolis, PA 15108-3886
Prepared by: COS
Date: 06/12/2008
Project Number:
07-1300-0253

Figure III-4


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-4
Hydrology
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
Forest County
Municipal Boundary
Water Quality Classifications
Cold Water Fishes
Exceptional Value
High Quality Cold Water Fishes
Warm Water Fishes
Act 167 Watersheds
ALLEGHENY RIVER
CLARION RIVER
OIL CREEK
TIONESTA CREEK
TOMS, CATHER, MAXWELL, BLYSON AND MCCANNA
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.
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Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062

Designated Act 167 watersheds in Forest County include:

Allegheny River

Clarion River

Tionesta Creek

Toms, Cather, Maxwell, Blyson & McCanna

Oil Creek

J. PA Chapter 93 Stream Classifications

Current (2008) PA Chapter 93 stream water quality classifications are shown on Figure III-4. A summary table of the streams in Forest County based on this data is presented below:

Table III-2

County Chapter 93 Stream Classification Summary

Classification	County Stream Miles	Percentage of Overall
Exceptional Value (EV)	30.21	3.62%
High Quality (HQ) Cold Water Fishery (CWF)	480.51	57.63%
Cold Water Fishery (CWF)	272.33	32.66%
Warm Water Fishery (WWF)	50.75	6.09%

K. Obstructions

Locations of significant waterway obstructions (i.e., culverts, bridges, etc.) were obtained by a number of methods. Some of the methods used to properly verify the presence and to further address the integrity of the obstructions was through the use of:

1. Inspection of the United States Geologic Survey (USGS) topographic base mapping
2. Data from the Pennsylvania Department of Transportation (PADOT)
3. FEMA Flood Insurance Studies
4. Phase 1 Stormwater Problem Area survey results

No obstruction field verification work was performed during this planning cycle due to schedule and budget limitations. Future planning cycles should include obstruction field verification work. Without field verification and inspection, it is unknown what real impacts occur due to undersized culvert pipes. Much of the hydrological modeling depends on proper data, and without such modeling it is inappropriate to make too many sweeping conclusions regarding the amount of stormwater problems that exist or what kind of measures are appropriate to address those 'ghost' problems. The municipal surveys did provide some feedback as to current conditions but only in a limited manner; culvert replacement, ditch maintenance, and other practices may solve a local condition but affect another area of roadway down stream in the watershed. Blanket replacement of culverts with larger sized pipes, for instance, could result in more water reaching undersized culvert pipes 'down' watershed within the same township or in a neighboring township. Therefore some solutions only transfer the problem geographically, and actually cause more

concentrated problems 'down' watershed. Nothing in this Plan should contribute to any wholesale solution without proper study being done within the watershed for the locality where the drainage work is being proposed. Any culvert size changes should occur from the lowest points in the drainage to the higher points in the drainage, thus avoiding over taxing smaller culvert sizes 'down' watershed during stormwater events.

A recommended field verification process would start using GIS data from the above sources and generating field maps. Field crews would then visually inspect and assess as many of the known structures as possible, as well as any unknown structures discovered during the fieldwork. The type of information obtained through the field investigations should include the following:

1. Verification that the structure is present
2. Type of structure
3. Physical characteristics and dimensions of structure
    a. Diameter/opening width
    b. Depth from bottom of channel to top of opening or crown of pipe
    c. Depth from pipe crown or top of opening to approximate crown of road above
    d. Bridge piers and abutments
    e. Pipe/bridge material
4. Structural condition of structure
5. Observed deficiencies with the structure
    a. Damaged pipe or bridge
    b. Siltation/sedimentation
    c. Evidence of insufficient capacity (visual evidence of overtopping)
6. Photographs documenting structure

All field data should be recorded on standardized field survey forms. Typically, any structure under 18 inches in diameter could be excluded from the field survey operations. Structures that small in size would not usually have a significant impact on overall watershed hydrology as they contain very little flow-carrying capacity and therefore would have little to no impact on water traveling through a watershed.

Based upon the limitations of the project and the reduction in scope and schedule, obstruction hydraulic capacity calculations were not performed. Consequently, capacity calculations for the obstructions are not included as part of this Plan. Future Plan updates should address capacity issues.

L. Dams and Impoundments

Existing dam locations are shown on Figure III-5 and are listed below.

Table III-3

Dams and Impoundments

Dam Number	Dam Name	Stream Name	Run of River?
27-011	Cooks Forest	Toms Run	Yes
27-015	Unnamed	Two Springs Run	
27-017	Buzzard Swamp No. 1	Tr Muddy Creek	
27-019	Ward's Ranch	Coon Creek	

M. Pollution and Stream Impairments

Table III-4 shows a summary of non-attaining segments of the Streams Integrated List representing stream assessments for the Clean Water Act Section 305(b) reporting and Section 303(d) listing.[1] PA DEP protects four (4) stream water uses: aquatic life, fish consumption, potable water supply, and recreation. If a stream segment is not attaining any one of its four uses, it is considered impaired. Based on the 303(d) data, the total number of impaired stream miles in Forest County caused by stormwater or urban runoff is approximately 19 miles. The impairment of these 19 miles is related to PCB's, heavy metals and mercury. Likely sources are unidentified. Since the impairments can be tracked upstream beyond the Forest County boundary, in both the cases of the Allegheny River, the Tionesta Creek and the Clarion River, it can be concluded that activities within Forest County probably did not create the impairments measured. Since there are virtually no urban areas in Forest County, and virtually no industry, stormwater events may be considered to be a non-contributor to the impairments encountered. The pH problems found in the waters of Forest County are a function of geology, the rocks of Forest County do not contain elements helpful to buffering acidic precipitation. If anything, the forest cover (93% of the County) aids in slowing stormwater velocity, as well as aids buffering, as it flows over and through organic materials found in the duff on the forest floor.

Table III-4

Non-attaining Impaired Stream Lengths

Impairment Source – Impairment Cause	Total (miles)
Natural Sources - Metals ; Natural Sources - pH ; Natural Sources - Siltation	2.37
Natural Sources - pH	1.57
Source Unknown - Mercury	14.99
Total Impaired Stream Miles:	**18.93**

[1] PA DEP Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division, 2006

Additional discussion and detailed information pertaining to pollution and stream impairments are discussed in the water quality portions of the Plan.

N. Stormwater Problem Areas

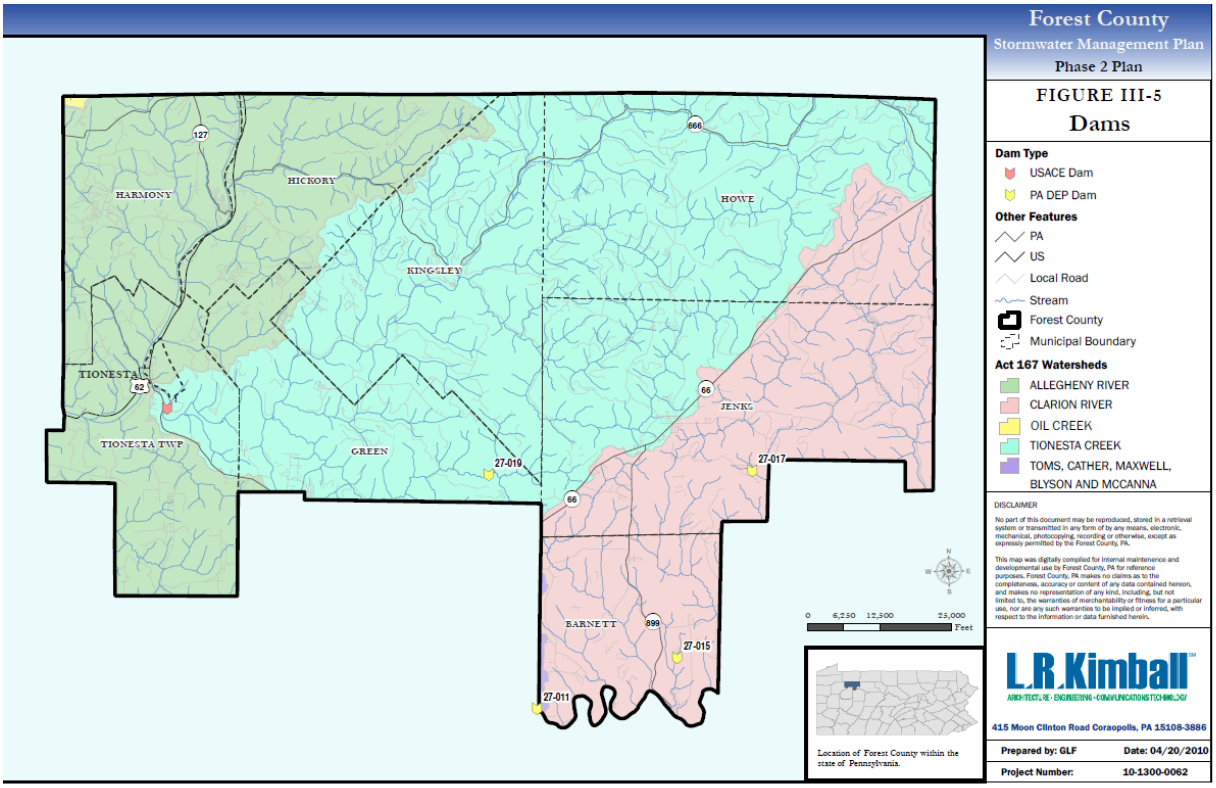
Through analysis of survey results received from the County municipalities, it was determined that the three primary stormwater problem types are street flooding, property flooding, and stream corridor flooding.

More detailed information pertaining to problem areas and possible solution strategies are discussed later in this Plan. While it is the initial intent of the Plan to focus on the primary stormwater problems identified above, the planning effort will also include further refinement and prioritization of stormwater problem solutions and strategies. Existing and potential problems caused by excessive stormwater runoff or pollution issues are indentified and addressed throughout the Plan. The Plan provides solutions and techniques to help better manage and mitigate existing problems and prevent future problems through proper management techniques and technologies. The problems identified in this section were further combined with other known issues within the County and then used to form the technological approach (discussed later in the Plan) for addressing the specific types of problems the County encounters.

The causes for the problems described above and listed on Figure III-6 range from increases in stormwater volume and velocity, inadequate infrastructure, obstructed waterways, AMD, excessive floodplain development, and illicit discharges. Refer to Figure III-7 for the identified problem causes.

The survey results provide a very general picture of conditions relating to stormwater events in Forest County. Factors that directly affect the results reported in the surveys include geography, antiquated drainage systems along roadways, improper installation of drainage structures, and other issues. Stormwater exacerbates some conditions that could be addressed in fairly simple ways. The geology of Forest County includes very steep walled and narrow valleys. The few buildings located within the watersheds of these valleys do not represent a large contribution to the concentration of stormwater resulting from extreme rainfall events. The solution to possible property damage in these valleys is the removal of the structures, in essence getting property out of harms way. Human intervention cannot mitigate such large geological and geographical conditions. Too many township roads are only a few feet above normal stream levels, and during storm events these roads become flooded. The solution is to raise the roadway or relocate the roadways, but this is cost prohibitive. In the past the location of some infrastructure and development ignored the natural conditions and placed these structures in harms way during extreme rainfall events. Little can be offered in this Plan to mitigate those decisions made in the past. Of course with proper funding and landowner cooperation, some stormwater problems could be addressed. However, common sense could be just as useful.

Figure III-5


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-5
Dams
Dam Type
USACE Dam
PA DEP Dam
Other Features
PA
US
Local Road
Stream
Forest County
Municipal Boundary
Act 167 Watersheds
ALLEGHENY RIVER
CLARION RIVER
OIL CREEK
TIONESTA CREEK
TOMS, CATHER, MAXWELL, BLYSON AND MCCANNA
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415 Moon Clinton Road Coraopolis, PA 15108-3886
Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
27-019
27-017
27-015
27-011
127
62
66
666
899
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.

A summary of the survey results indicating the types, frequency, and related severity of damage related to stormwater problems are shown in the table below:

Table III-5

Stormwater Management Problem Areas Identified in Survey

Municipality [1]	Problem Type	Problem Cause	Problem Frequency	Damage Type	Description
Barnett Township	3	1	1	3	
	3	5	1	3	
Green Township	2	1,2	2	2	
	2,3,5,6,7,8	1,2,5,4	1	2,3	Concentration of recreational homes with no SWM
	1,2,3,5,6,7,8	1,2,3	1	2,3	
	1,2,5,6,7,8	1,2,3	1	2	
Hickory Township	1,2,3,6,8	1,2,3,5	2	2,3	
	1,2,3,6,7,8	1,2,3	1	2,3	
	1,2,3,7,8	1,2,3	2	2,3	
Howe Township	1,2,3	1,2,3	2	3	Also road surface erosion
	1,3	1,6	2	2,3	
	1,2,3	1,2	2	2	Route 666
	5	3	1	2,3	SR 1----5
	1,4	1	2	2,3	Route 666
	1,2	1	3	2	Thad Shanty Run Route 666
	1,2	1	3	2	Reagan Run Route 666
	1,2	1,2	2	2	Rock Run Railroad Street
	1,2,8	1,2,5	4	2,3	SR 1----3 Emergency Parking Area
	3	1	3	3	Next to municipal office HC 1 Box 168
	3	1	3	3	15-1--A-154
	3	1	3	3	15-1---118
	3	1	3	3	US Forest Minister Campground
	2	--	--	2	
	2	--	--	2	
Kingsley Township	2	--	--	--	

Table III-5

Stormwater Management Problem Areas Identified in Survey

Municipality [1]	Problem Type	Problem Cause	Problem Frequency	Damage Type	Description
	2	--	--	--	
	2	--	--	--	
	2,3,1	--	--	--	
Tionesta Borough	1,2,3,5,8,5	1,2,4	1	2	Wet weather creek floods and erodes
	2,5,6	1,2	1	3	Flooding washes gravel from top of street to river
	2,5,6	1,2	1	3	
	1,3,5,6,7,8,9	1,2	1	3	
Tionesta Township	2,5,6,7,8	1,2	1	3	Jamison Run
	2,5,6,7,8,9,5	1,2,3	1	2,3	Pigeon
	2,7,8,5	1,2	1	3	
Allegheny NF [2]	5	5	1	--	SR 4----2 undersized culvert, road needs ditch work
	8	7	1	--	Piney Run-no riparian buffer, lake level fluctuations
	7,6	3,3	1	--	Sediment from T-356
	8	6	2	--	FR-145 in FP, seeps/stream compromise stability
	8,1	5,5	2	--	Erosion at snowmobile trail bridge by PA 666
	7,12	--	--	--	Sediment pollution source
	5	5	2	--	T-666 undersized culvert(s)
	5	5	2	--	Camp Run - undersized culvert
	8,5	7,7	1	--	T-328 1mi N PA 666
	7,12	1,6,7	1	--	Spring, Tionesta, Salmon, Beaver Creeks
	4,12	7,7	1	--	Millstone Creek - Acid deposition
Cornplanter SF [2]	2	1,2	2	2	Roadway flooded with heavy rain events
	2	1,2,3	1	2	Roadway narrows and stream parallels road

Table III-5

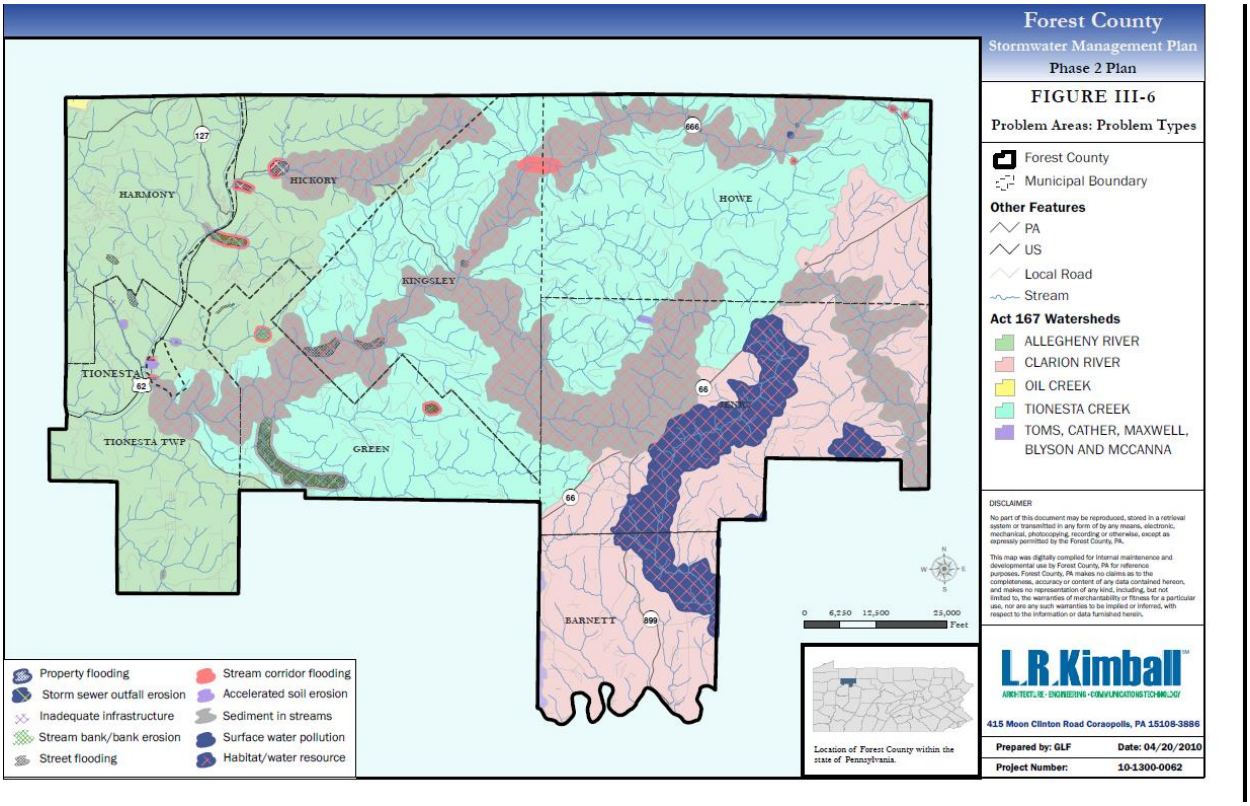
Stormwater Management Problem Areas Identified in Survey

Municipality [1]	Problem Type	Problem Cause	Problem Frequency	Damage Type	Description
	5	1,2	1	--	Previous problems in this area with culverts

Description Codes

Problem Types:	Description:	Problem Frequency:	Description:
1	Stream corridor flooding	1	Occurs > 1 per year
2	Street flooding	2	Occurs every 1 to 3 years
3	Property flooding	3	Occurs every 4 to 8 years
4	Surface water pollution	4	Occurs during flood events
5	Inadequate infrastructure (culverts/bridges/etc.)		
6	Accelerated soil erosion		
7	Sediment in streams		
8	Stream bed/bank erosion		
9	Storm sewer outfall erosion		
10	Habitat/water resources loss or damage		
11	Other		
Problem Cause:	**Description:**	**Damage Type:**	**Description**
1	Increase in the amount of stormwater (volume)	1	Loss of life
2	Velocity of stormwater	2	Loss of vital services
3	Poor drainage	3	Property damage
4	Discharge location (direction of flow)		
5	Water obstructions		
6	Floodplain development		
7	Other		

Figure III-6


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-6
Problem Areas: Problem Types
Forest County
Municipal Boundary
Other Features
PA
US
Local Road
Stream
Act 167 Watersheds
ALLEGHENY RIVER
CLARION RIVER
OIL CREEK
TIONESTA CREEK
TOMS, CATHER, MAXWELL, BLYSON AND MCCANNA
HARMONY
HICKORY
KINGSLEY
HOWE
TIONESTA
TIONESTA TWP
GREEN
BARNETT
Property flooding
Storm sewer outfall erosion
Inadequate infrastructure
Stream bank/bank erosion
Street flooding
Stream corridor flooding
Accelerated soil erosion
Sediment in streams
Surface water pollution
Habitat/water resource
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.
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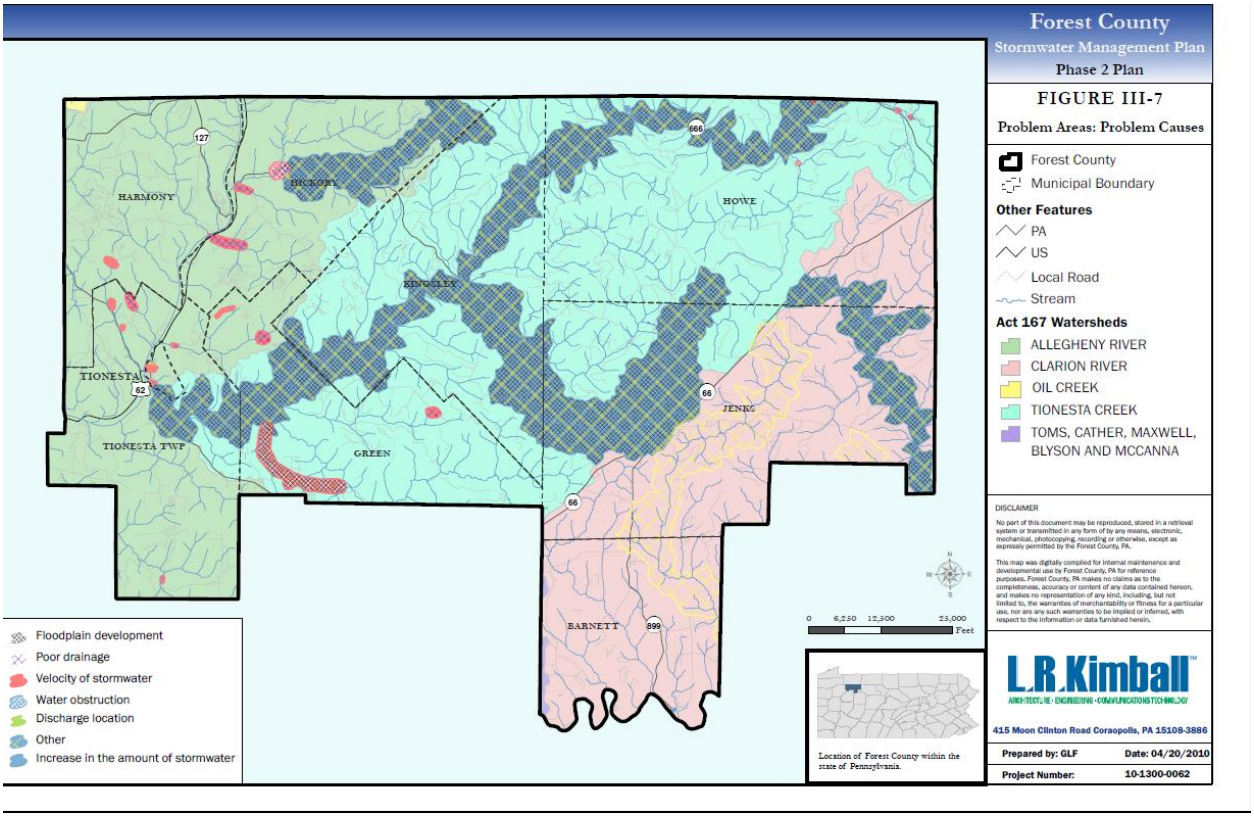
Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062

FIGURE III-7


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-7
Problem Areas: Problem Causes
Forest County
Municipal Boundary
Other Features
PA
US
Local Road
Stream
Act 167 Watersheds
ALLEGHENY RIVER
CLARION RIVER
OIL CREEK
TIONESTA CREEK
TOMS, CATHER, MAXWELL, BLYSON AND MCCANNA
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
127
666
62
66
899
Floodplain development
Poor drainage
Velocity of stormwater
Water obstruction
Discharge location
Other
Increase in the amount of stormwater
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.
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O. Land Use

Based on the National Land Cover Data Set for Pennsylvania, forests and wetlands cover roughly 259,600 acres, or 94 percent of Forest County. Of those 259,600 acres, 67 percent is interior forest habitat, 58 percent is hardwood forest, and the remainder is comprised of coniferous forest, mixed conifer-hardwood forest, shrub/scrub, and wetlands. The vast majority of contiguous areas of forest occur in blocks of less than 250 acres. The extensive acreage of publicly-held lands in the County has limited availability for development.

Forest County contains three major watersheds: the Clarion River, the Allegheny River, and Tionesta Creek.

Clarion River: Land uses in this watershed include Forest and Open Space, Agriculture, Commercial, Seasonal Residential, and Public Lands. Spring Creek-Wolf Run, Spring Creek and East Branch Millstone Creek watersheds are all considered Tier 1 Conservation Priority Watersheds, as determined by the Pennsylvania Aquatic Community Classification developed by the Pennsylvania Natural Heritage Program.

Allegheny River: Land uses in this watershed include Forest and Open Space, Agriculture, Commercial, Permanent Residential, and Public Lands. Two reaches of the Allegheny River within Forest County are Tier 1 Conservation Priority Watersheds. The East Hickory Creek watershed is also a Tier 1 Conservation Priority Watershed.

Tionesta Creek: Land uses in this watershed include Forest and Open Space, Agricultural, Commercial, Permanent Residential, Industrial, and Public Lands. The Tionesta Creek - Salmon Creek, Salmon Creek, South Branch Tionesta Creek, and Tionesta Creek main branch are also considered Tier 1 Conservation Priority Watersheds.

Land uses are identified and grouped below:

Table III-6

Land Use

Land Use	Area (Acres)	Area (Square Miles)	Percentage of County[2]
Rangeland Areas[3]	5226.20	8.2	1.90%
Forested Areas[4]	259,310.90	405.2	93.75%
Reservoirs	3776.0	5.9	1.37%
Residential	6769	10.6	2.45%
Transportation, Communications and Services	1449.20	2.3	0.53%
Totals:	**276,531.3**	**432.2**	**100%**

[2] Based on approximately 432 square miles

[3] Includes areas classified as croplands, pastures, and shrub-brush land

[4] Includes areas classified as deciduous, evergreen, mixed forest, and forested wetlands

Given that only 2.45% of Forest County is used for residential purposes, that being 10.6 square miles out of 432.2 square miles, and given that the average building density throughout the County is one of the lowest in the Commonwealth, it is logical to conclude that stormwater problems resulting from development must be extremely low. Low projections for population growth and limitations affecting development also would lead one to conclude that stormwater problems in the future will remain at levels similar to today or will decrease. Ground breaking work done by T. Schueler* showed how 10% of a watershed covered by impervious surfaces can have a detrimental affect on stream quality values. Looking at the data provided, 2.45% of the County is for residential purposes and 0.53% of the County is for transportation, etc. purposes. At a maximum, then, under 3% of the County is considered impervious surface, well below the 10% number where scientific study has shown impairment from impervious surfaces. Consideration of that fact must be made when establishing any coarse values to be made for use in a stormwater management ordinance. It must be understood also, that even with concentrations of residential and business dwellings in the few towns (none of which are over 700 persons) of Forest County, the percentage of land for those uses compared to the watershed percentage of land use remains below the 10% impervious surface impairment value.

Refer to Figure III-8 for Forest County Land Uses.

*(Schueler, T. 2003. Impacts of Impervious Cover on Aquatic Systems. Center for Watershed Protection. Ellicott City, MD)

P. Present (Existing) and Projected Development in the Flood Hazard Areas

The U.S. Department of Housing and Urban Development, Federal Insurance Administration, and Federal Emergency Management Agency (FEMA) prepare Flood Insurance Studies (FISs) and floodplain mapping for the municipalities in Forest County. This activity is now a responsibility of the U.S. Department of Homeland Security. Municipalities and the Pennsylvania Department of Community and Economic Development (PADCED) should be contacted as to the latest FIS studies before use.

There are two types of studies conducted in the FIS program: detailed and approximate. Detailed methods included hydrologic computations and detailed HEC-2 or HEC-RAS backwater computations. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction. Areas studied by the approximate methods were areas having low development potential or minimal flood hazards. Figure III-9 shows the 100-year floodplains classified as detailed and approximate as taken from the FEMA mapping for the entirety of Forest County.

Encroachments of residential, industrial, urban, transitional, transportation infrastructure, and commercial land covers are shown by overlaying these areas on the floodplain in the GIS.

Approximately 12,761 acres (4.6%) of the County are within floodplains.

The following table provides a summary of the total amount of floodplain area.

Table III-7

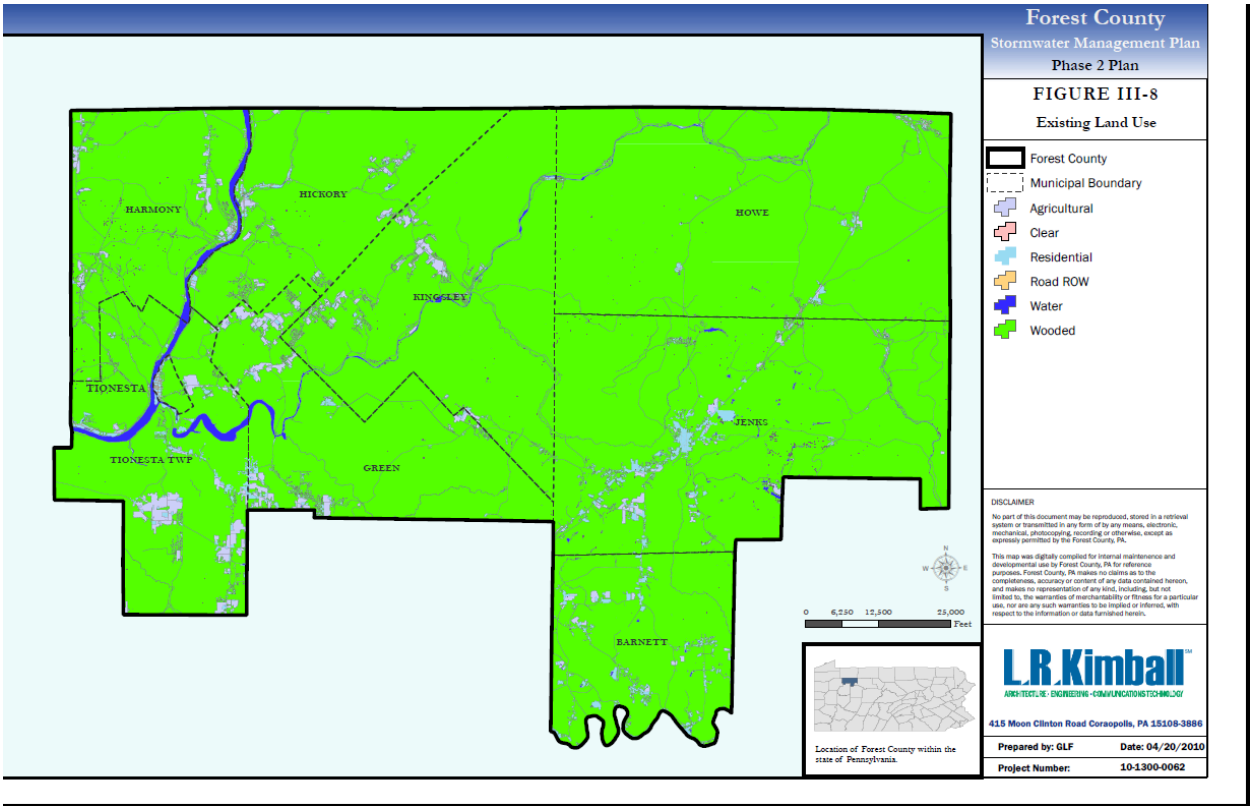
Floodplain Land Use

Land Use	Area (Acres)	Area (Square Miles)
Residential Areas	371.2	0.58
Wooded Areas	8896.0	13.9
Agricultural Areas	57.6	0.09
Water	3347.2	5.23
Transportation, Communications and Services	89.6	0.14
Totals:	**12,761.6**	**19.94**

Refer to Figure III-10 for mapping that overlays the existing, 100-year flood plain locations with the Forest County Land Uses. This map will show the degree to which urbanized development has occurred within the flood plain boundaries.

The evaluation of the returned municipal questionnaires shows occurrences of stream flooding throughout several of the more developed (rather than urbanized) areas of the County during major storm events, resulting in property damages. As a result, urbanized development of any kind within delineated flood plain areas is highly discouraged by this Plan. Restoration of existing flood plains and their eventual return to their naturally occurring conditions is key to improving the overall County stream conditions and flood-flow capacities. Recent map modernization of the floodplains in Forest County, and subsequent adoption of new Municipal Floodplain Ordinances should address the majority of stream flooding issues reported in the municipal surveys. A more detailed scientific study of existing floodplain conditions would reveal true conditions on the ground and point to more profound solutions to stream flooding occurrences. The funding limitations faced during this planning process have not allowed for the kind of work that could provide viable solutions in these confined watersheds where stormwater is directly related to stream flooding.

FIGURE III-8


Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-8
Existing Land Use
Forest County
Municipal Boundary
Agricultural
Clear
Residential
Road ROW
Water
Wooded
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.
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Prepared by: GLF
Date: 04/20/2010
Project Number:
10-1300-0062

FIGURE III-9

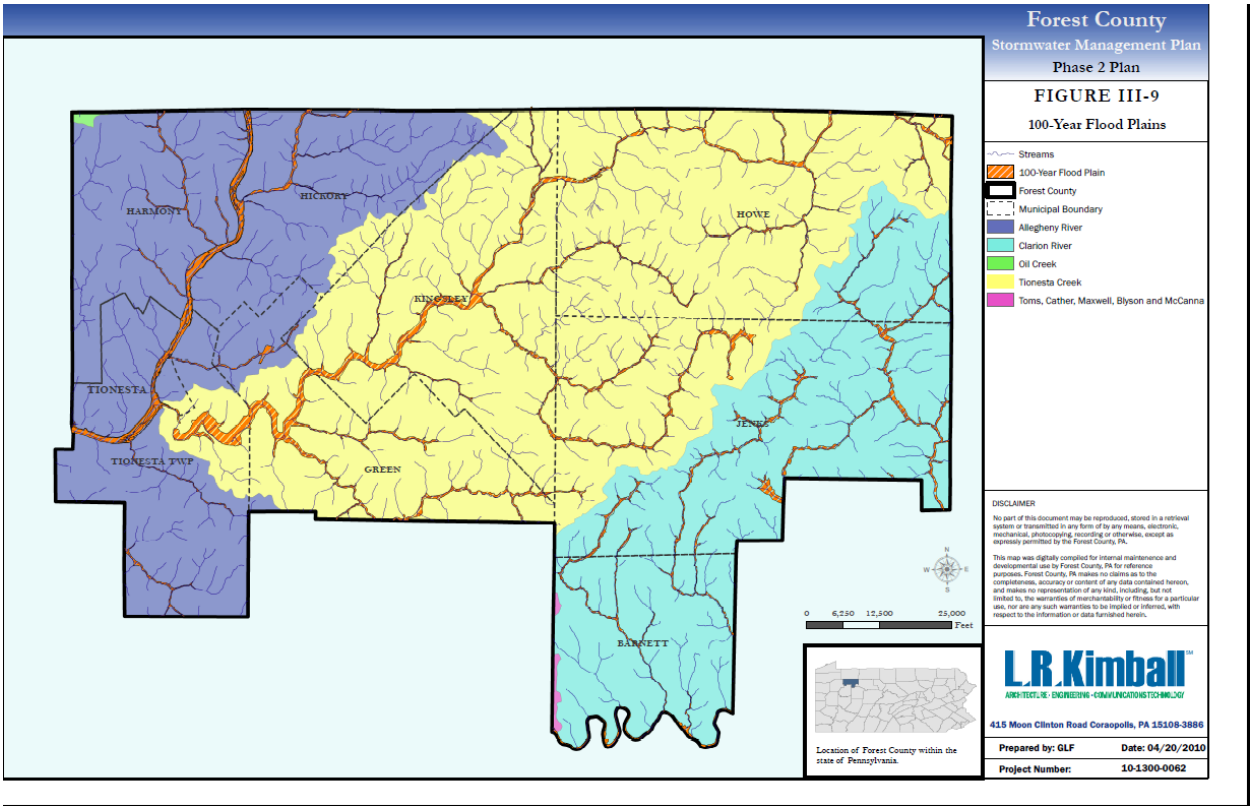
Forest County
Stormwater Management Plan
Phase 2 Plan
FIGURE III-9
100-Year Flood Plains
Streams
100-Year Flood Plain
Forest County
Municipal Boundary
Allegheny River
Clarion River
Oil Creek
Tionesta Creek
Toms, Cather, Maxwell, Blyson and McCanna
HARMONY
HICKORY
HOWE
KINGSLEY
TIONESTA
TIONESTA TWP
GREEN
JENKS
BARNETT
0 6,250 12,500 25,000
Feet
Location of Forest County within the state of Pennsylvania.
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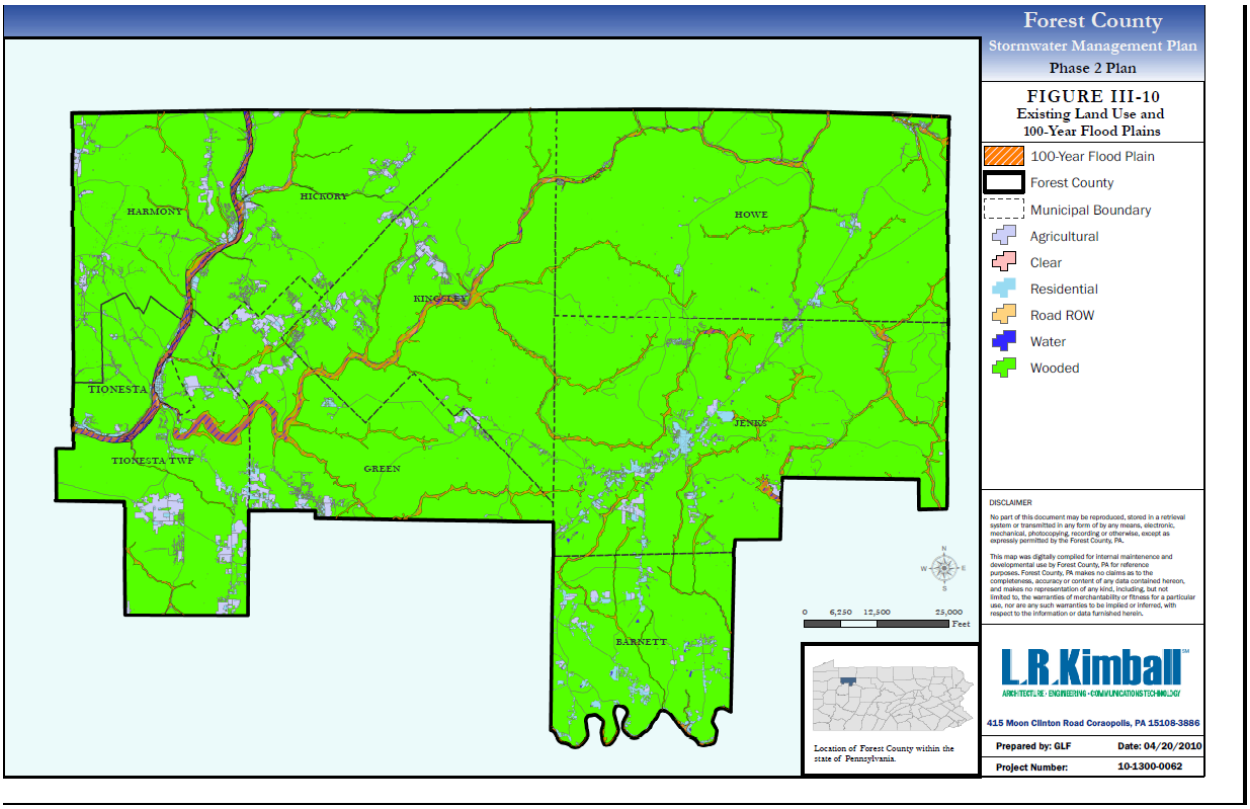
FIGURE III-10



SECTION IV WATERSHED TECHNICAL ANALYSIS

A. Watershed Modeling

The Phase 1 Scope of Study included hydrologic modeling for the watersheds shown below in Figure IV-1. Due to the schedule and budget limitations discussed previously, the hydrologic modeling for these watersheds was cut from the work conducted in the current planning cycle. Lack of hydrologic modeling does limit the ability for technical analysis that provides excellent guidance in management of stormwater dynamics as well as valid conclusions in regards to stormwater management techniques that are appropriate to each of Forest County's watersheds.

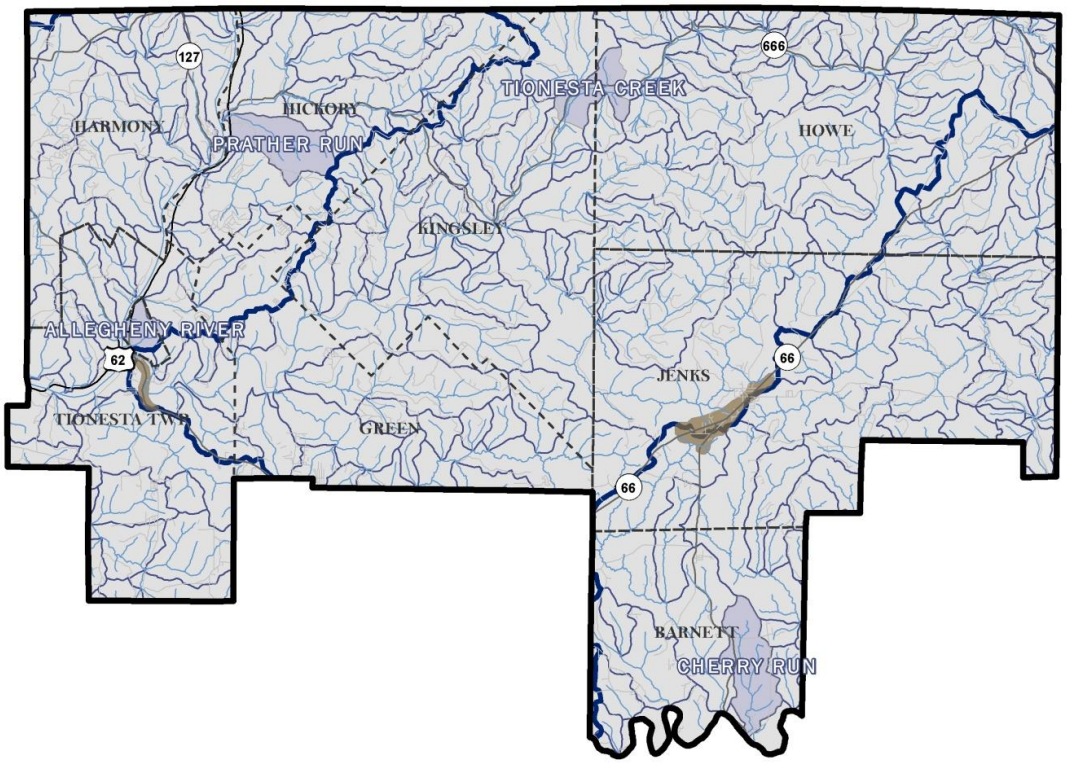


Figure IV-1

Lack of hydrologic modeling does not mean that no technical analysis was conducted in the current planning cycle. Rather, technical analysis was still conducted by breaking down watersheds of concern and evaluating their physical characteristics to determine watershed management and mitigation strategies based on the results of the analysis. Further and more rigorous analysis, including hydrologic modeling, should be implemented in future planning cycles.

The discussion below is a summary of the watershed modeling approach that should be used in future planning cycles.

In planning future Act 167 Stormwater Management Phase 2 update efforts, one of the initial steps should be the selection of a computer simulation package that can accurately and efficiently model the target watersheds.

The selected modeling method and program need to provide many capabilities related to stormwater modeling, but most importantly, it must achieve the following:

- Produce realistic and dependable results, while not requiring a disproportionate amount of input information
- Produce realistic simulations and results in comparison to the overall size of the study area
- Accurately and efficiently account for all pertinent physical properties of the naturally occurring hydrologic process
- Evaluate a variety of rainfall events, durations, and frequencies to generate outflow hydrographs which represented an accurate and realistic representation of the hydrologic conditions in all watersheds being studied

The recommended hydrologic model for use in future planning cycles is the U. S. Army Corps of Engineers (USACE), Hydrologic Engineering Center, Hydrologic Modeling System (HEC-HMS). The standalone HEC-HMS program should be supplemented with the use of the USACE GeoHMS software package in order to better leverage the value of the growing amount of countywide Geographic Information System (GIS) data available. The recommendation of the HEC-HMS and GeoHMS modeling software is based upon the following[5]:

- It is accepted by the Pennsylvania Department of Environmental Protection
- Provides the ability for combination modeling of the hydrology of natural watersheds as well as developed urban areas
- Provides the ability to represent engineered structures (e.g. pumps, diversions, reservoirs, etc.)
- The software places an equal value on both natural and urban watersheds (one of few software packages available that can model hydrology in watersheds with a mixture of conditions)
- The finalized model can easily be adapted for use in additional applications such as: estimating flood damage reduction, consideration of environmental restoration, future flexibility, and the ability to apply new methods that represent infiltration, new reservoir outlets, and several other components of the hydrologic cycle
- The use of the software allows for integration with other Federal, local, and private entities that are using compatible models produced from USACE software packages

While other commercially and freely developed software packages are available and possess the ability to provide similar results, HEC-HMS is recommended for the reasons outlined above as well as for HMS's ability to calculate flows for specific sub-watersheds along the stream/river route and then compare these flows with the overall watershed flows.

HEC-HMS has the ability to calculate runoff amounts for each specified storm or return period based on several physical, geological, and meteorological characteristics of the watershed. This flow is then generated and routed through the watershed system based on the stream's hydraulic parameters. This is one of the benefits of using the GeoHMS package in conjunction with HEC-HMS. The watershed's characteristics (listed above) are often available in GIS datasets from the County or other acceptable location. This greatly aids in streamlining the modeling process, increases the modeler's efficiency in producing the results, and helps to diminish the potential for "human error" by reducing the number of calculations that the modeler has to perform without the benefit of the software.

In essence, the amount of flow generated from any watershed is a result of the following contributing factors:

[5] The list is partially adapted from reference material published by the United States Army Corp of Engineers

- Basin Slope
- Hydraulic Flow Parameters of Related Streams/Rivers
- Soil Type/Hydrologic Soil Conditions (used for determination of the Soil Conservation Service (SCS) soil curve number)
- Land Use within the Basin (e.g. wooded cover, grassy areas, urbanized areas, open fields, etc.)

Composite SCS curve numbers (CN) are then generated by the software using the available soils and land use information. This information, along with flow travel times, basin slopes, and available rainfall data, are the basis for the resulting watershed and sub-watershed model results.

B. Modeling Process

The discussion below is a summary of the watershed modeling process recommended for use in future planning cycles.

The target watersheds within Forest County should be further subdivided into sub-watersheds for further study and analysis. The determination of sub-watershed boundaries should be based on a number of factors. Obstructions (e.g. bridges, culverts, and dams), reported problem areas (e.g. flooding, water-quality issues, excessive sedimentation, stream capacity issues, etc.), and confluence points between sub-watersheds are among the factors that should be used in the selection of sub-watershed areas.

The most downstream point of any sub-watershed, the point where the water will leave the sub-watershed and enter another sub-watershed, is known as the point of interest (POI). This is the point within each sub-watershed where the most significant results from the model are calculated. This is the point where the overall flow from the sub-watershed is determined. All areas upstream of this point are used to help determine the overall flow at any point of interest.

The point of interest should also be selected as a reasonable location for considering how to best and most effectively manage and control the runoff within the watershed contributing to the POI. The watershed POI acts as a management point, where a specific runoff rate can be determined and upstream management policies can be formulated around this quantifiable number. It also acts as a measurement point in determining any downstream impacts the overall watershed has on adjacent watersheds to which that watershed eventually discharges.

It is recommended that all watersheds and sub-watersheds be modeled to determine the overall runoff amounts for the following 24 - hour storm events:

- 2-year
- 10-year
- 25-year
- 50-year
- 100-year

The factors addressed during the modeling process should include:

- The peak discharge/overall runoff values at various locations along the stream and its tributaries within each modeled watershed
- The time at which the above mentioned peak discharge is reached (time to peak), and the overall timing of flow through the watershed

- Runoff contributions of individual sub-watersheds and sub-areas within those sub-watersheds at various downstream locations

After careful consideration by the County and PaDEP, it was agreed that a 5-year, 24-hour duration storm event adds little additional value to the hydrologic evaluation of a watershed. An Applicant may still analyze and evaluate a 5-year storm event at their discretion. However, if the 5-year storm is included, it must meet any stormwater management standards included in a county or municipal stormwater management ordinance.

The results for each individual watershed and the return periods shown should then be presented in an updated Technical Appendix of the Volume 3 document.

C. Calibration

The discussion below is a summary of the watershed model calibration process recommended for use in future planning cycles.

The most appropriate and accurate way to model any watershed is through the proper calibration of the model. The model should be calibrated against known field data and accurate, recent rainfall events collected within the analysis area. An acceptable alternative to the use of known physical and meteorological data is the use of statistical analysis or regression models (Paul A. DeBarry, 2004).

In its simplest form, calibration is the adjustment of model input parameters to converge upon and provide a realistic representation of the actual runoff and time conditions of the watershed based upon known, historical data.

Figure IV-2 shows a theoretical comparison between known, plotted data and the data provided by the model. An acceptably calibrated model will be one that reduces the amount of error between the plotted data when compared to one another. The information in Figure IV-2 is a simple stormwater hydrograph (flow versus time). As the two hydrographs come closer and closer together, and near a point of convergence, the model becomes more representative of realistic conditions within the watershed being modeled.

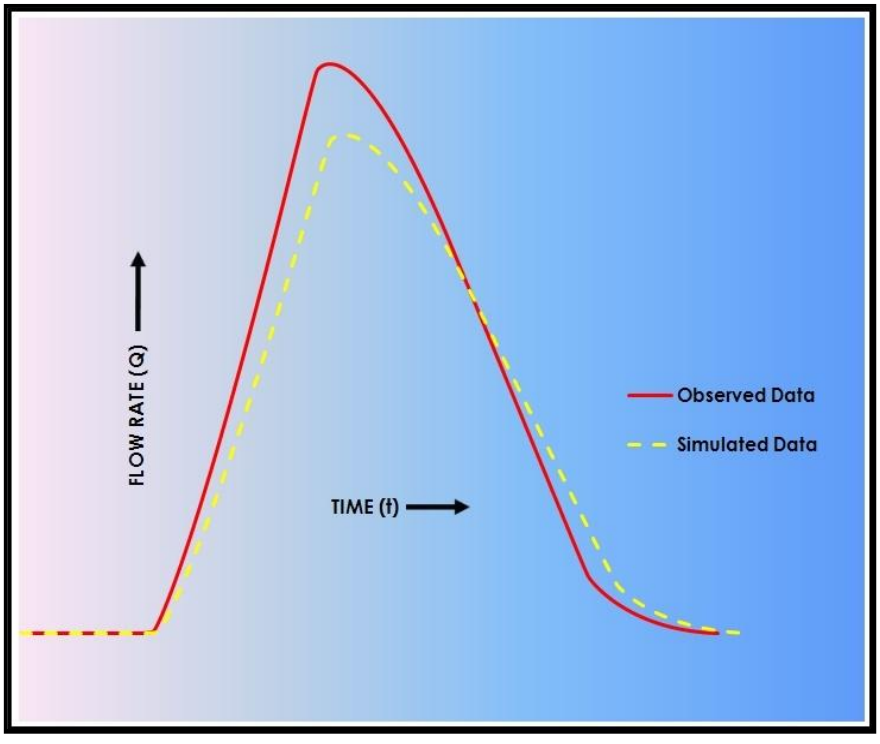


Figure IV-2

Hydrologic model calibration often uses the following procedures:

Table IV-1

Calibration Methods and Priority of Application (Paul A. DeBarry, 2004)

Priority	Data	Advantages	Disadvantages
1	Actual (historically recorded) stream flow data and rainfall hyetographs	Can adequately calibrate peak runoff, watershed timing, and runoff volumes	Historical and recorded data is often not available, especially in more rural areas; method of application is time-consuming
2	Statistical Frequency Analysis	Based on historically recorded data	Can only be used for the calibration of peak runoff amounts only; runoff volumes and watershed timing cannot be calculated
3	Regression Analysis (Regionally Derived)	Fast and not time-consuming for the modeler	The watershed in question may not fit the "regional trend[6]"
			Can only be used for the calibration of peak runoff amounts only; runoff volumes and watershed timing cannot be calculated

When historical precipitation and stream flow data is available, by way of recorded rain guage and stream flow information, the model can then be properly be set up to simulate hydrographs of the watershed.

If the modeler seeks to simulate a specific rainfall event, the model input needs to include information concerning the relative wetness and dryness of the watershed (antecedent moisture content) and the accurate distribution of rainfall throughout the watershed. The flow through any given watershed can be significantly impacted by the continuously changing antecedent moisture content.

Additional modifications to the simulation model are then also made in an effort to replicate the outflow hydrograph (shape and peak flow rates) at various measurement points within the watershed. The use of stream flow and rain gage data during the calibration process can only be used if the data is sufficient in amount as well as being geographically near the watershed. Since watershed distribution can vary quite significantly over relatively small areas, it is imperative that the rain and stream gages are numerous and as close as possible to the watershed in question.

The inclusion of more localized events and occurrences, such as snowmelt conditions, are typically not reliable sources of data for calibration efforts. This is because such data is not historically consistent and can often be unique to the area in question. The variation of this data over time makes it somewhat unreliable to yield realistic model simulation results.

[6] Regional trend is meant to indicate the varying flow conditions that can occur from watershed to watershed. Known rainfall data has proven that there is a possibility that precipitation conditions in one portion of a watershed can vary from that of another portion of the same watershed. This can even occur in very small watershed areas.

Forest County Calibration Effort

During future planning cycles where calibration is required, the following should be accounted for. Two USGS stream guages are present within Forest County (Stations 03016000 and 03020000, both on the western side of the County). However, the lack of an overall presence of such guages across the entire County limits the usefulness of their data, so comparison of the model runs with recorded or statistically analyzed historical data will not be a viable option. Any previously performed modeling efforts in Forest County likely used regression analysis methods for calibration. Therefore, the use of a regression analysis should be used to properly calibrate the future hydrologic modeling efforts as well.

The target watersheds should be calibrated by comparing the un-calibrated model results to a regression analysis. The regression analysis that is recommended for use is the "*Techniques for estimating magnitude and frequency of peak flows for Pennsylvania streams*" (Stuckey and Reed, 2000). This commonly accepted form of regression analysis presents equations that predict flood frequencies with return intervals of 10, 25, 50, 100, and 500-year intervals for un-gauged streams in Pennsylvania.

Specific basin characteristics should be used in the regression analysis formulas depending upon how the watershed being studied correlates with one of two delegated regions within Pennsylvania. These regions were delineated based upon technical evaluations revealing that flooding within Region A seems hydrologically unrelated to the flooding in Region B. See Figure IV-3 below for the Region map.

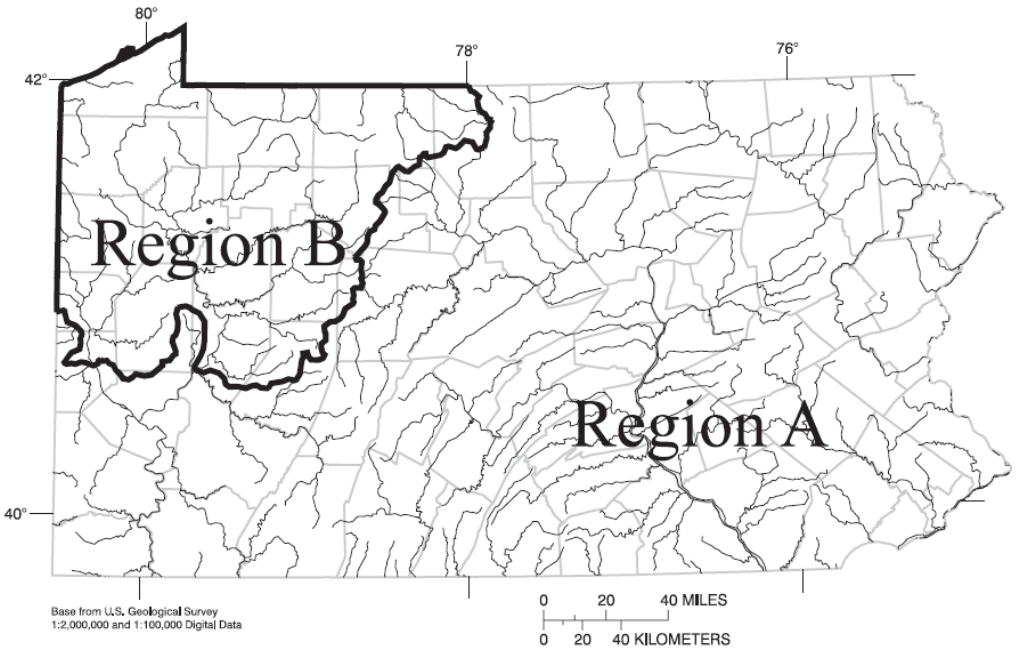


Figure IV-3
(Stuckey and Reed, 2000)

Forest County is located entirely within Region B, therefore future calibration efforts for Forest County should use the formulas for Region B. Regression equations for Region B were developed from 54 stream flow-gauging station records and have two (2) variables, drainage area and the percentage of basin controlled by lakes, swamps, and reservoirs. The area of the State that comprises Region B does not contain any significant areas of surface carbonate rock coverage (Figure IV-4). The percentage of urban area coverage is consistently low for stream flow-gauging stations in Region B. An overall lack of urban area coverage results in un-meaningful results during

analysis. The percentage of forest-type coverage was also not a significant variable and was therefore omitted from the analysis. From this information, each sub-basin area should be analyzed using the equations shown in Figure IV-4 below.

Q_T return flow (ft^3/s)	Basin characteristic coefficients						Residual standard error		Coefficient of determination (R^2)
	Intercept (A)	Drainage area (b)	Percentage forested area (c)	Percentage urban development (d)	Percentage carbonate area (e)	Percentage controlled area (f)	Log units	Percent	
Region A									
Q_{10}	2.5243	0.7770	-0.9712	1.0217	-1.7184	-0.5719	0.18	43	0.93
Q_{25}	2.7145	.7556	-1.0324	.7608	-1.5302	-.5302	.19	45	.91
Q_{50}	2.8441	.7414	-1.0821	.5785	-1.3955	-.4980	.21	50	.89
Q_{100}	2.9665	.7278	-1.1342	.4040	-1.2691	-.4637	.23	55	.87
Q_{500}	3.2294	.6994	-1.2666	.0208	-.9877	-.3834	.27	66	.82
Region B									
Q_{10}	2.3105	.7255	---	---	---	-1.2425	.12	28	.96
Q_{25}	2.4418	.7108	---	---	---	-1.3700	.13	30	.95
Q_{50}	2.5276	.7017	---	---	---	-1.4695	.14	33	.94
Q_{100}	2.6069	.6932	---	---	---	-1.5677	.16	38	.92
Q_{500}	2.7673	.6776	---	---	---	-1.8055	.19	45	.89

OR

Region A

$Q_{10} = 334.4\ DA^{.7770}\ (1 + .01F)^{-.9712}\ (1 + .01U)^{1.0217}\ (1 + .01C)^{-1.7184}\ (1 + .01CA)^{-.5719}$

$Q_{25} = 518.2\ DA^{.7556}\ (1 + .01F)^{-1.0324}\ (1 + .01U)^{.7608}\ (1 + .01C)^{-1.5302}\ (1 + .01CA)^{-.5302}$

$Q_{50} = 698.4\ DA^{.7414}\ (1 + .01F)^{-1.0821}\ (1 + .01U)^{.5785}\ (1 + .01C)^{-1.3955}\ (1 + .01CA)^{-.4980}$

$Q_{100} = 925.8\ DA^{.7278}\ (1 + .01F)^{-1.1342}\ (1 + .01U)^{.4040}\ (1 + .01C)^{-1.2691}\ (1 + .01CA)^{-.4637}$

$Q_{500} = 1{,}696\ DA^{.6994}\ (1 + .01F)^{-1.2666}\ (1 + .01U)^{.0208}\ (1 + .01C)^{-.9877}\ (1 + .01CA)^{-.3834}$

Region B

$Q_{10} = 204.4\ DA^{.7255}\ (1 + .01CA)^{-1.2425}$

$Q_{25} = 276.6\ DA^{.7108}\ (1 + .01CA)^{-1.3700}$

$Q_{50} = 337.0\ DA^{.7017}\ (1 + .01CA)^{-1.4695}$

$Q_{100} = 404.5 DA^{.6932}\ (1 + .01CA)^{-1.5677}$

$Q_{500} = 585.2\ DA^{.6776}\ (1 + .01CA)^{-1.8055}$

DA is drainage area, in square miles;

F is percentage of forest cover, in percent;

U is percentage of urban development, in percent;

C is percentage of basin underlain by carbonate rock, in percent;

CA is percentage of basin controlled by lakes, swamps, or reservoirs, in percent; and

b, c, d, e, f are basin characteristic coefficients of regression.

Figure IV-4
(Stuckey and Reed, 2000)

SECTION V STANDARDS AND CRITERIA FOR STORMWATER CONTROL

A. Watershed Level Control Philosophy

Within any watershed, an increase in development or disturbance to the natural hydrology results in an overall increase in peak runoff rates, stormwater runoff volumes, and in many cases, a decrease in overall stormwater runoff quality. However, the degree of impact by increased development or disturbance should also be balanced by the ability of local geologic and vegetative conditions to absorb the activities. With watersheds in Forest County being dominated by forest cover, it can be expected that conditions for absorption of activity impact have yet to near reaching a peak state. In other words, the limited development in Forest County can reasonably be expected to have a very limited impact in peak runoff rates, stormwater runoff volumes and any decrease in overall stormwater runoff quality. The precautionary principal is inappropriately and ineffectively applicable in Forest County.

The traditional approach to stormwater management has been the site specific or on-site control approach. The goal was to create a situation where the post-development peak runoff rates did not exceed those of the pre-development rates. This was often done through on-site collection and then conveyance to a large detention basin (or system of basins), located somewhere on the low point of the site. For many years, this was the methodology and philosophy behind managing stormwater.

However, new regulations (the result of new research) have begun to dictate the mitigation of not only peak runoff rates, but also runoff volumes and the issue of water quality. On-site stormwater management is still a key factor in overall watershed management; however, these new limiting factors can complicate the management process and make the traditional methods of managing stormwater a way of the past. New technologies and implementation practices are becoming the norm and no longer the anomaly.

The management of runoff volumes from a developed site is becoming a very important contributing factor, not only to on-site stormwater management, but also in overall watershed management. On-site volume controls (through various methods such as infiltration, stormwater re-use, bio-retention, limiting the source of runoff, etc.) are greatly reducing the volume of water (and the timing of its conveyance) that needs to be transported by streams through the watershed. This aids significantly in reducing excessive flows and volumes that can result in stream bank erosion and destructive flooding. On-site volume control also helps in the recharge of groundwater tables and aquifers by keeping the water within the watershed, instead of simply releasing it at a slower rate through the water shed and into adjacent, downstream watersheds. This methodology also helps in the management of water quality, an increasingly important issue. By allowing the natural characteristics of the watershed to naturally filter and treat runoff, overall water quality can be improved significantly.

B. Standards and Criteria

The purpose of the Act 167 Plan is to ensure the proper management of stormwater runoff. The Plan is intended to provide information and guidance to allow the design professional to manage stormwater in a manner that is consistent with proven, acceptable, and effective engineering practices; and to protect the public welfare through the protection of environmental resources. These engineering practices include acceptable land-use management practices as well as additional measures that will conserve and protect existing water sources and all other surface waters of the Commonwealth.

The Plan is also intended to reduce destructive and potentially dangerous flow conditions caused by accelerated surface runoff (due to excessive development) by reducing overall peak flow rates and volumes and return existing stream capacities to a quantity more conducive to their size. The restoration of the flood capacity of such streams is of paramount importance to protecting existing natural features as well as protecting the public and property.

The provisions that shall be implemented concerning the recharging and infiltration of stormwater runoff will not only help to achieve the goal of returning streams to their natural flow capacities, but also to help recharge groundwater tables and aquifers.

The easiest way to accomplish the goals of the Act 167 Plan is by the implementation of BMPs that will help to return the hydrological flow characteristics of a given watershed to a state comparable to its natural capacity and capabilities. This is the driving force behind the Act 167 Plan's concept of watershed-wide stormwater management and maintenance.

In order to achieve the desired results of the Act 167 Plan, the following five objectives should be implemented so that the watersheds can be properly conserved and protected:

1. Maintain groundwater recharge
2. Maintain or improve water quality
3. Reduce channel erosion
4. Manage overbank flood events
5. Manage extreme flood events

Refer to Figure V-1 for a schematic approach on how each of the five objectives can be accomplished and how their implementation can be achieved.

The standards were developed to take into account a number of land use and development activities. The standards provide the design professional with proven and common stormwater management methods and guidelines for their implementation.

The standards also incorporate information from the following tasks or assessments completed during both Phase 1 and Phase 2 activities:

- Maps depicting the characteristics of soils, slopes, and vegetative cover have been included in this Plan. These areas were identified using existing spatial data. This information was then streamlined for future use in hydrologic modeling efforts, and was also used for other technical evaluations.
- Mapping depicting the location of known structures and obstructions has been included in this Plan. These obstructions were identified by way of surveys sent to each municipality and through available spatial data provided by the County. Based on the limited scope of the project and Plan, no field verification work was conducted, nor have the identified obstructions been analyzed for capacity or potential impacts because of future development. This task will be addressed in more detail during the next planning cycle.
- Maps indicating the County Growth Priority Areas are included in this Plan. Based on the reduced scope of the project and Plan development and based on limited historical and future planning, a detailed review of such areas and their impacts on flooding or stormwater runoff has not been included in this Plan. Section III of this Plan identifies areas those areas that lie within floodplains and the specific land use of those areas. This task will be addressed in more detail during the next planning cycle.
- Mapping depicting the current known problem areas and their location within the county are included within the Plan. Mapping is based on municipal and stakeholder surveys conducted during Phase 1. The means for addressing these problems are addressed in various locations throughout the Plan and with a detailed description and breakdown of specific BMP measures that can be implemented in order to alleviate a specific problem area's impact on the watershed(s) in which it is located. The most common problems were identified and specific criteria for alleviating their impacts are included in this Plan.
- Based on the reduced scope of the project and Plan development and based on limited historical information pertaining to existing collection and conveyance systems, a detailed review of such systems and

their impacts on flooding or stormwater runoff has not been included in this Plan. This task will be addressed in more detail during the next planning cycle.

- Based on the reduced scope of the project and Plan development, specific criteria for identifying alternative runoff control techniques on a watershed-by-watershed basis has not been included in this Plan. These criteria should be considered for future revisions of the Plan. In lieu of prioritization of localized implementation criteria, the Plan shall be used in broader terms and currently contains information on addressing several factors that may or may not be present in each specific watershed. This task will be addressed in more detail during the next planning cycle.

Two (2) State and Federal flood control project were identified within Forest County. The projects were identified from a variety of sources including DEP project lists, U.S. Army Corps of Engineers project information, and FEMA FIS documents and FIRMs. Though identified in the records as two (2) projects, the reality is that there is no flood control project on the Little Tionesta Creek as listed below. The dam listed as being on Little Tionesta Creek, off T-312 Spillway Road, Tionesta Township is the same flood control project as listed as being the Tionesta Dam, Spillway Road, Tionesta Borough. The Tionesta Dam is in Tionesta Township and is located either off T-312 Spillway Road or off Route 36 South, Tionesta Township. No municipalities reported any flood control or protection projects, therefore the information below is considered as complete as possible based upon the data available for reference. Additional flood control projects should be added or modified within this Plan during the next planning cycle to better reflect County hydrology and efforts to mitigate the damages caused by excessive flooding. These projects and their approximate location or extents are identified below:

- Tionesta Creek
  - Dam, Tionesta Dam (USACE), Spillway Road, Tionesta Borough
- Little Tionesta Creek (incorrect identification, this dam is on the Tionesta Creek and is same as above)
  - Dam, Off T-312 Spillway Road, Tionesta Township

- Growth in Forest County is very slow and sporadic. The County and municipalities are primarily in a reactive mode regarding extension of stormwater collection and control facilities. Based on the reduced scope of the project and Plan development, specific criteria designating areas to be served by stormwater collection and control facilities have not been included. Consequently, estimates relating to the design capacity and cost of such facilities are not included in this planning cycle. The Forest County Stormwater Management Ordinance, as well as the model municipal ordinance included with this Plan, contain information and guidelines relating to financing, construction and operation, and institutional arrangements to implement and operate the facilities. The information presented in the municipal model ordinance is intended only as guidance. Future planning cycles will more fully address this task. Mapping depicting the current FEMA flood plain and flood hazard areas and their location within the county is included within the Plan.

The Forest County Stormwater Management Ordinance, as well as the model municipal ordinance included with this Plan, contain specific criteria and standards for the control of stormwater runoff from existing and new developments that are necessary to minimize dangers to property and life and carry out the purposes of the Plan. It is anticipated that all the municipalities within Forest County will elect to be governed by the County Ordinance. However, the municipalities will have the option to adopt local regulations including, at a minimum, the measures included in the model municipal ordinance.

- Based on the limited scope of the project and Plan development, specific criteria for implementation on a watershed-by-watershed basis have not been included in this Plan. All watersheds identified in the Phase 1 Scope of Study for detailed hydrologic modeling were excluded from this planning cycle. Specific watershed criteria should be considered for future revisions of the Plan. In lieu of prioritization of specific

implementation factors, the Plan shall be used in broader terms and currently contains information on addressing several factors that may or may not be present in each specific watershed. These tasks will be addressed in more detail during the next planning cycle.

It is recommended that the Plan be reviewed and revised in five (5) year cycles in order to identify and address any of the above items that were not studied in detail during development of this current Plan. This will allow for the identification of new problems within the watershed(s) and the development of potential strategies to alleviate them. A review/update of the Plan will also allow for the consideration of any new regulations and the implementation of new practices which may impact future development and stormwater runoff management methods and technology

Detailed stormwater management measures and BMP information can be found in the Pennsylvania Stormwater Best Management Practices Manual, (Document #363-0300-002), prepared by the Pennsylvania Department of Environmental Protection (PADEP BMP Manual). Such information includes:

- Selection Criteria
- Sizing and Computational Information
- Maintenance
- Construction Specifications
- Applicability
- Safety Procedures

The acquisition of an NPDES Permit (General or Individual) for stormwater discharges associated with construction activity is required to adhere to Control Guideline – 1 (CG-1) or Control Guideline -2 (CG-2), which is clearly outlined and defined in the PADEP BMP Manual. This manual is the key source for information concerning acceptable and applicable stormwater management BMP measures in Pennsylvania that will allow the designer to achieve conformance with CG-1 or CG-2.

PennDOT and Pennsylvania Turnpike Commission Projects

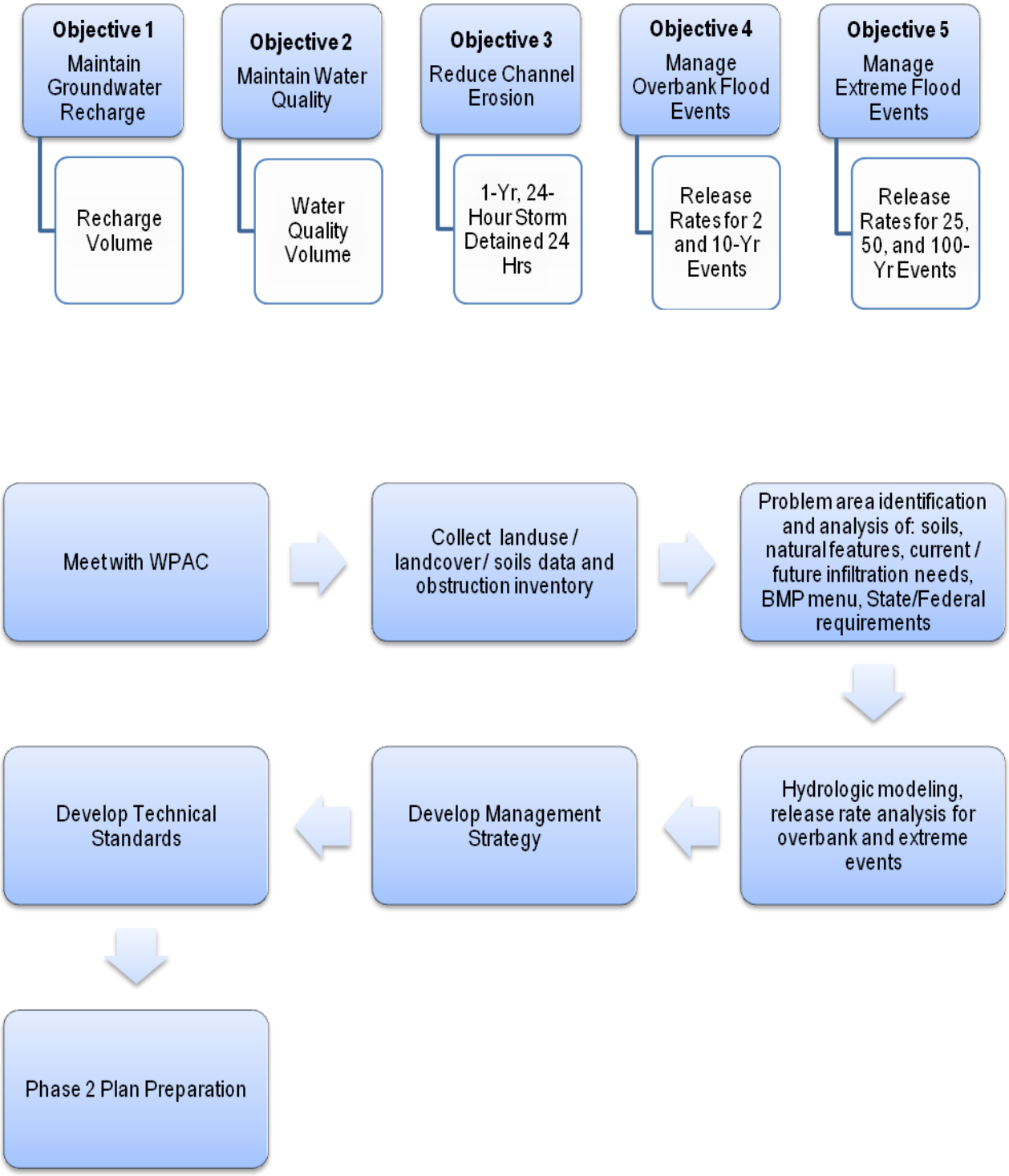
In addition to the information contained herein, for projects regulated by PennDOT or the Pennsylvania Turnpike Commission, the following shall govern their administration:

For purposes of Act 167 Stormwater Management Plans (Plans), design policy pertaining to stormwater management facilities for PennDOT and PTC roadways and associated facilities are provided in Sections 13.7 (Anti-degradation and Post Construction Stormwater Management Policy) of PennDOT Publication No. 13M, Design Manual Part 2 (August 2009), as developed, updated, and amended in consultation with PADEP. As stated in DM-2.13.7.D (Act 167 and Municipal Ordinances), PennDOT and PTC roadways and associated facilities shall be consistent with Act 167 Plans. DM-2.13.7.B (Policy on Anti-degradation and Post Construction Stormwater Management) was developed as a cooperative effort between PennDOT and PADEP. DM-2.13.7.C (Project Categories) discusses the anticipated impact on the quality, volume, and rate of stormwater runoff.

Where standards in Act 167 Plans are impracticable, PennDOT or PTC may request assistance from DEP, in consultation with the County, to develop an alternative strategy for meeting state water quality requirements and the goals and objectives of the Act 167 Plans. Since this option exists for State transportation agencies, it is only appropriate that the option also exists for the nine (9) municipalities in Forest County.

For purposes of this Act 167 Plan, road maintenance activities are regulated under 25 Pa Code Chapter 102.

Figure V-1
Five Comprehensive Management Objectives and Analysis Process



Objective 1 – Maintain Groundwater Recharge

Surface water reaches the ground surface and then sheet flows to adjacent streams or water bodies. A portion of this surface water returns to the atmosphere through evapotranspiration or sublimation. Yet another percentage of the water returns to the soil through infiltration and groundwater recharge. Typically, water infiltrates through the soil until it is transferred through the evapotranspiration process or it reaches the groundwater table and replenishes the local aquifer.

The movement of water through the sub-surface is complex, and less permeable soils, clay layers, and rock strata are often encountered, especially in areas in the central and western portions of Pennsylvania. This water moving through the soil is typically referred to as one of the following:

- Gravitational water or drainage water
- Capillary Water (water held in soil pores by surface attraction, sometimes called "capillary action")
- Hygroscopic Water (water tightly held within soil particles and removable only through the physical drying process of the soil)

While capillary water does play a role in evaporation processes, gravitational/drainage water is the primary concern from a stormwater management perspective. Figure V-2 provides an illustrative representation of the water cycle process.

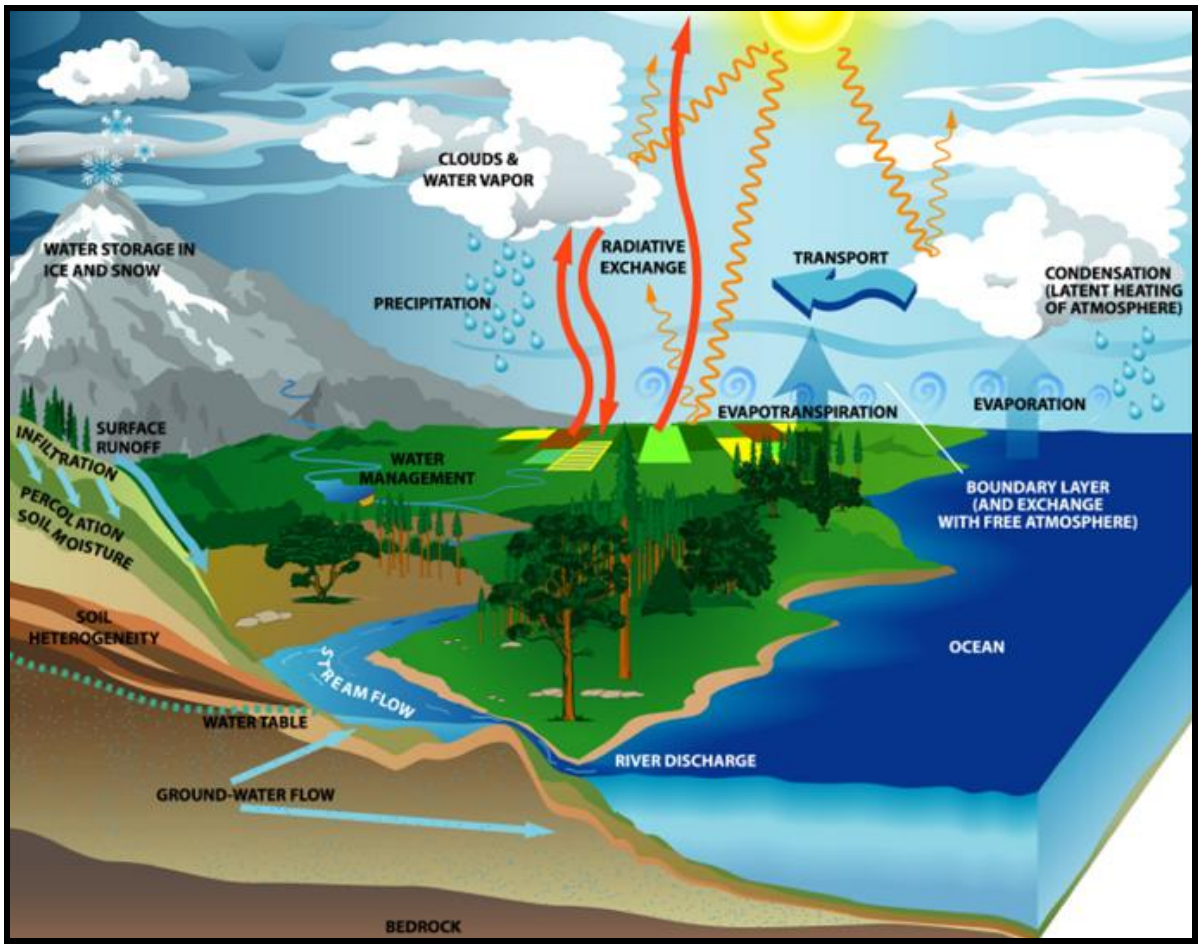


Figure V-2
(US Climate Change Science Program, 2003)

The process and ease by which gravitation water is transmitted through soil layers is based upon several factors. These factors include:

- Layering
- Structure
- Texture
- Presence of macropores (flow pathways within the soil)

The texture of a soil is based upon the ratio of sand, clay, and silt present in the soil. The permeability and hydraulic conductivity of a soil layer is significantly affected by the grain size of the soil layer. In general, these flow characteristics decrease as the grain size of the soil layer decreases. Gravitation or drainage water moves more easily through sand than it does through silty or clay-based soils. The texture of an individual soil layer also influences the shape of the wetting front as water travels through it due to the cohesive forces of both the water and the soil particles themselves.

One of the most critical components of understanding the methods and practice by which the designer will recharge the existing groundwater aquifer is by gaining an understanding of the specific soils on a project site and how their individual characteristics will influence the infiltration and absorption of excess stormwater runoff.

Maintaining groundwater recharge helps maintain watershed hydrology and is a method of meeting specific stormwater management regulations for volume control, peak-rate control, and even water quality.

There are many acceptable and practical methods for infiltrating water and thereby meeting the requirements for ground water recharge. The PADEP BMP Manual breaks BMPs down by the desired function of the designer as well as by structural or non-structural methods. Non-structural methods can be a cost effective means of addressing the infiltration/recharge issue, as well as the other necessary technical objectives when dealing with stormwater runoff. However, there are times when non-structural methods are not practical or cannot provide the necessary results from a quantitative standpoint. Some of the more common structural and non-structural BMP applications are listed in Table V-1.

Table V-1[7]

Recommended BMPs for Groundwater Recharge/Infiltration

Non-Structural BMPs	Structural BMPs
Protection of Sensitive Areas	Infiltration Basins and Trenches
Site Clustering	Subsurface Infiltration Beds
Minimize Soil Compaction	Drywells/Seepage Pits
Reduce Street/Parking Imperviousness	Constructed Filters
Minimize Total Disturbed Area	Rain Gardens
Rooftop Disconnection	Floodplain Restoration Practices

A comprehensive list of non-structural and structural BMPs and their applicability towards a specific technical objective can be found in Figures V-7 and V-8 at the end of this chapter.

[7] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

The requirements pertaining to the proper and adequate design, sizing and application of stormwater BMPs shall be in strict accordance with local and Commonwealth regulations, as well as the design information contained in the PADEP BMP Manual. The PADEP BMP Manual provides comprehensive information concerning the applicability of specific BMPs as well as other necessary requirements concerning soil testing, case studies, available resources, design formulas, information pertaining to vegetative covers, and other necessary guidance materials. It should be noted however, that while the PADEP BMP Manual is the primary source for proper BMP design in Pennsylvania, it is intended to be used as a guide and should not discourage the experienced design professional from using additional BMPs or to curtail the innovative process and application of stormwater management methods that may not be listed in the current BMP Manual version. While the manual does contain specific guidelines and criteria that must be followed, it is not intended to be the sole source for stormwater management design. Additional and hybrid management methods will be considered by the proper regulatory agency on a case-by-case basis.

Another additional factor to consider during the implementation of recharge/infiltration BMP usage is the surrounding site conditions. Not all sites chosen for development will be sites that have been untouched and undisturbed for several years. There are also specific sites within the Commonwealth that have been identified for their special contribution to the waters of the Commonwealth or have been deemed environmentally sensitive areas. The PADEP BMP Manual refers to these specific types of sites as "special management areas." The following list identifies some of the more commonly encountered special management areas:

- Karst Areas
- Brownfields
- Previously Mined Areas
- Surface and Well Water Supply Areas
- Highways and Roads
- Special Protection Watersheds (High-Quality and Exceptional Value Watersheds)

Special care and consideration must be taken when these types of sites are encountered. The presence of such sites does not necessarily prohibit the designer from using infiltration practices. However, specific guidelines and overall environmentally sensitive decisions should be exercised when these types of sites are encountered. These types of sites are extremely prevalent in western Pennsylvania, with the possible exception of karst areas, which tend to occur more often in central and southeastern Pennsylvania.

Karst Areas: There are no Karst areas within Forest County. No surface Karst features exist due to the depth of any substantial areas of carbonate bedrock.

Brownfield Areas: Brownfields are areas within the Commonwealth where the potential presence of hazardous materials and pollutants could hinder future development. Applicable laws concerning the classification of brownfields should be consulted prior to beginning the process of any potential development work; however, brownfields can often be found in areas (though not limited to) that fall into the following categories:

- Abandoned steel mill facilities or sites
- Abandoned industrial facilities or sites
- Areas where petroleum or petroleum by-products were stored (e.g. fueling stations)
- Areas related to specific mining activities
- Abandoned commercial facilities or parking facilities

Areas such as these pose a threat to the environment by being contaminated with a number of possible pollutants.

However, while these areas are often considered a blight by the community, they are prime locations for the use of green infrastructure and smart growth technologies. The redevelopment of these sites can help revitalize depressed areas, contribute to environmental clean up through mitigation of the hazardous materials, and serve the public interest by providing a mixed-use environment to help the community thrive.

When applying for any permits for a site deemed as a brownfields site, it is important to disclose the following information, as well as any other necessary or requested information, per the PADEP BMP Manual:

- Existing and previous land uses
- Potential pollutants, along with a summary of sampling data.
- Source and location of the potential pollutant(s) on the Erosion and Sediment Control (E&S) Plan drawings,
- A description of what measures are proposed to manage and control discharges of these pollutants to eliminate the potential for pollution to surface waters of the Commonwealth.

Table V-3[8]

Recommended BMPs for Brownfields

Soil Contact Areas	Non-Soil Contact Areas
Bio-Retention in areas where soil has been remediated or pollutants are NON-SOLUBLE in nature. Soils containing soluble pollutants should be filtered through the bio-retention areas and then allowed to exit via by-pass piping. Infiltration in these areas should not be permitted.	Stormwater Collection/Re-Use • Vegetated Roofs • Cisterns • Rain Barrels
Stormwater management options are available for use on brownfield sites where the contaminated soil has been completely removed from the site. These options include minimizing earth disturbance and soil compaction, minimizing impervious areas, maximizing stormwater infiltration (where applicable), and dispersing runoff to BMPs scattered across the site rather than concentrating runoff to just a few locations.	
With the exception of structural stormwater infiltration BMPs, the stormwater management BMP measures listed in PADEP BMP Manual are also available for use on brownfield sites where potentially contaminated soil is isolated and sealed, or the contaminated soil was blended with clean soil. Since soil contaminants are still present at these sites, the use of structural stormwater infiltration BMPs should be used only if the residual soil contaminants are non-soluble pollutants.	
Refer to the PADEP BMP Manual and supporting documentation for additional information on stormwater management, remediation, and environmental due diligence concerning the development of brownfield sites.	

Highways and Roads: Highways and roadways within the Commonwealth have the potential to severely affect the hydrologic integrity of any watershed. The increase of impervious area (a near certainty in new roadway construction) results in excessive peak runoff rates and volumes. The other key issue concerning highway and roadway construction in relationship to stormwater management is that of water quality. The potential for heavy metals, de-icing salts and chemicals, petroleum pollutants, hazardous materials from vehicular spills, as well as

[8] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

thermal impacts during hot-weather months, can all contribute to de-graded water quality. The following table taken from the PADEP BMP Manual lists suggested BMPs available for roadway and highway applications:

Table V-4[9]

Recommended BMPs for Highway and Roadway Applications

Non-Structural BMPs	Structural BMPs
Reduced roadway/cartway widths (as applicable, and in accordance with all local and Federal regulations)	Vegetated Swales and Infiltration Trenches along contours perpendicular to the road and along the right-of-way
Reduction or elimination of curbs and gutters	Bioretention areas along the roadway
Reduction of stormwater collection/conveyance infrastructure (as applicable, and in accordance with all local and Federal regulations)	Bioretention and Bio-Infiltration in cul-de-sac areas
	Catch Basin Inserts and Treatment Devices

Mined Areas: Areas of proposed development that have been previously mined should be treated with special care. Areas that have been strip/ surface mined or are underlain by deep wall mining facilities are an extremely difficult location in which to apply stormwater BMPs. Acid mine drainage caused by previously (and presently) mined areas is one of the largest environmental problems in Pennsylvania. The infiltration and percolation of water through mined areas has resulted in thousands of miles of contaminated streams and waterways. Infiltration and groundwater recharge BMPs are prohibited in such areas, thus rendering most available structural BMPs unusable for development in these areas. There are only a few acceptable and practical structural BMP methods available for use in these areas. BMPs such as vegetated roofs and capture/re-use (e.g. rain barrels) methods are applicable. Limiting and prohibiting infiltration or percolation of stormwater runoff into previously mined sites is of the utmost importance.

The most reasonable solution for the management of runoff is through the re-direction of stormwater runoff from areas contaminated with mine wastes. If this is not entirely feasible then the use of lined BMPs should be considered to separate the runoff from the contaminated soils. Lined detention basins for rate mitigation are an option for storage. Volume reduction in these areas is specifically difficult to achieve. Rate mitigation and water quality should be the primary factors for the designer. The most important item to consider when proposing a plan for development is to provide for the protection and restoration of native vegetative cover to the greatest extent possible. Natural vegetative cover provides the best method of treating and restoring these soils back to their native conditions (Pennsylvania Department of Environmental Protection, 2006).

Groundwater Supply Areas: Any stormwater management practice in areas adjacent to ground water supply sources is of critical importance. It is estimated that approximately half of Pennsylvania's residents receive their drinking water from ground water supply sources (Pennsylvania Department of Environmental Protection, 2006)

In relationship to the protection of groundwater supplies, three (3) zones must be taken into consideration when proposing the use of infiltration practices for new development:

- Zone 1 – The innermost protective zone surrounding a well, spring, or existing infiltrative gallery. This zone ranges from 100 to 400 feet depending on the site-specific source and characteristics of the aquifer (Pennsylvania Department of Environmental Protection, 2006). Proposed infiltration BMPs should not be located in Zone 1 protection areas (Pennsylvania Department of Environmental Protection, 2006).

[9] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

- Zone 2 – The capture zone that encompasses the area of the aquifer through which it supplies water to a well, spring, or existing infiltration gallery. This zone is determined to be a one-half mile radius around the source unless more extensive hydrogeological testing is done. Extreme care should be used when implementing infiltration BMPs in Zone 2 areas. Aquifers can become easily contaminated, and therefore extensive pretreatment measures should be used to filter and diminish pollutants (Pennsylvania Department of Environmental Protection, 2006).
- Zone 3 – The area beyond the capture zone and contributes significant recharge to the capture zone aquifer in Zone 2 (Pennsylvania Department of Environmental Protection, 2006).

  A minimum distance of 50 feet should be used when placing infiltration BMPs adjacent to privately owned wells and water sources serving non-community supply systems (Pennsylvania Department of Environmental Protection, 2006).

As in nearly all instances, some of the best measures available for adequately managing stormwater runoff are to eliminate or reduce the amount of runoff at its source of generation. This can be done by reducing impervious areas or through the capture and re-use of stormwater runoff. Another recommended practice is the scattering of stormwater BMPs across the entire development site. The measure of dispersing stormwater runoff more evenly helps to maintain the hydrological balance within the watershed and helps to prevent the concentration of runoff quantities and pollutants at only a few points within the watershed. The pre-treatment of stormwater runoff prior to dispersing it can make water quality mitigation much easier and more effective.

Table V-5[10]

Recommended BMPs for Areas Adjacent to Ground Water Supply Areas

Non-Infiltrative BMPs
Reduce Parking Imperviousness
Rooftop Disconnection
Vegetated Roof
Rain Gardens/Bioretention
Capture and Re-Use
Wet Ponds
De-icing alternatives consisting of sand or other inert materials

Surface Water Supply Areas and Special Protection Watersheds: Stormwater management practice in areas adjacent to surface water supply sources and special protection watersheds (exceptional value, EV and high quality, HQ, as determined by the PA DEP) is of critical importance. The PA DEP anti-degradation requirements can be met in these watersheds by infiltrating a volume in the post-development conditions that is equal or greater than that of the pre-development infiltration volume. Another component of this requirement is that the post-development runoff is pre-treated and managed so that it will not degrade the physical, chemical, or biological characteristics of the receiving water body (Pennsylvania Department of Environmental Protection, 2006).

The project should be designed and constructed in a manner that will minimize the amount of impervious area. Any post-development runoff that is generated should then be infiltrated to the maximum extent possible. Water quality BMPs should be implemented across the site for adequate treatment but also to help in spreading the water across

[10] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

the watershed and not concentrating it at only a few points. The last component is that the final volume and rate of any stormwater discharge must be properly managed to prevent the physical degradation of the receiving waterway, including scour and stream bank stabilization. Appropriate BMPs for pre-treatment and for addressing water quality issues can be found in Table V-6, later in this chapter.

While infiltration is a key factor in stormwater management in areas adjacent to surface water supply areas and special protection watersheds, care must be taken during the design process. Any proposed infiltration BMPs within two miles on either side of surface water supply areas or special protection waters must be designed and constructed to provide maximum pollutant removal prior to the runoff being infiltrated or discharged to the receiving stream.

The proximity of infiltration areas and adjacent surface water areas and special protection waters should follow the following guidelines:

- Zone A – Represents a 1/4 mile buffer on either side of the river or stream extending from the area 1/4 mile downstream of the intake upstream to the five hour time-of-travel (TOT) (Pennsylvania Department of Environmental Protection, 2006).
- Zone B – Represents a two-mile buffer on either side of the water body extending from the area 1/4 mile downstream of the intake upstream to the 25 hour TOT. (Pennsylvania Department of Environmental Protection, 2006).
- Zone C – The remainder of the watershed area (Pennsylvania Department of Environmental Protection, 2006).

Objective 2 - Water Quality

Maintained landscape areas and impervious surfaces (e.g. roadways, parking lots, common pedestrian areas, etc.) collect pollutants that are carried in solidified form, or are dissolved and transported via runoff to the surface waters of the Commonwealth. Pollutants such as nitrates, phosphorus, suspended solids, oils, and petroleum by-products can be transported to, and cause the pollution of nearby streams and lakes.

It has been shown in many studies that these pollutants display their heaviest concentrations at the start of a runoff event, often referred to as the "first flush." Many particulates such as suspended solids, trash/litter, heavy metals, organic particles and clay particles can often be observed in a water body prior to the occurrence of a peak runoff.

Areas where accelerated pollutants are generated are often referred to as pollutant "hot spots." These hot spots often occur at the following locations:

- Fueling Stations
- Parking Lots
- Dumpsters and Trash Disposal Areas
- Industrial Sites
- Areas Prone to Heavy Travel and Traffic

While these areas appear obvious as potential sources of pollution, the notion that pervious areas do not generate pollution is a large misconception. Maintained lawns, landscaped areas, gardens, and other "natural" areas can cause pollution due to the use of chemicals and fertilizers. An undisturbed, pervious area can often possess the ability to treat and remove pollutants from direct runoff. However, the previously mentioned areas are often constructed upon heavily compacted soils that do not allow any natural infiltration or surface filtration of potentially polluted runoff. In essence, these heavily compacted areas can often take on the physical characteristics of impervious (e.g. paved, concrete, rooftops, etc.) areas.

The proper approach to managing stormwater quality is a two-phased method. The first phase is control of point source of pollutants, and the second phase is protecting, restoring, and creating the natural systems that are able to capture and remove these pollutants from direct stormwater runoff.

Stormwater quality and quantity are inherently linked. Their singular management can become a simultaneous endeavor, even in situations where this is not the designer's initial intent. This is related to the fact that many stormwater *quantity* BMPs, by the nature and physical process of how they function, actual serve as effective stormwater *quality* BMPs as well.

The two most common types of pollutants found in stormwater runoff are solutes (dissolved particles) or particulates (particles still in solidified form). An example of these two types of pollutants can be found by examining two common fertilizers, phosphorous (often referred to as total phosphorus or TP) and nitrate (NO_3). Stormwater BMPs that rely on filtration or delayed detention are highly effective at the removal of total phosphorous because the pollutant typically remains in particulate form and will bond to colloidal soil particles. This keeps the particulates larger in size, making them more easily captured.

Nitrates on the other hand, tend to be found in soluble form and are not impacted by structural BMPs that rely on filtration or capture of suspended solids. Therefore, it is imperative to consider exactly what types of pollutants are to be targeted.

As with many BMP applications, when compared with their intended use, the use of a cost-benefit analysis can often be a useful tool in determining the most effective means of implementing a BMP treatment design. While it may seem elementary in nature, one additional method of treating pollutants is to curtail the generation of them at the source. The selection of vegetative cover that requires little to no treatment or fertilization, emergency spill management plans, oil/grease separation devices, and any other means that either eliminates/decreases the potential for pollutants, or greatly aids in their immediate capture prior to being introduced to stormwater runoff is a very effective means of treating potential pollutants.

The PADEP BMP Manual offers many non-structural and structural solutions for treating pollutants in stormwater runoff that will help the designer meet the requirements of the technical objectives for water quality. Table V-6 lists some of the more common and recommended BMPs for water quality.

Table V-6[11]

Recommended BMPs for Water Quality Treatment

Non-Structural BMPs	Structural BMPs
Protect Sensitive and Special Value Areas	Landscape Restoration
Protect/Conserve/Enhance Riparian Areas	Constructed Wetlands
Cluster Uses at Each Site; Build on Smallest Area Possible	Vegetated Filter Strips
Concentrate Uses Area Wide Through Smart Growth Practices	Constructed Filters
Minimize Soil Compaction in Disturbed Areas	Infiltration Trenches/Infiltration Basins
Re-Vegetate and Re-Forest Disturbed Areas, Using Native Species	Subsurface Infiltration Beds

[11] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

A comprehensive list of non-structural and structural BMPs and their applicability towards a specific technical objective can be found in Figures V-7 and V-8 at the end of this section.

Another area of particular concern in regards to water quality is that of impaired waters and total maximum daily/pollutant loadings (TMDLs).

Using the watershed approach requires selection or definition of watershed size, and begins with a comprehensive assessment of water quality problems in the watershed. Pennsylvania has already begun this effort with its Un-assessed Waters Initiative, which will assess over 83,000 miles of surface waters. After water quality problems are identified, a planning process occurs to develop strategies that can successfully address and correct water pollution problems in the watershed. Pennsylvania is using this process, in conjunction with federal Clean Water Act requirements, for establishing TMDLs to clean up polluted streams so that they meet water quality standards. Water quality standards are the combination of water uses, such as water supply, recreation and aquatic life, to be protected and the water quality criteria necessary to protect them.

In Forest County there are listed two waterways with TMDL Plans; the lower Clarion River and the Walley Run watershed. Both waterways originate from outside Forest County as do the problems associated with these waterways.

TMDLs must be developed for several categories[12]:

- Point sources (permitted sewage and industrial discharges)

  Point source TMDL development is very similar to developing water quality-based effluent limitations for water discharge permits. The TMDL is developed to meet water quality standards for the critical period during the summer, when streams are at low flow and the effluent makes up a greater percentage of the water. This method assures that under less severe conditions, water quality will also be protected. DEP has carried out this same type of analysis using several well-established modeling tools for many years under the National Pollutant Discharge Elimination System (NPDES) program. Under this program, DEP calculates limits on the amount of pollutants that sewage and industrial facilities may discharge and still protect water quality. New tools were not needed for these types of TMDLs and most have been completed. By regulation, the TMDLs are implemented through DEP's issuance and enforcement of permits.

  Within Forest County there are only two municipal sewage facilities and there are no industrial sites with discharges.

- Nonpoint sources (agriculture and urban runoff)

  Nonpoint sources are not subject to the same regulatory requirements as point sources.

  Furthermore, the critical period for nonpoint or runoff sources is not during low flow conditions, but when rainfall washes pollutants across the land and into the streams. For these reasons, the tools that determine TMDLs for point sources do not work for nonpoint sources. DEP has developed a reference watershed approach to develop nonpoint source TMDLs. This method compares an unimpaired watershed of similar size, geology and land use distribution to the impaired watershed. Geographic Information Systems (GIS) technology is employed in the characterization of land use, background pollutant concentrations in soil and groundwater and other physical and chemical properties of each watershed. Computer simulation models are then used to estimate the loading rates in each watershed and to determine the load reductions of pollutants needed to correct the impairment. A load allocation is assigned to each contributing source, and those sources identified as the causes of impairment are given prescribed reductions. The TMDL sets the stage for citizens to define a plan to correct the impairments. DEP will support their efforts to develop the plan and, through Growing Greener grants, will provide funds to put practices in place to correct the

[12] Per PA DEP Document 3800-FS-DEP2248

problems. For nonpoint source TMDLs, the input of local citizens replaces the regulated implementation procedures for point source TMDLs.

Within Forest County, there are no areas that can be identified as urban, and many agencies list Forest County as 100% rural. The agricultural community in the County is also in decline with many former farm fields reverting to more natural states. These two sources of non-point source pollution are not significant in any way.

- Lakes

  Lakes have characteristics that differentiate TMDLs from other waters. Lakes are not free flowing like streams, but are contained waters that trap pollutants for long periods. Most lake impairments are from high nutrient or sediment loads. Wherever possible, lake TMDLs are developed with the information in the lake study reports that were sponsored by local watershed groups or other local interests. Target acceptable pollutant loads are set at the level of a watershed largely unaffected by human induced impacts. Load allocations are given to the pollutant sources using the same methods as nonpoint source TMDLs. Other indicators of water quality are also considered in the evaluation of a lake. One indicator is the Tropic Status Index (TSI), which refers to the degree of nutrient enrichment in the lake. Nutrient enrichment causes growths of algae that consume oxygen and interfere with the health of the aquatic organisms in the lake. The TSI is affected by factors such as lake volume, water residence time and nutrient loads to the lake. After target loads are set, the TSI is evaluated under reduced nutrient load conditions to assure that the pollutant reductions will bring the TSI into an acceptable range. Implementation of lake TMDLs is best accomplished though local participation.

- Abandoned mine drainage (also called acid mine drainage or AMD)

  AMD from abandoned surface and underground coalmines is a leading source of impairment to Pennsylvania waters. AMD can seriously degrade the aquatic habitat and the quality of water supplies because of toxicity, corrosion, incrustation and other effects from dissolved constituents. The TMDL analysis of AMD streams uses a statistical method of determining the in-stream allowable loading rate at the point of interest in the stream. Discharges that are permitted or have a responsible party are point sources, and make up the waste load allocation portion of the TMDL. Nonpoint sources are all other sources and constitute the load allocation. AMD impaired watersheds are evaluated for aluminum, iron, manganese and pH using statistics and Monte Carlo (probability) simulations to model existing conditions, to determine required reductions and to calculate allowable concentrations. When the reductions are met, the water quality standards will be met.

  Within Forest County, the only few waterways that have AMD are not from sources within the County but are the result of AMD outside the County.

- Specific bio-accumulative chemicals (PCBs and chlordane that contaminate fish, resulting in fish advisories limiting or banning the number of fish that a person can safely consume)

  The overall goal of a PCB/chlordane TMDL is to achieve the fishable/swimmable goal of the Clean Water Act. Fish consumption advisories are issued when fish samples exceed certain triggers. For PCBs, the advisory is based on protection of human consumers from neurological effects. A Federal Drug Administration (FDA) action level determines when an advisory for chlordane is issued. Advisories cause the water to be listed as impaired and make TMDLs necessary. The method used for PCB/chlordane TMDLs is to translate the fish tissue concentration into a water column concentration by using a bio-concentration factor. Bio-concentration factors are mathematical expressions that account for fish accumulating the pollutants in their bodies. Accumulation is based on pollutants in the sediment being ingested by small organisms, which are then consumed by larger organisms, small fish and larger fish, each time magnifying the amount of pollutant that is introduced into tissue of the consumer. The TMDL defines

how much the loading of pollutant must decrease in order to meet the water quality standard. Meeting the water quality standard in the water means the fish living in the water will be acceptable to consume.

- Complex situations (combinations of different types)

  Complex TMDLs draw on the procedures for all the TMDL types previously discussed.

A list of TMDLs currently identified in Forest County by major watershed, along with pertinent information is listed below[13]:

Table V-7

County TMDLs by Major Watershed

Watershed	Information	Status
Lower Clarion	County: Forest, Clarion, Jefferson Category: AMD Cause: Metals, pH HUC: 5010005	EPA Approved 4/9/2009
Walley Run	County: Forest, Clarion Category: AMD Cause: Metals HUC: 5010003	EPA Approved 4/9/2009

Refer to Table III-4 in Section III for a County summary of non-attaining segments of the Streams Integrated List representing stream assessments for the Clean Water Act Section 305(b) reporting and Section 303(d) listing.[14] PA DEP protects four (4) stream water uses: aquatic life, fish consumption, potable water supply, and recreation. If a stream segment is not attaining any one of its four uses, it is considered impaired.

Objective 3 – Reduce Channel Erosion

Several areas of stream bank erosion were found within Forest County and the associated watersheds during the stakeholder surveys and site visits, however no field visits confirmed how significant or non-significant the stream bank erosion is. As storm flows increase, the corresponding flow velocities in streams also increase, thus exacerbating stream bank erosion problems. Typical stream bank capacities are equivalent to approximately the 1 ½-year storm, and stream banks begin to erode when flows approximate this depth. Therefore, stream flows kept to near the one-year storm flow would minimize stream bank erosion. Detaining the 2-year post-development storm to the one-year predevelopment storm and detaining the 1-year storm a minimum of 24 hours would therefore minimize the number of storms causing stream bank erosion.

The PADEP BMP Manual's approach to mitigating the 2-yr, 24-hour stormwater runoff volume also greatly assists in achieving this Objective. The low building density found in Forest County would lead one to understand that there can be no significant contribution to stormwater runoff experienced during extreme storm events, the exception being very localized and due to other exacerbating circumstances such as severe slope topography or concentrated cloud bursts with localized abnormal rainfall volumes. The on-site retention (through infiltration, re-use, etc.) of this runoff

[13] PA DEP TMDL Website http://www.dep.state.pa.us/watermanagement_apps/tmdl/default.aspx, more detailed information pertaining to these TMDLs and their physical properties, including locations and quantities can be found on the website
[14] PA DEP Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division, 2006

volume interrupts site-specific stormwater runoff events and delays the arrival of any site-specific hydrographs to the watershed's point of interest (POI). The continuous delay of water contribution to a watershed's conveyance stream will greatly decrease the volume of water that the stream must convey at any one time (and flow velocity as well). This delay allows less water to be conveyed over a longer period. This not only helps restore the benefits of the natural water cycle, but also aids in the reduction of stream channel erosion.

Table V-8[15]

Recommended BMPs for Preventing Stream bank Erosion
(Tennessee Department of Environment and Conservation)

Vegetative BMPs	Structural BMPs
Stream Buffers	Infiltrative Practices to Reduce Overall Volume
Erosion Control Blankets and Netting	Detention/Retention to Delay Time to Peak of Peak Flows
Select Vegetative Covering	Sediment Filtering Devices (silt fence, interceptor devices, sediment basins, constructed wetlands, slope drains, etc.)
Disturbed Area Stabilization (e.g. mulch, sod, etc.)	Check Dams (to reduce flow velocities)
Spray Polymers and Other Binding Agents (for use in areas with very fine soil particles)	Protective Channel Linings (e.g. geotextiles, gabion baskets, rip rap linings, etc.)

Objective 4 – Manage Overbank Flood Events

Overbank and localized flooding events are a common problem in Forest County. Overbank events have the potential to damage conveyance structures and property downstream from the overbank event location. Overbank events are often caused by new development and the subsequent discharge of additional stormwater runoff to adjacent streams that do not have the capacity to convey the flows without exceeding the defined bed and bank of the stream. In Forest County, assuming that overbank and localized flood events are being caused by new development and the subsequent discharge of additional stormwater to adjacent streams is just not the truth. Very little development occurs in the County, most of that development is confined to separate single family lots, usually located in rural areas and non-connected from neighboring development by hundreds of feet. The primary problem of concentration of stormwater in many of the valleys in Forest County is due to roadways, both state and municipal. Highways constitute the most volume of impervious area found in most of the valleys that experience flood events.

The typical stream usually has the capacity to convey storm events up to the 2-year storm. The 2-year event is therefore generally assumed to be the point where a stream reaches its "bank full" capacity. This is the point where the stream is flowing completely full and is about to spill over bank and encroach into the adjacent flood plain.

An overbank event is typically considered a flooding event that occurs due to a rainfall between the 2-year and 10-year storm events (Center for Watershed Protection, 2000). Anything beyond the 10-year event usually floods to a much greater extent, commonly referred to as an "extreme event," which will be discussed in the next section.

[15] BMP methods are suggested based upon research and real-world performance, and are intended for use in the most commonly encountered site conditions. Specialized BMPs should be used as necessary.

The typical method for preventing overbank events is to properly manage runoff from the 2-year through 10-year storm events. This is most effectively done by not increasing the peak discharge of these storm events from the pre-development to post-development scenarios. Peak rate and volume mitigation of these storm events is a crucial factor in managing and preventing overbank events. In areas where there is a history of excessive overbank event occurrences, additional mitigation might be necessary to address the problem at a watershed level basis.

Simply managing stormwater to a degree where it is quantitatively equal from the pre-development and post-development conditions may not be adequate. Additional control measures using the "release rate" concept may be required in certain watersheds. The release rate concept will be discussed in more detail later in this Section.

While overbank events can have a detrimental impact on downstream property and structures, they also provide a beneficial effect to the ecosystem within the floodplain. The deposition of suspended sediments can help replenish topsoil to agricultural lands as well as raising the elevation adjacent to streams, which can help prevent further erosion over time. Overbank events that occur in typically rural and non-inhabited areas are often a benefit to the local ecosystem and are generally not considered for extensive mitigation measures.

Objective 5 – Manage Extreme Flood Events

Extreme events are similar to overbank events in that they represent a flooding scenario due to the lack of capacity in the conveying stream. However, these extreme events go beyond those of the previously discussed overbank events in their ability to cause damage.

Storm events in excess of the 10-year event have the greatest potential for causing extreme events. The most common storms (based on common modeling practices) that can lead to extreme events are the 25, 50, and 100-year storm events.

It is virtually impossible to eliminate all occurrences of overbank and extreme flooding events. However, it is prudent to control the frequency at which these events occur. The goal is to achieve a balance between the recurrence interval of overbank and extreme events. This balancing point or benchmark is created so that upstream development can occur and yet not create a situation where downstream events occur on a more frequent basis and have more damaging effects.

Given the historic and the expected future development trends in Forest County, it is unlikely that upstream development will occur in sufficient amount to affect downstream events as a function of the frequency basis.

C. Release Rate Stormwater Management District Concept (For Overbank and Extreme Events)

As previously indicated, no hydrologic modeling was performed in Forest County during the current planning cycle. Consequently, release rate analyses were not conducted either. However, this section should be consulted and the methodology applied to future Plan updates.

The discussion below is a summary of the release rate concept and methodology recommended for use in future planning cycles.

Throughout the Commonwealth, many of the previously created Act 167 plans implemented a "release rate" approach to stormwater management. The release rate concept is simply a way of managing post-development runoff rates by pre-determining a release rate (as a percentage value of the pre-development peak runoff rates) that is applicable to a specific watershed or portion of a watershed.

This release rate value is created to limit the amount of water being discharged from a smaller, sub-watershed area into a larger watershed area downstream. This is typically done in areas where problems already exist and flooding events are more common. Release rates are a way of over-detaining stormwater runoff to help alleviate downstream capacity problems.

A release rate is calculated by analyzing the peak rate of runoff for an overall watershed area, as well as the time at which this flow peaks. This time is then applied to each individual sub-watershed area. The rate of runoff from each individual sub-watershed area (at the overall watershed's peak time) is documented. The runoff rate from the overall watershed is then divided by the runoff rate from the sub-watershed's runoff rate (at the peak time of the overall watershed). If the peak runoff rate for the overall watershed is greater than that of the individual sub-watershed, a value that is greater than or equal to 1.0 is achieved. This indicates that no additional rate release constraints need to be applied to the sub-watershed area. However, if the overall watershed's peak rate of runoff is less than that of any sub-watershed's peak runoff (at the time to peak of the overall watershed), then a decimal value is achieved (Paul A. DeBarry, 2004).

Release Rate Calculation Example:

In a fictitious watershed consisting of two sub watersheds comprising one overall watershed, the pre-development runoff rates are shown in Figure V-4:

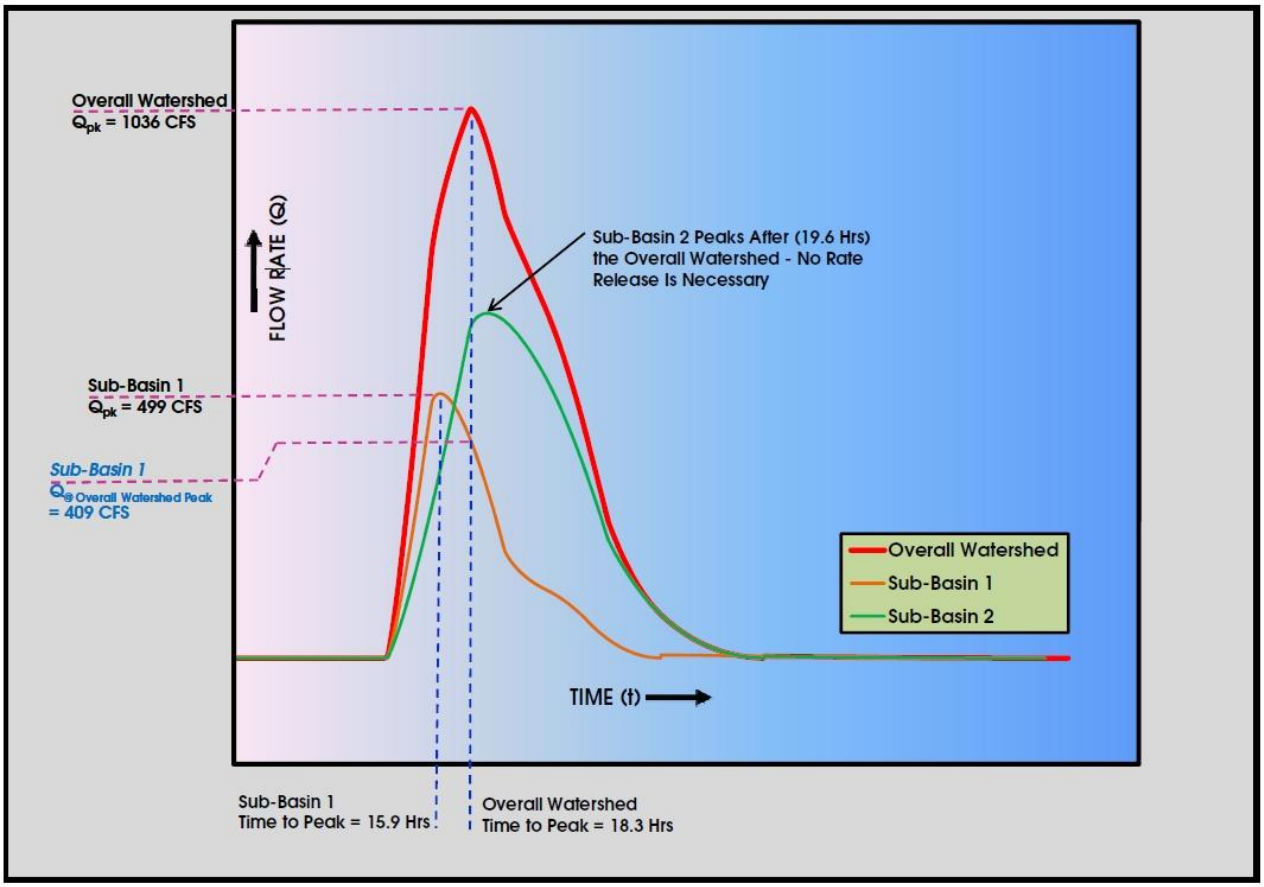


Figure V-4

The pre-development runoff rate of Sub-Basin 1 is 499 CFS and this watershed peaks at 15.9 hours. The pre-development runoff rate of Sub-Basin 2 is 650 CFS and this watershed peaks at 19.6 hours. The pre-development runoff rate of the overall watershed (Sub-Basin 1 and Sub-Basin 2 combined) is 1036 CFS and this watershed peaks at 18.3 hours.

Based upon the fact that Sub-Basin 1 peaks prior to the overall watershed, Sub-Basin 1 contributes a flow of 409 CFS at the time of peak of the overall watershed.

In the rate release method, only sub-watersheds that peak prior to the overall watershed are taken into account. Therefore, Sub-Basin 2 does not require any release controls.

Development within Sub-Basin 1 later occurs which results in an overall increase of runoff from Sub-Basin 1. The flow increases from 499 CFS to 713 CFS. Traditionally, the design of a detention structure would be implemented to control the peak rate of runoff from the developed watershed to ensure that the post-development rate is equal to or less than that of the pre-development conditions. The results of the impacts of the new detention basin that will control flow and limit post-development runoff to 499 CFS (the pre-development flow rate) are shown in Figure V-5:

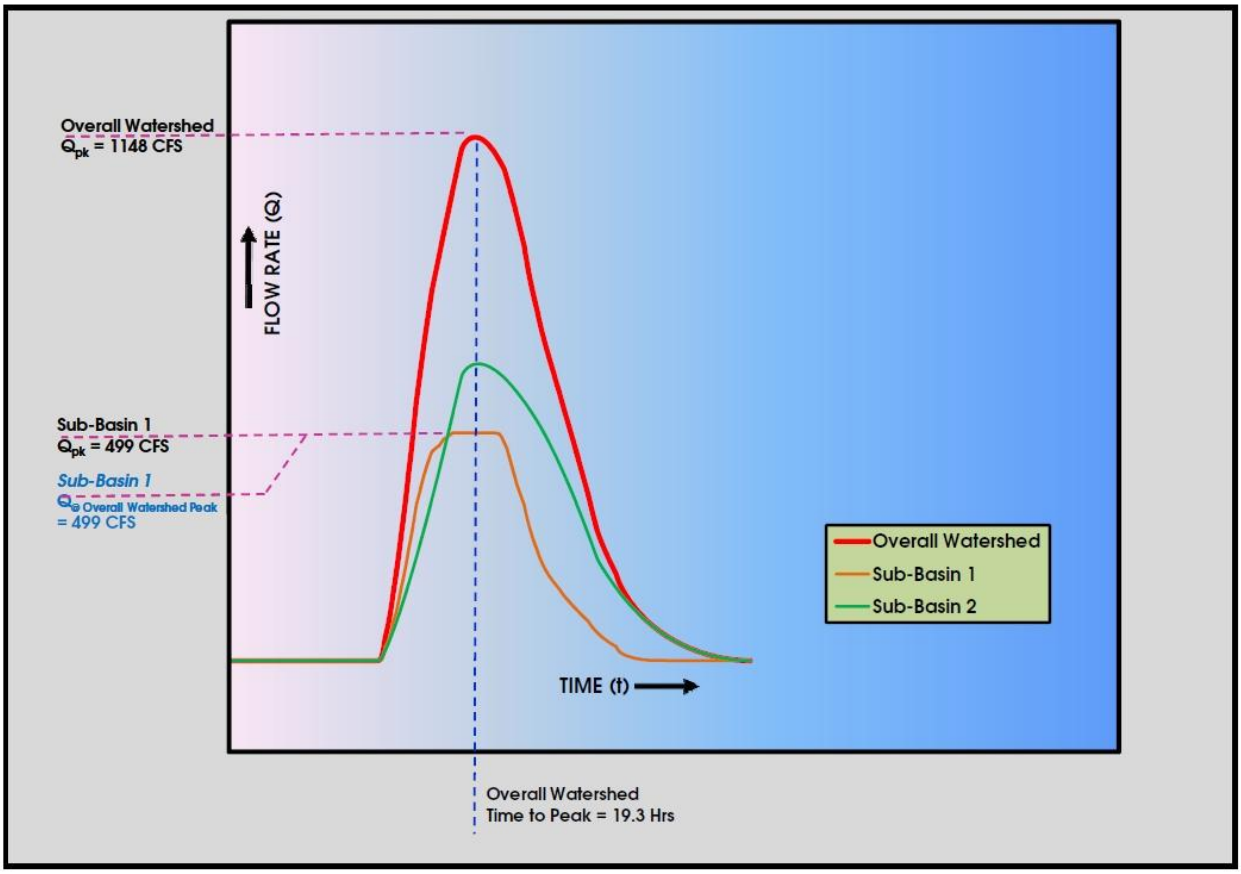


Figure V-5

As can be seen from the figure, the pre-developed flow rate of 499 CFS from Sub-Basin 1 has been maintained. However, the amount of flow that Sub-Basin 1 contributes to the overall watershed, at the overall watershed's time to peak, has increased by 90 CFS. This is a result of the new detention structure in Sub-Basin 1 releasing a higher volume of water, at a slower rate and over a longer period. While the flow discharging from Sub-Basin 1 is equal between the pre and post-developed conditions, the overall watershed's discharge rate has increased 112 CFS.

Therefore, instead of simply control the rate of release of Sub-Basin 1 as a singular entity, it must be analyzed in a more comprehensive manner, as part of the overall watershed.

Taking into account the pre-development runoff rate of Sub-Basin 1 at the time the Sub-Basin peaks (499 CFS) and the amount of runoff from Sub-Basin 1 at the time the overall watershed peaks (409 CFS), this creates the need for rate release control.

The calculation is done by dividing the amount of pre-development runoff from Sub-Basin 1 at the time the overall watershed peaks (in this case 409 CFS) and the peak rate of runoff from Sub-Basin 1. Keeping in mind only sub-basins that peak prior to the overall watershed peaks require rate controls.

Therefore: **409 CFS / 499 CFS = 81.9%**

In order to simplify the release rate districts or zones, the calculated release rates can be rounded slightly. In this case, 81.9% will be rounded to **80%**. This is now the allowable release rate for Sub-Basin 1. Any development that will result in a net increase of runoff from the pre-developed condition to the post-developed condition will require an additional 80% beyond the pre-development peak runoff rate.

A sample development in this example Sub-basin 1 may have a development condition peak flow of 100 CFS. Using the calculated release rate, then the final post-development site can only release a peak flow of 80% of 100 CFS, or 80 CFS.

Looking at the original example, when the 80% release rate is applied to Sub-Basin 1, the following results are achieved:

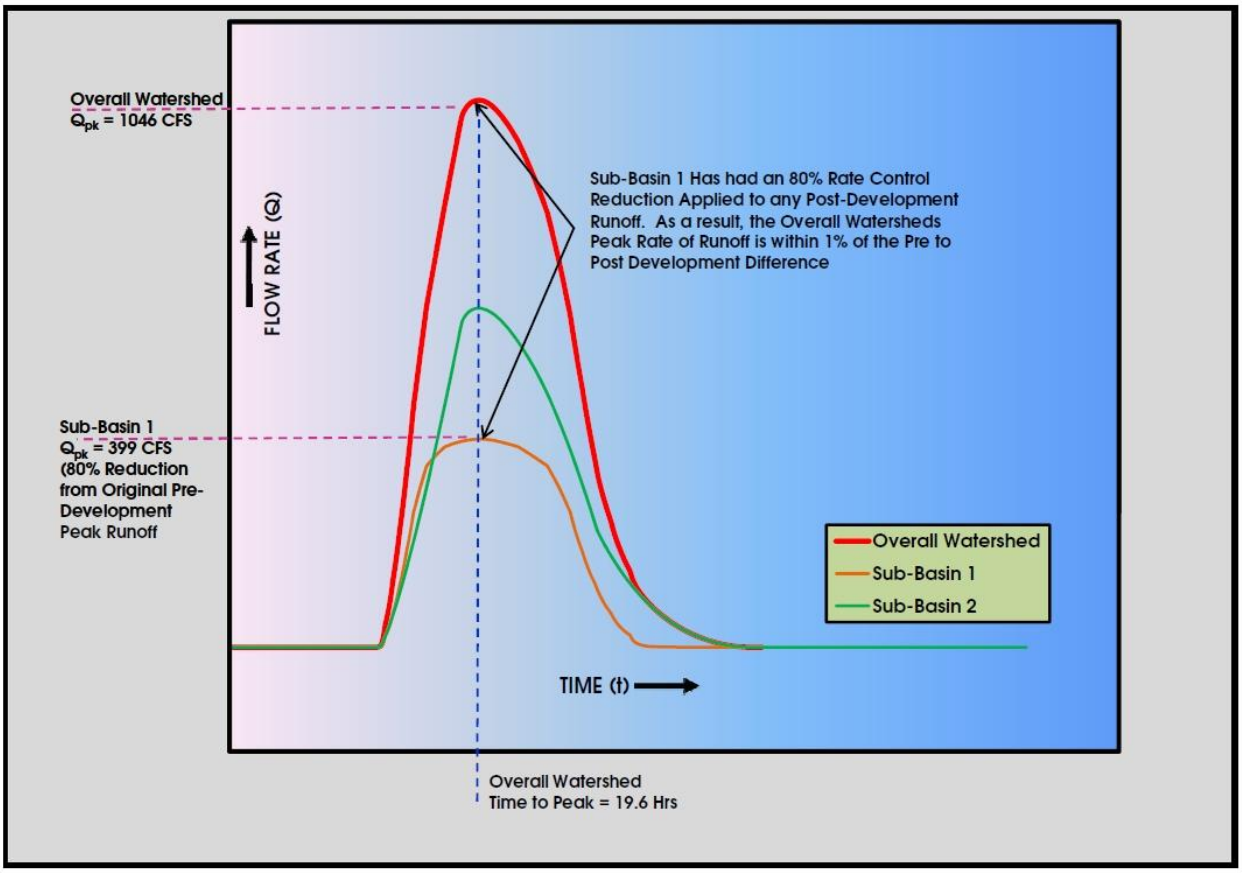


Figure V-6

The overall peak rate of runoff from Sub-Basin 1 is now 399 CFS. Sub-Basin 2 remains un-changed, as it was not necessary to apply rate release controls.

The peak rate of runoff from the overall watershed is now 1046 CFS, an increase of only 10 CFS from the entire watershed. This results in a net change of less that 1% between the pre and post-development runoff rates from the overall watershed. Therefore, the 80% release rate application to Sub-Basin 1 achieved its intended results. Due to the nature of the calculations and specific rounding of values, getting the values to match exactly is nearly impossible. However, a net change of less than 1% is well within the threshold of what the theory is trying to accomplish and it has now been accomplished in this watershed.

D. Structural and Non-Structural BMPs

The following two figures are a comprehensive listing of structural and non-structural BMPs available for the assistance in mitigation of the four major stormwater functions in Pennsylvania. The BMPs are ranked (in potential efficiency) from high to low for each of the four functions, peak rate mitigation, recharge, volume mitigation, and stormwater quality.

The BMPs come directly from the PADEP BMP Manual and are accompanied by the following acronyms (indicating potential effectiveness when properly applied and administered):

VH Very High

H High

HL High to Low (a special category in which specific parameter dictate a BMPs effectiveness)

MH Medium to High

LM Low to Medium

L Low

VL Very Low

LN Low to None

N None or Not Applicable

The figure(s) can be used by a design professional by determining which desired function is to be mitigated and then working down the chart and selecting BMP(s) that will work singularly or in combination with other BMPs to mitigate a specific function or multiple functions. The most effective means of selecting BMPs is to choose a BMP or multiple BMPs that have moderately high rates of success for all, or some combination, of all the desired functions requiring mitigation.

For example, the use of the BMP dictating the reduction of parking imperviousness is an effective BMP for all four of the mentioned stormwater functions. It rates VH (very high) for three of the functions and H (high) for the fourth. This makes the potential use of this BMP a practical selection.

However, BMP selection is based on a number of criteria including:

- Applicability to existing conditions
- Efficiency
- Cost Benefit
- Maintenance Concerns

Figure V-7[16]

[16] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*.

Structural Best Management Practices (BMPs)			
Stormwater Desired Fuctions			
Volume Reduction	**Recharge**	**Peak Rate Control**	**Quality**
Floodplain Restoration (HL)*	Floodplain Restoration (HL)*	Constructed Filter (HL)*	Landscape Restoration (VH)
Constructed Filter (HL)*	Constructed Filter (HL)*	Dry Extended Detention Basin (H)	Constructed Wetlands (H)
Subsurface Infiltration Bed (H)	Dry Well/Seepage Pit (H)	Wet Pond/Retention Basin (H)	Vegetated Filter Strip (H)
Infiltration Basin (H)	Infiltration Trench (H)	Constructed Wetlands (H)	Constructed Filter (H)
Vegetated Roof (MH)	Subsurface Infiltration Bed (H)	Vegetated Swale (MH)	Infiltration Trench (H)
Runoff Capture and Reuse (MH)	Infiltration Basin (H)	Subsurface Infiltration Bed (MH)	Subsurface Infiltration Bed (H)
Riparian Buffer Restoration (M)	Rain Garden/Bioretention (MH)	Infiltration Basin (MH)	Infiltration Basin (H)
Dry Well/Seepage Pit (M)	Riparian Buffer Restoration (M)	Floodplain Restoration (M)	Riprarian Buffer Restoration (MH)
Rain Garden/Bioretention (M)	Pervious Pavement with Infiltration Bed (M)	Soil Amendment and Restoration (M)	Infiltration Berm and Retentive Grading (MH)
Infiltration Trench (M)	Soil Amendment and Restoration (LM)	Infiltration Berm and Retentive Grading (M)	Vegetated Swale (MH)
Pervious Pavement with Infiltration Bed (M)	Landscape Restoration (LM)	Dry Well/Seepage Pit (M)	Rain Garden/Bioretention (MH)
Soil Amendment and Restoration (LM)	Vegetated Filter Strip (LM)	Infiltration Trench (M)	Floodplain Restoration (MH)
Landscape Restoration (LM)	Vegetated Swale (LM)	Pervious Pavement with Infiltration Bed (M)	Soil Amendment and Restoration (M)
Infiltration Berm and Retentive Grading (LM)	Level Spreader (L)	Landscape Restoration (LM)	Water Quality Filters and Hydrodynamic Devices (M)
Vegetated Filter Strip (LM)	Wet Pond/Retention Basin (L)	Riparian Buffer Restoration (LM)	Wet Pond/Retention Basin (M)
Vegetated Swale (LM)	Constructed Wetlands (L)	Rain Garden/Bioretention (LM)	Runoff Capture and Reuse (M)
Level Spreader (L)	Runoff Capture and Reuse (L)	Special Detention Areas - Parking Lot, Rooftop (LM)	Vegetated Roof (M)
Dry Extended Detention Basin (L)	Infiltration Berm and Retentive Grading (L)	Level Spreader (L)	Dry Well/Seepage Pit (M)
Wet Pond/Retention Basin (L)	Special Detention Areas - Parking Lots, Rooftop (VL)	Runoff Capture and Reuse (L)	Pervious Pavement with Infiltration Bed (M)
Constructed Wetlands (L)	Water Quality Filters and Hydrodynamic Devices (N)	Vegetated Roof (L)	Level Spreader (L)
Special Detention Areas - Parking Lots, Rooftop (VL)	Dry Extended Detention Basin (N)	Vegetated Filter Strip (L)	Dry Extended Detention Basin (L)
Water Quality Filters and Hydrodynamic Devices (N)	Vegetated Roof (N)	Water Quality Filters and Hydrodynamic Devices (N)	Special Detention Areas - Parking Lot, Rooftop (L)

Figure V-8[17]

[17] BMP methods are taken directly from the Pennsylvania DEP's, *Pennsylvania Stormwater Best Management Practices Manual*.

Additional Means for Objective Achievement

In addition to the criteria listed within this Plan, other methods of achieving the outlined methods may be required. Some of the more common and tangible methods for objective achievement include, but are not limited to:

- Changes, upgrades, and improvements to municipal maintenance policies
  - Including both frequency and method of practice, as well as dedicated funding
- Construction or improvement projects that will increase the efficiency and effectiveness of community stormwater and flood control facilities, collection and conveyance systems, and treatment appurtenances
- Improvements and changes to municipal construction codes and design standards which better implement methods and technologies that will address stormwater at the source and not at the eventual problem area
- Improvements and retrofit scenarios where existing stormwater and flood management facilities are made more efficient and effective in managing stormwater runoff and increasing their ability to support public welfare as well as private and public property

There is not a specific timeframe for completion of these upgrades. However, they should be implemented in a timely fashion and a fashion in which removed constraints allow. New technology, additional funding, increased public support, timely revisions to this Plan will all contribute to the expediting of improvement implementation.

Non-Achievable Objectives

Not all objectives can be immediately met through the implementation of this Plan. It is the intent of the Plan to meet each objective to the greatest extent possible. However, it is not feasible to correct every problem, known or otherwise, within the county.

Some of the potential reasons for not meeting objectives or correcting/mitigating known problems are:

- Reduction in scope in development of the Plan
- Limited technology or inefficient technology
- Financial constraints or limited resources for implementation of technology
- Political and social issues that complicate the corrective action necessary or exaggerate conditions and problems for ulterior motives.
- Lack of immediate public education and outreach programs (which through implementation of this Plan will better educate and inform the public of the impacts of stormwater)
- Limited historical data

The easiest and most efficient means of correcting and improving upon the limitations previously listed would involve periodic revisions (recommended every five years) of the Plan. This would include the implementation of new local, State, and Federal guidelines and regulations that could alleviate current impediments. Improved and more efficient technology that will augment the mitigation process. Implementation of, and additional analysis of watersheds based on newly acquired data or field gathered historical data that can be used to provide more efficient watershed analyses. Support from both the public and private sectors that will assist in the implementation, funding, and educational aspects of stormwater management methodologies.

It will be through periodic updates that the Plan will remain a useful source of information and data that can be used to assist in the mitigation of known problems and to achieve objectives beyond what are outlined in this current revision of the Plan.

SECTION VI MUNICIPAL ORDINANCE INTRODUCTION (This introduction will suffice for both the Municipal and the County versions of the Stormwater Management Ordinance.)

A. Supporting Information

Based upon the granted authority set forth in the Storm Water Management Act, October 4, 1978, P.L. 864 (Act 167), 32 P.S. Section 680.1, et. seq., as amended, all municipalities within the Commonwealth of Pennsylvania, including counties, are empowered to regulate all land use activities within their boundaries.

Act 167 also includes four (4) major requirements:

1. Each county within the Commonwealth must prepare an individual, countywide stormwater management plan. The plan must adhere to the requirements of Act 167 for every watershed within the county.
2. The enacted plan must analyze present and potential future runoff within each individual watershed and make technical recommendations to assist in the effective management of runoff from new and proposed development. This management must address peak rate, volume, and water quality mitigation.
3. The plan must be Implemented and enforced by a regulatory ordinance effective in each "municipality".
4. Developers must control the quantity and quality of runoff from new development (including redevelopment) in accordance with the implementing ordinance.

Section 11 of Act 167, states that each municipality shall adopt or amend, and shall implement such ordinances and regulations, including zoning, subdivision and development, building code, and erosion and sedimentation ordinances, as are necessary to regulate development within the municipality in a manner consistent with the applicable watershed stormwater plan and the provisions of the act. The Act 167 definition of "municipality" includes any city, borough, town, township, or county. Therefore, the requirement of Act 167 that the plan must be implemented by ordinance effective in each "municipality" may be accomplished in one of two ways: by a county wide ordinance administered at the county level, or by separate ordinances of each of the municipalities within the county, administered by each separately. This Plan adopts the first of these alternatives and proposes adoption of a county wide ordinance which, like the Forest County Subdivision and Land Development Ordinance (SALDO), will be administered by the Forest County Conservation District and Planning Commission.

Also like the SALO, each municipality within Forest County will have the option to develop and adopt its own ordinance and administrative procedures, in which case the municipal ordinance would, to the extent it is not less stringent than the County ordinance, supersede the County Ordinance within that municipalities political boundaries. The proposed Forest County Stormwater Management Ordinance is attached to this Plan. With minor adjustments for local application, it contains essentially the same elements as are found in the model municipal stormwater management ordinance published by the PADEP.

In summary, each municipality is free to choose the solution that best serves its citizens: accept the county wide ordinance, or enact its own more stringent ordinance.

The most critical of the necessary elements included in the proposed county wide stormwater ordinance are as follows:

- The stormwater drainage standards and management criteria
- Technical performance requirements for stormwater management facilities

- Detention/Retention Facilities for Peak Rate Control
- Volume Control BMPs
    - Infiltration BMPs
    - Bioretention BMPs
    - Land Use/Impervious Area Reduction BMPs
    - Stormwater Collection/Re-Use BMPs
- Water Quality Facilities and BMPs

An ordinance should be understandable and practical in all aspects of its intent. It is not intended to be too rigid and should encourage hybrid solutions and creativity in order to achieve the overall intent, which is to manage stormwater effectively, safely, and efficiently. An ordinance, while it should be stringent in nature, should also not be overly oppressive in a manner in which it could actually limit potential development by creating restrictions that could serve as a deterrent to potential developers. It is not the purpose of an ordinance or stormwater management plan to solve stormwater issues by eliminating development. The intent is to provide an effective and safe means by which development can continue and expand in a regulated and safe environment where the natural hydrology of the county is not only protected and maintained, but also improved by the use of new technologies that will help mitigate existing problems, as well as preventing future ones.

B. Required Ordinance Contents

Note: Act 167 contains no required ordinance content, it only requires non-specific measures which will serve the goals and objectives of Act 167 and stormwater management. The following items originate from the Pennsylvania Department of Environmental Protection.

- Article I- General Provisions
    - This section is intended to provide information based upon the following items:
        - A short title identifying the ordinance document.
        - A statement of findings indicating general information that reinforces the need and requirements for the creation of a universal stormwater management ordinance.
        - A section identifying the purpose of the ordinance. This will include verbiage addressing topics related to both public welfare legal precedents and requirements for the creation of the document, as well as basic technical information that the document will address.
        - A brief section outlining the statutory authority that the empowerment of the ordinance is based upon.
        - A brief section identifying the applicability of the ordinance and the types of activities the ordinance as the authority to regulate.
        - A section indicating that any additional ordinances within the municipality in question that are not consistent with the provisions of this ordinance, are hereby repealed to the extent of the inconsistencies.

- A section describing that if any standing court order declares any section of this ordinance invalid, this decision will not affect the validity of the remaining provisions of the ordinance.
- A statement indicating that compliance with this ordinance does not release the applicant from adherence with any other local codes, laws, or regulations. Nor does it release them from their necessary duty to acquire required permits and approvals from other governing bodies.

- Article II- Definitions
  - This section is intended to provide the appropriate and intended interpretation of certain words, terms and entities included in the ordinance.
- Article III- Stormwater Management Standards
  - This section is intended to clearly present and define the technical regulations for stormwater management within the municipality. This should, at a minimum, include the following:
    - Definition of water quality (WQ) requirements and provisions
    - All necessary design criteria and applicable supporting data
    - Requirements for meeting erosion and sedimentation control guidelines and regulations
    - Acceptable methods and models for preparing calculations
    - Information concerning applicable stormwater management districts and the implementation of specific control criteria therein
    - Small project exemption criteria
    - Waiver criteria
    - Information pertaining to timber harvesting and silviculture activities
- Article IV- Stormwater Management Site Plan Requirements
  - This section is intended to provide an outlined description of the necessary components that will represent an acceptable stormwater management site plan. It shall also include information describing the appropriate procedures for plan submittal, review, approval guidelines and protocol, fees, sub-sequent follow up, and closeout procedures at project completion.
- Article V-Operation and Maintenance
  - This section defines the municipality's roles and authority in the determination of operation and maintenance of any and all stormwater management facilities. The determination of the ultimate party responsible for such operation and maintenance will be made prior to final plan approval. An appropriate O/M agreement should also be included that defines the owner's responsibility for proper operation and maintenance of the facility and the municipality's rights to enforce the agreement or charge fees associated with maintenance of any facility owned by an entity other than the municipality.
- Article VI-Fees and Expenses
  - This section should outline all costs incurred in the review fee, and that the municipality may charge such fees to an applicant. The review fee may include but not be limited to costs for the following:
    - Administrative/clerical processing.
    - Review of the SWM Site Plan.
    - Attendance at Meetings.

        - Inspections
- Article VII-Prohibitions
    - This section addresses all necessary prohibitions and definition of unacceptable activities, which are deemed to not adhere to the language of the ordinance. Items of the following type, but not limited to, should be included in this section:
        - Any illegal and illicit discharges prohibited under the provisions of the ordinance
        - Specific guidelines regulating the installation and function of residential and commercial roof drain systems
        - Specific guidelines regulating the alteration or retrofitting of any existing stormwater management facility or BMP device
- Article VIII-Enforcements and Penalties
    - This section outlines the municipality's rights concerning enforcement of the ordinance guidelines and applicable and allowable penalties. A detailed description of the following items should be included:
        - The municipality's right of entry
        - The municipality's right of inspection
        - The municipality's rights of enforcement of the terms of the ordinance and any associated agreements
        - Information concerning suspensions and revocation
        - A detailed listing of penalties that are considered in direct violation of the terms of the ordinance and any associated agreements
        - A detailed outline of the appeals process available to any applicant
- Article IX- References
    - Supporting documentation used for the creation and formulation of any portion of the ordinance

- Appendix A:
    - Low Impact Development Practices
- Appendix B:
    - Site Conditions Suitable for Infiltration
    - BMPs for Infiltration
    - BMPs for Rate Control
    - BMPs for Evapotranspiration
- Appendix C:
    - Operation and Maintenance Agreement, Stormwater Best Management Practices
- Appendix D:
    - Rational Formula Runoff Coefficients
- Appendix E:

- Small Project SWM Plan Application and Worksheets

- Appendix F:
  - Disconnected Impervious Areas

- Attachment A:
  - Additional Ordinance and Technical Guidelines Toolbox

SECTION VIII PRIORITIES FOR IMPLEMENTATION

Preparation of Forest County's Act 167 Stormwater Management Plan concludes with final acceptance of the plan by the County Commissioners, (which will occur simultaneously with adoption of the Forest County Stormwater Management Ordinance) and submission of the final plan to PA DEP.

A. DEP Approval of the Plan

Once the final Plan is adopted by Forest County, it is then submitted to the PA DEP for review. The PA DEP will review the Plan for the following items:

- Consistency and adherence with floodplain management plans
- Commonwealth regulations concerning the management of dams, waterway encroachments, and all other possible waterway obstructions
- Commonwealth and Federal flood control guidelines

This specific Act 167 Plan was prepared exclusively for Forest County and the municipalities located therein. However, based upon the fact that watershed boundaries overlap between counties (and in this case states), the Plan must be consistent and compatible with other Act 167 and stormwater management plans and policies that are already in place, or currently being prepared in adjacent jurisdictions.

B. Publishing the Final Plan

Upon final review of the plan by PA DEP, the County will provide each municipality with a final copy, together with the model municipal ordinance and the Forest County Stormwater Management Ordinance.

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C. County Adoption of Ordinance to Implement the Plan in all Municipalities

The Forest County Commissioners, upon acceptance of this Plan, will enact the Forest County Stormwater Management Ordinance and will be in effect within all the municipalities within the County. This ordinance, like the County SALDO, provides a base set of county-wide regulations that will be administered by the Forest County Conservation District & Planning Commission.

Each individual municipality will nevertheless have the option to develop and adopt its own Stormwater Management Ordinance in which case the municipal ordinance would, to the extent it is not less stringent than the county ordinance, supersede the county ordinance within that municipality's political boundaries.

The only remaining requirement relating to local implementation would be to formally correlate any existing County and/or municipal ordinances in order to identify conflicts with the regulations developed under this Plan. The Forest County Planning Commission will assist municipalities with revising existing regulations to eliminate such conflicts and to refer persons planning to engage in Regulated Activities to the new governing ordinance.

D. Level of Government Involvement in Stormwater Management

The current process for the management of stormwater from a regulatory basis within the Commonwealth of Pennsylvania is a blended mixture of objectives and directives from a number of governing bodies.

Stormwater within a single watershed currently has the potential to be managed and regulated at a federal, state, county and local (municipal) level. Each of these entities can possess their own guidelines and regulations based on their specific intent and place as a stakeholder in the regulatory process. It becomes the responsibility of the developer or applicant to address, adhere, and gain approval from each separate entity based upon their singular guidelines, which at times, can even be in direct conflict or contradiction with another regulatory entity's guidelines and regulations. This lack of a sole, regulatory entity, responsible for the implementation of all rules, regulations, reviews, assistance, and approval during the stormwater process makes the process in and of itself extremely difficult to navigate.

It is not the intent of this Plan or the Act 167 process to simplify this process. However, implementation of the Plan guidelines and minimum requirements of Act 167 can be accomplished without significant disruption to the current permitting and approval process in any particular watershed. The most significant action will occur at the municipal and county level. The technical review of stormwater management plans must include the input of both a representative municipality as well as the county in a joint, cooperative effort. Along with the review and approval of Plan applications, intermittent updates to the computer model (created as an end product of the Plan preparation, and provided as a final deliverable) are required in order for data to remain current and to indentify new or potential problems. The collection and storage of physical data (new development, changes to the watershed(s), etc.) also will be required in order to have a current inventory of county stormwater infrastructure and impacts to hydrology.

Upon final adoption of the Plan, the following types of projects will be subject to the provisions of the Plan and remain consistent with the rules and regulations set forth in the Plan:

- New Public Facilities
- New Facilities for the Provision of Public Utilities
- New Facilities Owned or Financed by Commonwealth Funds

These public or publically funded facilities are required to comply with the Plan even if they are not subject to any municipal regulation.

The primary role of the local municipalities will be to review the County's Stormwater Management Plan and determine the best course of action for future regulation and administration of the guidelines therein. It is expected that most, if not all of the municipalities in Forest County will simply rely on adoption of the Forest County Stormwater Management Ordinance as the basis of their compliance with the mandates of Act 167, but each is nevertheless free to adopt an ordinance of its own, in which case the municipal ordinance, would, to the extent it is not less stringent than the County Ordinance, supersede the County Ordinance within that municipality's political boundaries.

The Forest County Conservation District & Planning Commission will be responsible for the review of stormwater management plans and erosion and sedimentation control plans for any new development, in conformance with the guiding regulations. Unique within Pennsylvania, the Forest County Conservation District & Planning Commission combines both conservation and planning responsibilities under one agency. This allows for easy attainment of consistency and conformance.

The necessary evidence that state and federal agencies have been contacted and notified of regulated activities will also be required. This applies in most instances to any impact or potential impact to areas, through acceptable delineation practices, which are considered wetlands. This process is intended to ensure that all Plan guidelines and regulations are being followed and have been implemented.

E. Correction of Existing Drainage Problems

The completion of the stormwater management Plan will provide an outline and source of reference for the elimination of existing stormwater management problems within the County. Unfortunately, due to the lack of funding, specific scientific studies were not completed that would yield beneficial data appropriate to localized watershed problems. If problems continue or escalate, funding will be needed for basic hydrologic study and modeling in order to establish better answers to pre-existing conditions. Each municipality will have at its disposal a resource for identifying and addressing these problems at the local level. The municipality will not only have a better framework for addressing and correcting existing problems, but for providing an environment in which future problems are prevented.

The information provided is not intended to be the only approach to correcting problems and in no way is anything considered to be mandatory. It is only a list of suggestions for providing an individual municipality a means to correcting existing problems. Since problems, as well as the means to correct them, vary between municipalities, not every recommendation is applicable in all cases.

- A list of existing stormwater management issues within the municipality should be created and prioritized. This list should take into account the following parameters:
  - Threat to human life
  - Threat to property and existing infrastructure
  - Frequency of occurrence
  - Proximity to other existing problems
  - Financial ramifications
- A technical evaluation of each problem area, costing evaluation to determine repair requirements, and a proposed course of action for the municipality to follow
- Implementation of the corrective action plan should begin and be integrated with the municipal capital or maintenance improvement budget on an annual basis

F. Culvert Replacement

One of the most common drainage problems within the county is flooding caused by unmanaged or insufficiently managed stormwater runoff from development that is tributary to culverts. A large number of these culverts were never designed to pass the higher flows generated by excessive development. These culverts are not able to safely convey these higher flows, resulting in localized flooding, damage to infrastructure, roadway overtopping which results in driving hazards, as well as many other problems.

A culvert replacement plan should be enacted as part of the overall corrective action plan for each municipality. In general, the procedure for determining the proper culvert size is as follows:

- Identify the location of the problem culvert from the obstruction data provided in the Act 167 Plan and its assigned identification number
- Determine the appropriate design storm frequency based upon the PA DEP's Chapter 105 guidelines:
  - In determining flood flows and frequencies for purposes of this subchapter, hydrologic analysis shall be by methods generally accepted in the engineering profession
    - Rural areas—25-year frequency flood flow
    - Suburban areas—50-year frequency flood flow
    - Urban areas—100-year frequency flood flow
- Using the information provided in the Act 167 Plan, locate the appropriate flow (CFS) for the obstruction in question and based upon the return period criteria listed above
- Using sound and acceptable engineering practices, size the culvert based upon the determined parameters and within any ordinance or regulatory agency having jurisdictional control over the culvert replacement
- All necessary local, state, and federal permits and approvals should be obtained prior to construction

It is advisable that culvert replacement from smaller sizes to larger sizes should proceed from the downstream end of a drainage area and move toward the top so as not to overtax capacity of smaller culvert sizes down slope.

Not all obstructions within the county were identified, and none were modeled. In the event of a known problem obstruction area that is not listed in the Act 167 Plan, sound and acceptable engineering practices should be used in the proper design and replacement of the culvert. Portions of the previously listed method for replacement are still applicable, and should be implemented to the greatest extent possible. The most notable exception is that of calculated flow for the obstruction. This must be calculated by the design engineer for the culvert replacement and should be done in accordance with sound engineering practice as well as all local, state, and federal regulations governing the design of culverts in the municipality in question.

G. PennVEST Funding

PENNVEST has been empowered by Pennsylvania state law, Pennsylvania Infrastructure Investment Authority Act 16 of 1988, to administer and finance the Clean Water State Revolving Fund (CWSRF) and the Drinking Water State Revolving Fund (DWSRF) pursuant to the federal Water Quality Act of 1987, as well as to administer the American Recovery and Reinvestment Act of 2009 (ARRA) funds. PENNVEST also finances, through the issuance of special obligation revenue bonds, water management, solid waste disposal, sewage treatment and pollution control projects undertaken by or on behalf of private entities.

The PENNVEST Clean Water State Revolving Fund (CWSRF) program provides funding to projects throughout PENNSYLVANIA for the construction and maintenance of wastewater treatment facilities, storm water management projects, nonpoint source pollution controls, and watershed and estuary management.

This program offers low interest loans with flexible terms to assist a variety of borrowers that include local governments, municipalities, and privately owned entities and to establish partnerships to leverage other funding sources.

The CWSRF program is managed under the Pennsylvania State Regulations for PENNVEST funding wastewater projects. In partnership with the Pennsylvania Department of Environmental Protection, management occurs during project planning, application submission, contracting and financing, and site inspection and reporting.

The Pennsylvania Code establishes project evaluation criteria for PennVEST funding. The criteria for stormwater projects seeking PennVEST assistance is currently defined as[18]:

- Public health and safety
  - Elimination of critical ongoing safety or health hazard
  - Elimination of a chronic safety or health hazard which frequently occurs
  - Elimination of a potential safety or health hazard associated with periodic flooding
- Environmental impact
  - The improvement or prevention of a problem to the environment or to natural resources
  - Whether the project is located in areas of karst topography and susceptible to sinkhole development or has no natural watercourse within the municipal boundaries encompassing the project
- Economic development
  - Development, activity and job creation retention resulting directly or indirectly from a project
  - Opportunity to use other State programs, such as the Business Infrastructure Development, Site Development and Community Facilities Programs, to fund the project
  - Degree of local distress in the county where the project is located
- Compliance
  - Improvement of compliance with existing laws, rules and regulations if compliance will eliminate the necessity to issue an order
  - Compliance with law, an order, decree, agreement or a deadline specified in regulation
- Adequacy and efficiency
  - The extent that the project proposes facility regionalization or system consolidation to improve operation, maintenance or function of the stormwater facility
  - The extent that the project involves multiple-governmental participation
  - The extent that the project has a sponsoring municipal entity which has a population less than or equal to 12,000 residents as reported in the latest census

In order to qualify for funding consideration, the applicant must meet two important factors:

- The project seeking funding must be located within a watershed where a DEP approved and county adopted stormwater management plan is currently in place
- The project seeking funding must be located within a watershed where a stormwater management ordinance has been implemented as is consistent with the guidelines of the county-wide stormwater management plan

[18] The Pennsylvania Code, §963.9a adopted July 7, 1995, effective July 8, 1995, 25 Pa.B. 2720

H. Landowner's/Developer's Responsibilities

Any individual or landowner taking part in land development activities, or any other activities that may result in the alteration of the existing coverage or land use, within Forest County is required to implement necessary stormwater management controls. All controls shall be in conformance with the guidelines set forth in the stormwater management plan and local ordinance governing such activity, and shall seek to protect the public welfare and other property.

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