A Model Watershed Management Plan With Stakeholder Partnership

Subijoy Dutta, P.E.

Abstract

This paper focuses on the scope of developing an unique watershed management plan for the Delaware, Maryland, Virginia or DELMARVA area, using GIS and remote sensing technologies, for protecting and restoring aquatic ecosystems, protecting human health, and preserving other natural resources. Major features of this watershed management plan are identifying and assessing priority problems and vulnerability, looking at changes in some of the indicators in the watershed and their possible impact, encouraging a high level of stakeholder/local resident involvement, measuring program success through monitoring and other data gathering efforts.

Introduction and Background

A natural boundary draining to a water-body can be considered as its watershed. All areas that drain to a common water-body such as a lake, a river, or an estuary is generally termed as the watershed of that water-body.

The environmental and ecological status of a locality is a sheer reflection of the health of the watershed it belongs to. Since the passage of clean water act more than 25 years ago, regions throughout the country have made significant progress in protecting and restoring the health of the nation's waters. Despite this progress, 40 percent of our nation's waterways are still unsafe for fishing and swimming. While pollution from factories and sewage treatment plants have been reduced, runoff from city streets, pesticide-laden rural and agricultural areas, and other sources, commonly referred to as non-point sources, continues to degrade the environment and is adding risk to drinking water supplies, aquatic habitats, and other water uses. These problems call for a more comprehensive solution. In recent years the U.S. Environmental Agency (EPA) has joined with other public and private entities to promote community-based watershed management programs as a means to further restore and maintain water quality, protect sensitive habitats, and preserve land resources. EPA has been working with federal, state, and local governments by allocating specific pollutant loads to identified segments of various water bodies, such as creeks and river, within delineated watersheds through the Total Maximum Daily Loads (TMDL) regulation.

This study focuses on developing a unique watershed management plan with an effective strategy for protecting and restoring aquatic ecosystems, human health, and other natural resources. Major features of the proposed watershed management plan identified in this paper include:

- Identifying priority problems;
- Looking at changes in some of the indicators;
- Using remote sensing technologies and GIS tools;

- Encouraging stakeholder/community partnership; and
- Measuring program success through monitoring.

Various factors need to be considered in developing a watershed management plan even for a small watershed. This study involves a large, tri-state, Delaware, Maryland, and Virginia, or the popularly known DELMARVA basin of the Chesapeake Bay watershed. The different physiographic provinces of this watershed are shown on Figure 1 (USGS report HA 730-L 1998).

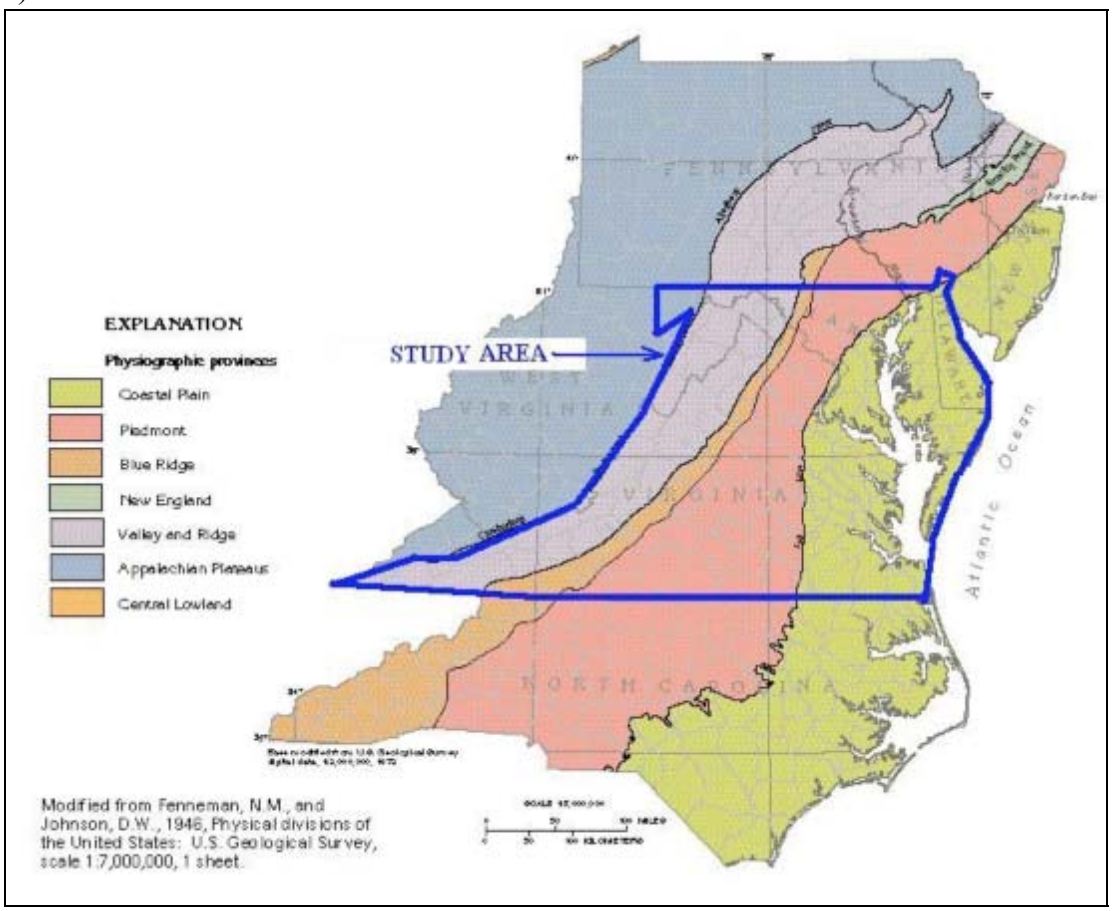

Figure 1. Physiographic map of the study area (USGS 1998)

As shown on Figure 1, this entire segment 11 (USGS 1998) includes the Coastal Plain, the Piedmont, the Blue Ridge, the New England, the Valley and Ridge, the Appalachian Plateaus, and the Central Lowland physiographic provinces. About 30% of this watershed (as marked in Figure 1) includes the States of Delaware, Maryland, and Virginia or the DELMARVA. Most of the above watershed drains into the Atlantic Ocean. Only a small part of the northwestern and north central Pennsylvania drain to Lake Erie and Lake Ontario; the rest of the segment containing Delaware, Maryland, and Virginia drains to the Atlantic Ocean through the Chesapeake or the Delaware Bay.

Although rivers are important sources of water supply for many cities, such as Trenton, N.J.; Philadelphia and Pittsburgh, Pa.; Baltimore, Md.; Washington, D.C.; Richmond, Va.; and Raleigh, N.C., one fourth of the population, particularly the people who live on the Coastal Plain, depends on ground water for supply. These study elements and factors are of great importance in the development of the watershed management plan for the area. Cities such as Camden, N.J.; Dover, Del.; Salisbury and Annapolis, Md.; Parkersburg and Weirton, W.Va.; Norfolk, Va.; and New Bern and Kinston, N.C., use ground water as a source of public supply (USGS 1998). Most of the watershed is underlain by aquifers in semi-consolidated and consolidated rocks. The aquifers are grouped and described (USGS 1998) according to the physiographic province.

Proposed Methodology

The unique plan visualized by this study emphasizes an effective protection and restoration of aquatic ecosystems, protection of human health, and preserving other natural resources within the watershed. This strategy is based on the premise that many water quality, ecosystem, and land resources problems are best dealt with at the watershed level rather than the individual water-body level. Major features of the proposed watershed management plan are:

- Identifying and assessing priority problems and vulnerability due to highly toxic pesticides/herbicides,
- Looking at changes in some of the indicators in the watershed and their possible impact,
- Using Environmental indicators, such as remote sensing technologies using satellite Imagery and GIS tools and techniques,
- Encouraging a high level of stakeholder/local resident involvement, and
- Measuring program success through monitoring and other data gathering effort.

A step by step approach in developing a watershed management plan for the study area involves the following:

1. Select a local watershed in the DELMARVA (Delaware-Maryland-Virginia) region that has a diverse land use, and hydrogeology.
2. Form a broad coalition of local property owners, water and wastewater agencies, environmental groups, agricultural parties, governmental entities, and other private interest groups.
3. Gather all available data on the selected watershed.
4. Establish a baseline condition of the watershed by identifying and assessing priority problems and vulnerability.
5. Establish a few indicators (such as aerial imagery, Satellite Imagery, GIS mapping, Vegetation sampling, and forest cover) that reflect temporal changes in the watershed.
6. Prepare specific goals and educational material with information on the watershed and seek stakeholder participation for a responsible management of a healthy watershed.
7. Establish a comprehensive watershed monitoring program that tracks changes in the watershed.

Another important factor in developing a sustainable watershed management plan is to use effective tools, strategies, and methodologies of a well developed watershed management plan.

The local watershed referred above should be selected carefully to capture as much diversity of land use, population, and vegetation as possible to fairly represent the tri-state area. According to the 2000 US census report the total land areas for Delaware, Maryland, and Virginia are 1,954.6, 9,774.6, and 39,597.8 sq. mi. respectively, yielding a total of 51,327 sq mi. for the whole DELMARVA area. The population densities are 340.8, 489.2, and 156.3 per sq. mi. for Delaware, Maryland and Virginia. A suitable size for this model watershed could be in the range of 200-750 square miles with a mix of rural and urban land use within the watershed boundary. A satellite imagery of the DELMARVA area overlain by State boundaries is shown on Figure 2 below.

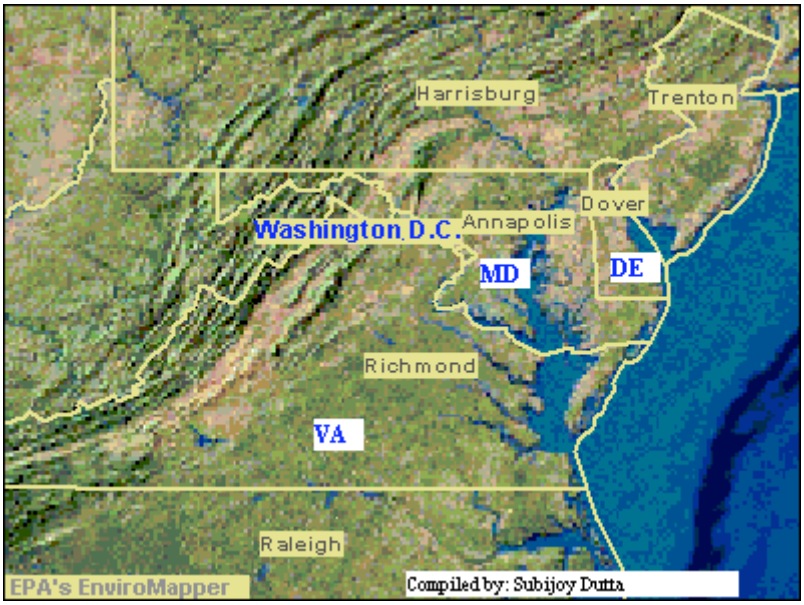

Figure 2. An imagery of the DELMARVA Area (source: EPA's EnviroMapper)

Amongst the five major features identified above for developing a watershed management plan, the most critical component is to build a solid stakeholder partnership and interaction. The following three case studies will succinctly reflect how the stakeholder partnerships worked and are in the works towards restoration and protection of these three watersheds.

Goose Creek Watershed, VA

In addition to the Virginia Department of Environmental Quality (DEQ), a few other organizations conduct periodic monitoring of the surface water quality of the streams and other water bodies in Loudoun County. Loudoun streams have generally been well monitored by DEQ and by citizen groups. DEQ has sampled 23 sampling stations since the 1970's. The Loudoun Soil and Water Conservation District (LSWCD) has sampled 15 stations since 1999. The Loudoun Wildlife Conservancy (LWC) has sampled 12 stations for at least two years. They have 3 new stations. The North Fork Goose Creek Watershed Committee has sampled 5 stations since 1993 and has added 3 stations in recent years. The Loudoun County Environmental Indicators (LEIP) project has sampled eight sites since year 2000. The different watersheds in Loudoun County, VA along with the surface water sampling sites of LEIP are shown on Figure 3

(Dutta et al. 2001). Among the eight major watersheds that drain the County, the Goose Creek watershed is the largest of all, draining an area of 150,683 acres. The change in impervious surface due to the fast growth in Loudoun County was also studied by LEIP. A GIS map of the Broad run (creek) watershed showing the range of impervious cover in percent of the land area in this watershed is shown on Figure 4 below (Fuller 2001).

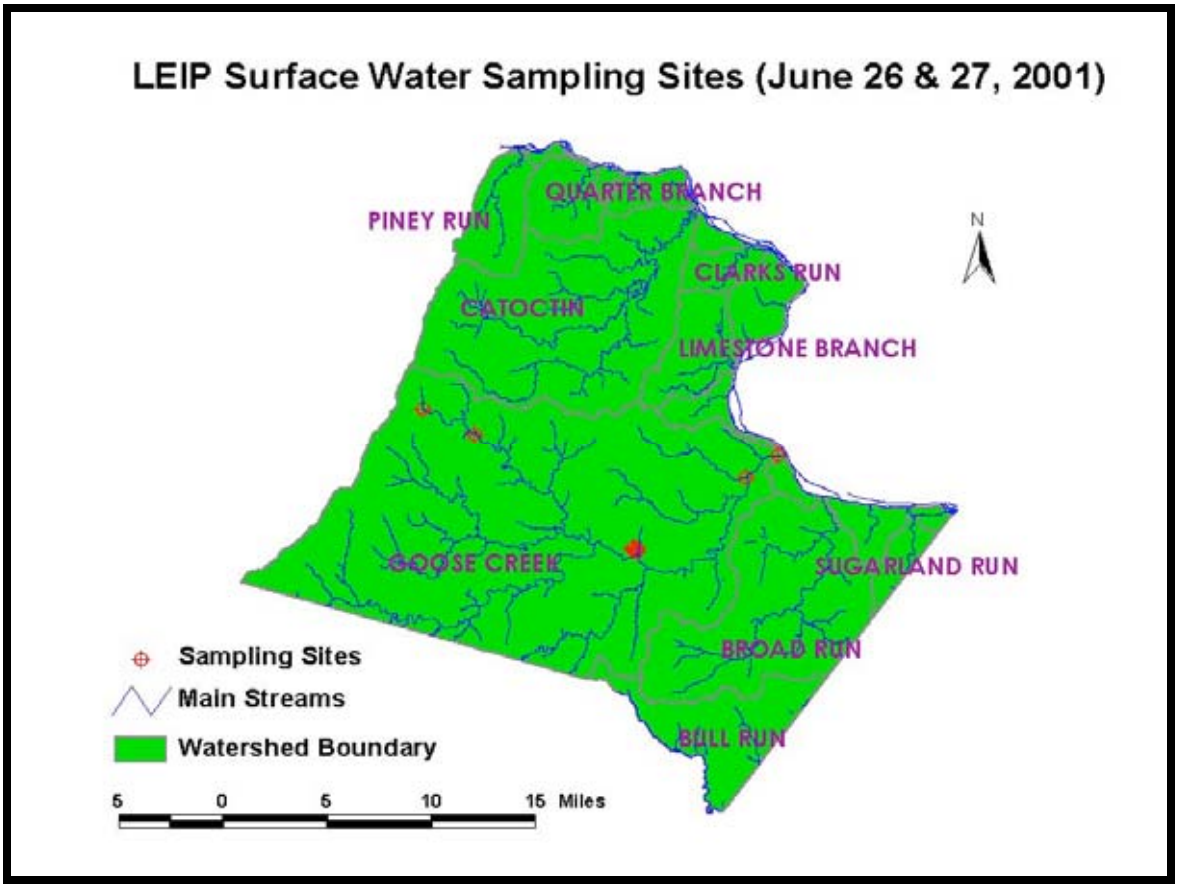

Figure 3. Major Watersheds in Loudoun County, VA (Dutta et al. 2001)

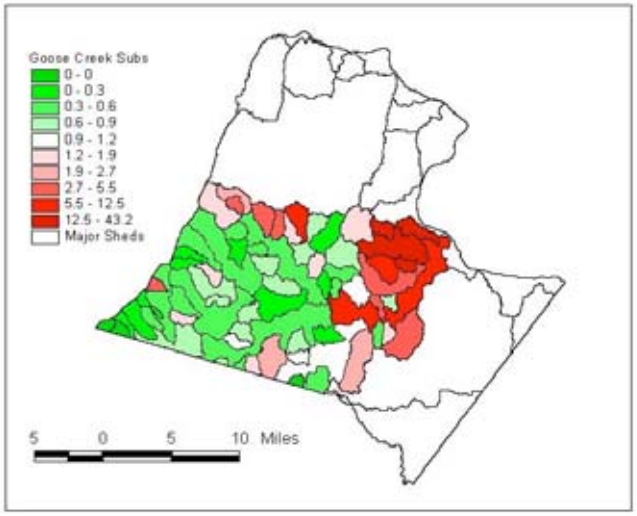

Figure 4. GIS map of the impervious surface in the Goose Creek Watershed (Fuller 2001)

Every major stream in Loudoun is being sampled by at least one group. The frequency of monitoring and the list of parameters monitored by DEQ in Loudoun County are more extensive than the monitoring efforts of all other organizations. A water quality forum was arranged in November 2002 with participation of most of the stakeholders. The major issue faced by the stakeholders was the lack of a central body to organize watershed protection/restoration activities with active coordination of various citizens' group. Also, no watershed management plan existed for the Goose Creek watershed or any other major watershed in Loudoun County. A satellite imagery of western Loudoun County showing the Catoctin Creek Watershed is shown on Figure 5. A few segments of the Catoctin Creek have TMDL impairments, which was another concern amongst local communities who have been living there for a long time. The water quality forum at least identified some of the major issues at hand and provided a more open platform for discussion amongst the stakeholders.

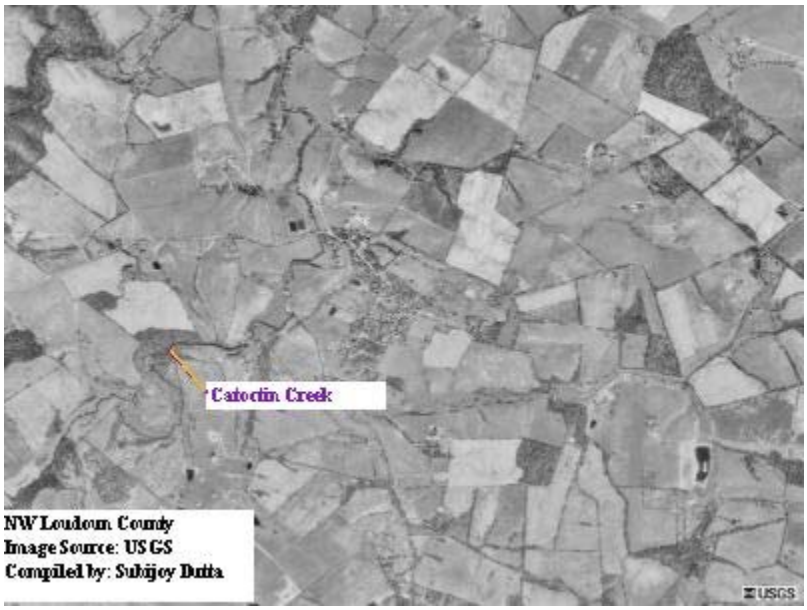

Figure 5. Satellite Imagery Showing Catoctin Creek Watershed in Western Loudoun County

Calleguas Creek (CA) Watershed Management Plan

The Calleguas Creek (California) watershed management plan (Figure 6) was reviewed and analyzed in this study for identifying some of the effective techniques and methodologies. The temporal changes in growth and development of Camarillo are shown on the inset of Figure 6.

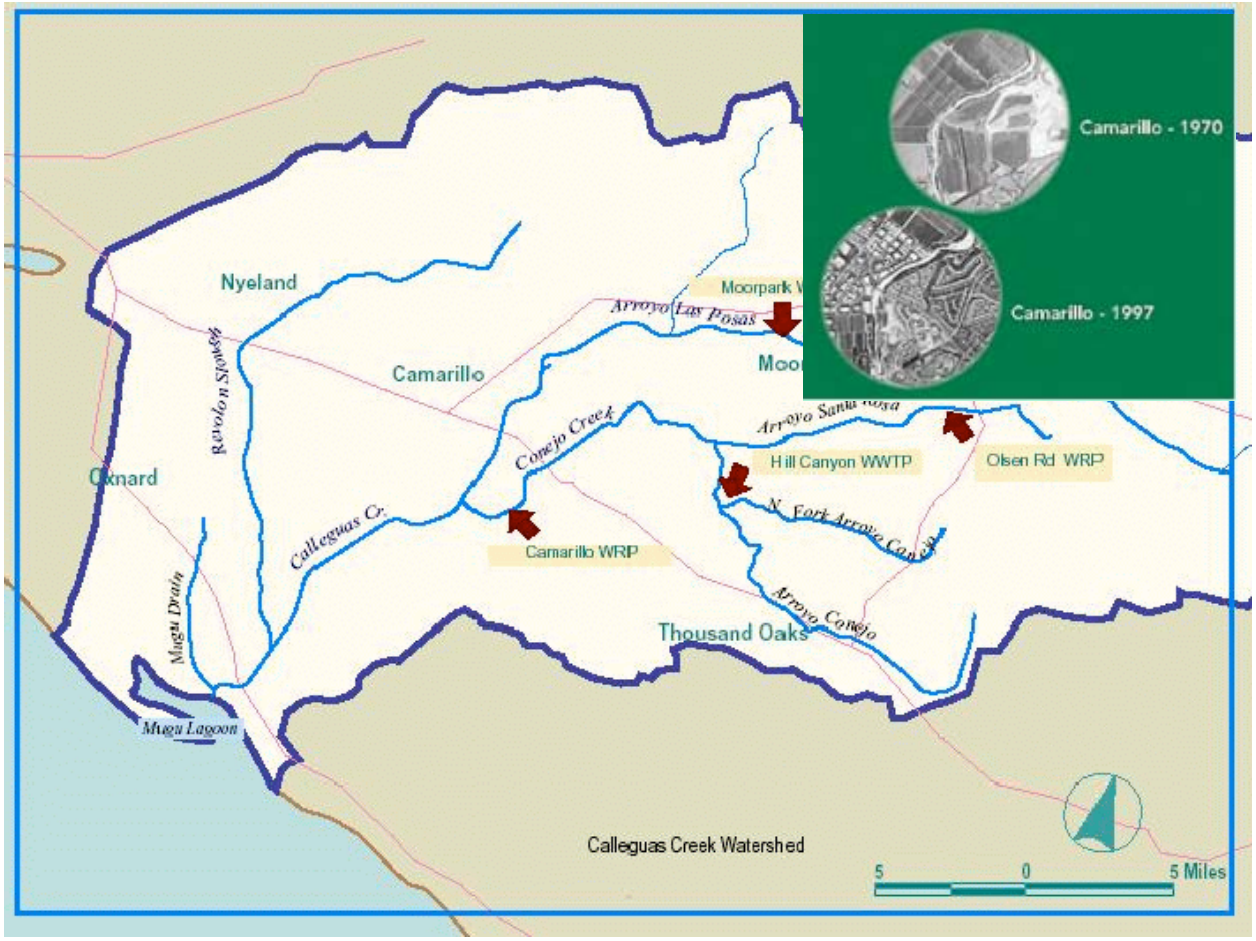

Figure 6: Calleguas Creek Watershed (CCWMP 2001)

Some of the issues considered in developing the Calleguas Creek Watershed Management Plan were 1. **Flooding**: (Redline Channels) (Arteries)
-NEEDS:
(1) Protection Of Life
(2) Public Infrastructure
(3) Private Property
(4) Natural Resources
-FLOOD PROTECTION:
(1) Flood Plain Management
(2) Flood Control
(3) Conversion To Flood Plain
-DOWNSTREAM IMPACTS:
(1) Land Use & Time Of Concentration
(2) Detention/Retention
(3) Waterway/Bridge Constrictions
-MAINTENANCE:
(1) Damage Restoration
(2) Maintenance Of Capacity

(3) Public Health (Rodents, Mosquitoes, Odor)
(4) Nuisance
(5) Herbicide Use
(6) Clearing - See "Maintenance Of Capacity"
(7) Disposal Of Debris & Vegetation
(8) Public Facilities
(9) Private Channels
- EDUCATION ON FLOODING:
(1) Information On Causes And Effects Of Flooding
(2) Terminology (Dovetail With The Public Outreach Subcommittee)

- Impact Of Sediment On Stream/Channel Capacity:
(1) Suspended Sediment Increases Volume Of Flood Flows and Sediment Deposition Reduces Stream/Channel Capacity
(2) Vegetation Can Cause Sediment Deposition And Slows Down The Flow
(3) Increased Bed & Bank Erosion Can Be Caused By Reduced Sediment Delivery in the System And Sediment Deposition.

2. Drainage:

(Local Runoff – City Storm Drain System, Road-Side Ditches, And Agricultural Return)

Concerns:
- NON-STORM FLOW (not caused by precipitation)
(1) Flow during traditionally dry periods promotes vegetation growth.
(2) Saturated beds and banks are more susceptible to erosion.
(3) Standing water causes mosquito infestation.
(4) Local drainage systems are conduits for delivery of contaminants to surface and ground waters.
(5) Local runoff may cause land loss by eroding stream banks.
- STORM FLOW
(1) Downstream Impact
(2) Increased Downstream Flooding
(3) More Frequent Increases In Peak Flows
(4) Vegetation, Habitat, And Sediment Impacts
(5) Localized Flooding
(6) Crop Loss & Property Damage
(7) Detention
(8) Land Loss
(9) Water Quality Degradation

3. Erosion, And Sedimentation:

CONCERNS
- EROSION / LAND LOSS:
(1) Agricultural Practices
(2) Urban Activities (Including Land Loss Due To Wastewater Treatment Plant Discharges)
(3) Stream Bed & Bank Erosion

(4) Impact Of Land Clearing / Grading
(5) Natural Erosion

- DISPOSAL OF ACCUMULATED SEDIMENT
(1) Re-Use Options
(2) Permitting
(3) Contaminated Sediment

4. Flood Water Conservation / Reuse:

- Hillside Protection
- Structural Controls
- Non-Structural Controls

Complete consideration of the above factors and open discussion and education of the stakeholders lead to the development of the Calleguas Creek Watershed Management Plan.

Christina River (DE, MD, PA) Watershed Management Plan

This Christina Basin Water Quality Management Strategy (Udel 1999) can be cited as a model example of a joint effort involving a diverse group of stakeholders. In developing this water quality protection strategy, local agencies in Delaware and Pennsylvania coordinated the activities of the overall watershed management on behalf of the Christina Basin Water Quality Management Committee. The Chester County Water Resources Authority and Chester County Conservation District served as local watershed coordinators for the Pennsylvania portion of the basin. The University of Delaware, Institute for Public Administration, Water Resources Agency served as local coordinator for the Delaware portion of the Basin. A combination of Federal, State, and local entities served the following roles beginning from 1998 in the development of this management plan:

Watershed Coordination:	Chester County Water Resources Authority Chester County Conservation District University of Delaware, Water Resources Agency
GIS Watershed Inventory:	University of Delaware, Water Resources Agency
Stream Monitoring:	Pennsylvania Dept. of Environmental Protection Delaware Dept. of Natural Resources and Environ. Control
Stormwater Monitoring:	U.S. Geological Survey University of Delaware, College of Agriculture
Total Maximum Daily Load (TMDL) Modeling:	Delaware River Basin Commission U.S. Environmental Protection Agency
Public Education/Outreach:	Brandywine Valley Association Red Clay Valley Association Christina Basin Task Force

BMP Implementation Projects:	Chester County Conservation District New Castle Conservation District
Integrated Watershed Programs:	Chester County Water Resources Authority (Water Resources Mgmt. Plan) Delaware DNREC (Piedmont Whole Basin Program)
Section 319 Funding:	Pennsylvania DEP, Bureau of Watershed Conservation Delaware DNREC, Div. of Soil and Water Conservation U.S. Environmental Protection Agency, Region III

The mission of the Christina Basin Water Quality Management Strategy is to conduct a cooperative, interstate effort to implement programs to protect and improve the water quality of streams, waterways, and groundwater in the Brandywine, Red Clay, White Clay Creeks, and Christina River watersheds of DE, MD, and PA (Udel 1999).

Legend (people per square mile)

- 0-400
- 401-700
- 701-1650
- 1651-3600
- 3601-5750

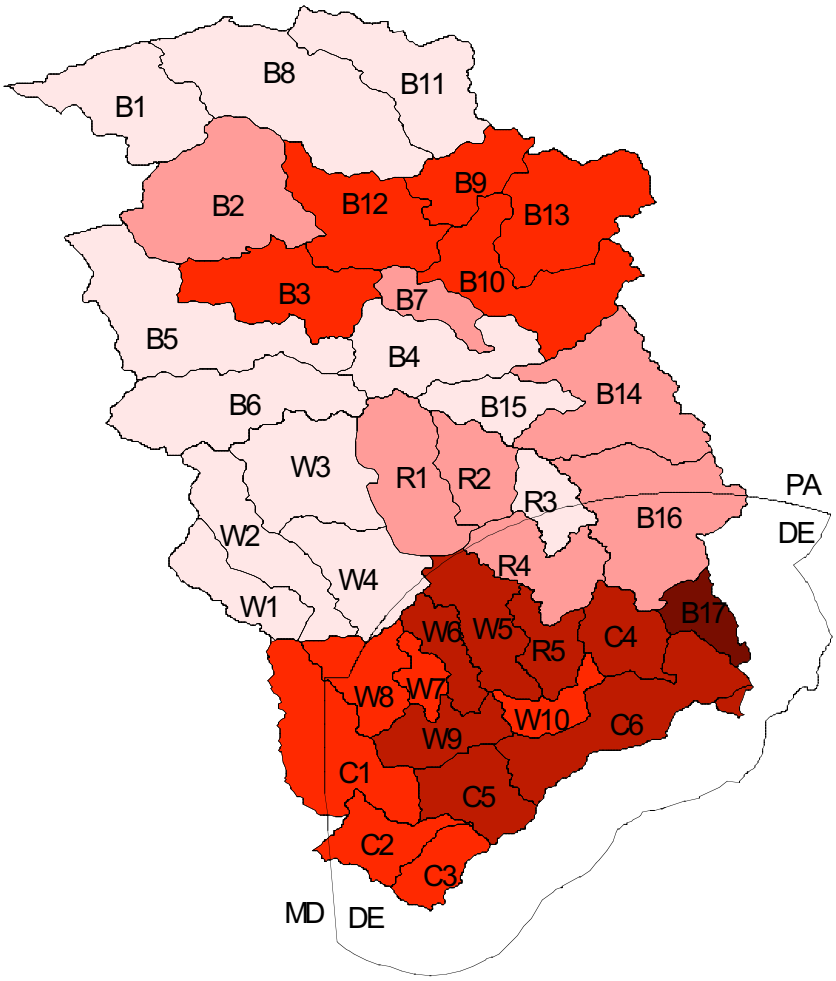

Figure 7. Demography of the Christina River Watershed (Udel 1999)

The demography of the Christina river basin is shown on Figure 7. The Christina Basin Water Quality Management Committee initially planned a six-point implementation and funding plan to address the water quality problem of the Cristina River. The six-point plan included the following components:

1. Watershed Coordination
2. Monitoring and Modeling
3. Public Education/ Outreach and Involvement
4. Urban/ Suburban Best Management Practices (BMPs)
5. Rural and Agricultural BMPs
6. Conservation, Riparian and Non-Structural BMPs.

Conclusions & Recommendations:

Developing a comprehensive watershed management plan for the DELMARVA area is a massive undertaking and the most effective way to complete that in a timely fashion and with high accuracy is to undertake development of management plans for various sub-watersheds within this huge watershed with an active stakeholder partnerships amongst various citizens' groups and relevant local, state, and federal government agencies in each of these sub-watersheds. Each sub-watershed could be further subdivided, if necessary, for higher precision and accuracy in data gathering and more effective management. A good case study of an existing watershed management plan should be reviewed in detail for identifying various issues encountered during the development process. The Calleguas Creek watershed management plan report (CCWMP 2001; website: www.calleguas.com) may provide useful information in this regard.

Amongst many advantages of a comprehensive watershed management the following benefits are most noticeable:

- Development of a truly comprehensive solutions, integrating impacts from such sources as pesticides, industrial pollutants, nutrients from cattle/chicken farming, erosion, sedimentation and flooding problems etc. in a specific geographic area.
- Increased efficiency and cost effectiveness by integrating programs already in progress.
- Encouragement for area residents, business owners, and other interested parties to get involved by bringing natural resource decisions closer to the community.
- Greater awareness and support from the public through active participation of the area residents due to their involvement in decision-making as well as hands-on protection and restoration activities.

References

US Geological Survey (USGS). "Principal Aquifers of the 48 Conterminous United States", compiled by James A. Miller, Madison, Wisconsin, July 1, 1998.

Calleguas Creek Watershed Management Plan (CCWMP) 2001, "Revised Public Review Draft, Calleguas Creek Nutrient TMDLs" Water Resources/Water Quality subcommittee under an EPA Section 205(j) Grant awarded bythe State Water Resources Control Board Agreement No. 7-120-250-0, March 2001

Dutta, Subijoy, and Wells, Elizabeth, F. "Water Quality Sampling of Goose Creek Watershed, Loudoun County, VA", Loudoun County Environmental Indicators Project (LEIP) Annual Report 2001.

Fuller, Doug, "Impervious Surface Study, Loudoun County, VA", Loudoun County Environmental Indicators Project (LEIP) Annual Report 2001.

Kauffman, Gerald, et al., University of Delaware (Udel) , Phase III report, Christina Basin Water Quality Management Strategy, Christina Basin Water Quality Management Committee, Newark, DE 1999.

Author Information

Subijoy Dutta, P.E.
U.S. EPA, OPP/EFED (7507C)
1200 Pennsylvania Ave., NW, Washington, DC 20460
Ph: 703-308-3852, Fax: 703-305-0609; email: dutta.subijoy@epa.gov