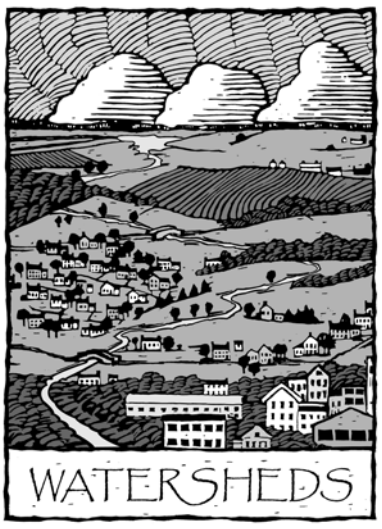
Chester Creek

Watershed Action Plan

December 2002



Watersheds Mission Statement

To protect, sustain, and enhance the quality and quantity of all water resources to insure the health, safety, and welfare of the citizens, and preserve the diverse natural resources and aesthetic and recreational assets of Chester County and its watersheds.

Disclaimer

The maps, data and information presented herein were compiled by the Chester County Water Resources Authority for the County of Chester, PA and are hereby referenced to the *Chester County, Pennsylvania Water Resources Compendium* (2001). These information and data are provided for reference and planning purposes only. This document is based on and presents the best information available at the time of the preparation.

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Section 1. Watershed Setting

The Chester Creek watershed has several primary characteristics that lay the foundation for the priority management needs:

- The land use of the watershed is approximately 50% developed, with most of this being single-family residential (36%).
- The watershed is a source for 2 public drinking water supply intakes that serve portions of Chester and Delaware Counties.
- Extensive growth (18% population increase) is projected within the watershed over the next 20 years.
- Substantial areas of the watershed are densely developed and have no stormwater management facilities.
- Because of the dense development in the upper and lower portions of the watershed, the estimated percentage of impervious cover for the watershed is 19%, just under the 20% threshold often associated with impaired stream systems.

The Chester Creek watershed is located in eastern Chester County (PA) and western Delaware County (PA) as shown in Figure 1. It consists of two subbasins covering about 66 square miles (Figure 2 and Table 1). Chester Creek and its tributaries include an estimated 128 miles of streams, and flow into the Delaware River at the City of Chester. There are 21 municipalities in Chester and Delaware Counties that are located either fully or partially within the watershed, as illustrated in Figure 3.

As summarized in Table 2, major land use groups within the Chester Creek watershed includes a mix of agricultural, with 13% of the land area, developed (50%) and other uses (37%). The estimated population for the Chester Creek watershed in 1998 is 100,100 and there are about 2.4 people per acre (1,517 people per square mile). In 2020, the projected population in the watershed is 117,700 or an increase of 18% from the 1998 estimate.

As a watershed that is considerably developed with residential communities, the Chester Creek watershed faces numerous problems for protecting, restoring and managing the water resources of the watershed. With impervious cover at nearly 20% for the watershed, stormwater runoff and the resulting flooding and diminished ground water recharge is a concern. Extensive areas of development have no stormwater management facilities. As a result, several tributaries have suffered extensive erosion and impacts. Improved stormwater management is a critical management need. The watershed serves as a major source of drinking water supplies with one reservoir and two surface water intakes, and source water protection is a very important management objective. Over fifteen miles of the watershed's stream segments have been identified by the Commonwealth of Pennsylvania as not meeting the designated water use. These "impaired" streams must be addressed and the sources and causes of the impairments need to be resolved. Figure 4 presents the problems and concerns identified in Chester Creek watershed. In addition, during low flow conditions, high levels of nitrate resulting from wastewater treatment plant effluent can occur in the Chester Creek.

In addition to the problems identified, the Chester Creek watershed has many significant resources that provide benefits to the community and environment that must be protected and preserved. As discussed above, one reservoir, West Chester Reservoir, two surface water intakes, and numerous community water supply wells are located within the watershed for public water supplies. The watershed also has areas that contain or may contain rare and endangered species as

noted in the Pennsylvania Natural Diversity Index (PNDI), including the Hershey Mill Barrens in East Goshen Township, Chester County. Green Creek is designated as cold water fish protected waters. Figure 5 presents the mapped resources and competing needs identified in Chester Creek watershed.

A more comprehensive description of the characteristics of Chester Creek watershed is presented in Section 3: Watershed Characteristics. Unless otherwise noted, all data and information presented in this document are taken from the *Chester County, Pennsylvania Water Resources Compendium* (Chester County Water Resources Authority, 2001).

Section 2. Planning Framework

One of the most challenging aspects to those working in watershed protection is to determine which areas are most in need of their efforts, and what strategies will yield the most benefit to the watershed. The information presented here is intended to summarize key information on watershed characteristics, present results from various analyses that were conducted and described in the *Chester County, Pennsylvania Water Resources Compendium*, and to develop a broad structure of goals and priorities that reflect the needs and challenges for the watershed consistent with the guidance and framework of the Chester County ***Watersheds*** Plan.

It is important to recognize that the goals and priorities presented here are intended to be flexible and change over time. The value of this *Watershed Action Plan* will decrease over time unless the citizen groups, watershed organizations, land trusts, municipalities, and other governmental organizations communicate and work together to make revisions and improvements where possible. With that in mind, strong efforts to coordinate watershed planning and implementation must be stressed.

The purpose of the ***Watersheds*** Plan is to provide a framework of guidance and implementation strategies to achieve the following seven goals:

- Engage and Educate Individuals, Communities and Governments in Watershed Stewardship.
- Enhance Water-Based Recreational and Cultural Resources.
- Preserve Natural Resources.
- Improve Water Quality.
- Reduce Stormwater Runoff and Flooding.
- Protect Watershed Water Balances.
- Integrate Utility and Municipal Planning to Meet Future Water Supply and Wastewater Needs.

Watersheds was adopted by the Chester County Board of Commissioners in September 2002 as the water resources element of ***Landscapes***, Chester County's comprehensive plan. In 1996, the Chester County Board of Commissioners adopted ***Landscapes*** as the County's comprehensive plan policy document. The vision of ***Landscapes*** is to "preserve and enhance the unique character of Chester County's landscapes by concentrating growth in the most appropriate areas." ***Landscapes*** sets forth a vision of the growth patterns of Chester County based on public input. It also includes goals and related policies that lay the foundation for the protection and use of the County's natural resources, including (among other goals):

- Resources Goal – to sustain and enhance the natural, scenic, and historic resources for the benefit of current and future generations while accommodating planned growth.
- Utilities Goal – to provide utility facilities and services to meet all needs in the County, protect the environment and public health, and support development consistent with the future landscapes pattern.

Watersheds builds upon these goals and provides detailed recommendations for all stakeholders to enhance and protect the natural water resources of the County's watersheds. This includes better management of water for domestic, commercial, industrial, agricultural, recreational, and natural uses. On a broader scale, the intent is to accommodate existing land uses and planned growth in a manner that maintains or re-establishes the natural hydrologic characteristics of the

watersheds. Furthermore, we must strive to preserve and protect the historic and cultural resources, scenic rivers, and areas of natural habitats and diversity that comprise the County's natural landscape and character.

The inter-related nature of water and society, and the need to involve all stakeholders, present overlapping and complex challenges. Sound planning can provide effective, achievable strategies that are based on sound science, ***Landscapes***, local land use planning, and Pennsylvania's existing regulatory framework.

The *Chester Creek Watershed Action Plan* was prepared as part of the *Chester County, Pennsylvania Water Resources Compendium* in conjunction with the Chester County ***Watersheds*** Plan. The *Chester Creek Watershed Action Plan* is part of a series of action plans developed for each of the 15 major watersheds that are part of the *Compendium* study area, and collectively the action plans represent Part 4 of the *Compendium*.

The *Compendium*, ***Watersheds***, and this *Chester Creek Watershed Action Plan* were prepared to provide the planning and strategies necessary to accommodate existing land use and planned growth in a manner that is consistent with the natural characteristics of our streams and aquifers, and to sustain:

- ground water recharge,
- stream baseflows,
- stable stream channels,
- the flood-carrying capacity of streams and their floodplains,
- the water quality of streams and ground water, and
- riparian and aquatic living resources.

Chester Creek watershed has the benefit of a long-established watershed association (Chester Ridley Crum Watershed Association) to coordinate overall implementation of watershed management actions and public participation. This organization largely relies on volunteer efforts. The long-term viability of this organization and the long-term success of the watershed-wide cooperative implementation strategies are essential to the long-term health of this watershed. This *Watershed Action Plan* includes numerous recommendations for implementation by numerous entities. However, the role of this citizen-based non-governmental watershed organization has been demonstrated to be a key asset to truly successful long-term watershed management efforts.

Through this *Chester Creek Watershed Action Plan*, substantial data, conclusions, and summaries of analyses are presented. All data, information and mapping presented herein were compiled by the Chester County Water Resources Authority for the County of Chester, PA and are hereby referenced to the *Chester County, Pennsylvania Water Resources Compendium* (published 2001), unless otherwise stated. These information and data are provided for reference and planning purposes only. This document is based on, and presents, the best information available at the time of preparation.

Section 3. Watershed Characteristics

Population

Population estimates for the Chester Creek watershed indicate that the watershed has approximately 100,100 people as of 1998. This is about 2.4 people per acre (1,517 people per square mile). In 2020, the projected population in the watershed is 117,700 or an increase of 18% from the 1998 estimate. Table 3 presents the breakdown by subbasin of the population within the watershed.

Land Use

Major land use groups within the Chester Creek watershed include a mix of agricultural, with 13% of the land area, wooded (31%), and single-family residential (36%). Table 4 and Figure 6 present the percent of land area within the watershed in each land use category.

Impervious Cover

One way to evaluate the impacts of land use on the health of a watershed is to evaluate the pervious and impervious land cover in the watershed. Generally, where impervious surfaces (pavement, concrete, rooftops, etc.) cover less than 10% of the land area, the watershed functions well and supports sensitive resources. As the percent of impervious surface area increases above 10%, impacts to both water quantity and quality occur. Watersheds with more than 20% of the land area covered with impervious surfaces often show flow patterns and water quality that are indicative of a degraded (or impaired) watershed.

The percent of impervious cover for the entire watershed is estimated to be 18.8% in 1998 (Figure 7). It is projected to increase by 2.9% to 21.7% by 2020. The estimates of percent impervious for each subbasin within the watershed for 1998 and 2020 are presented in Table 5.

Geology

The geology of the Chester Creek watershed is almost entirely crystalline rocks (Figure 8). The predominant geologic rock type found in the watershed is described below:

- Crystalline Geology: Ground water in crystalline rocks moves through intergranular openings in the weathered zone, and through a network of interconnecting secondary openings (fractures and joints) in the unweathered rock. Permeability of the unweathered rock depends on the number and size of the fractures, as well as how well interconnected they are. The ground water table reflects the topography of the land, and the ground water flow is usually local, with streams acting as the discharge points. Usually the ground water and surface water divides coincide. In general, well yields for the crystalline rocks are significantly lower than well yields in other geologic formations.

- Coastal Plain Formations: The Fall Line represents the contact between the Atlantic Coastal Plain sediments and crystalline rocks of the Piedmont Province. The Coastal Plain Province consists of a series of unconsolidated gravel, sand, silt and clay deposits dipping eastward to southeastward. They are primarily located in the southern portion of the watershed. The Coastal Plain sediments overlie the crystalline bedrock, which dips steeply to the east/southeast. The thickness of the Coastal Plain sediments ranges from 0 feet at the Fall Line to several hundred feet at the Atlantic Ocean shoreline. There are several formations included within the Coastal Plain and several are very productive aquifers.

- Unconsolidated Sediments: Unconsolidated sediments are a formation of sediments that are loosely arranged or unstratified (not in layers) or for which the particles are not cemented together (soft rock). Such a formation can occur either at the ground surface or at a depth below the surface.

Watershed Water Budgets

Water budgets are often used to describe the distribution of water as it moves through the natural hydrologic cycle within the watershed system. Water budgets typically use the volume of average annual precipitation as the expression of total water in the system (expressed as inches per year, in/yr). The typical components used to describe water budgets are:

- Precipitation: the volume of average annual precipitation determined from meteorological records.
- Baseflow: the annual average volume of water discharged from ground water aquifers to streams.
- Recharge: the annual average portion of precipitation that moves through the unsaturated soils and recharges the ground water system.
- Runoff: the annual average portion of the precipitation that flows over the land surface and into surface water bodies, primarily into streams.
- Evaporation: the annual average portion of precipitation expected to return to the atmosphere as water vapor from open water surfaces, surface soils, or water landing on vegetation, pavement, and other surfaces that allow the water to be converted to water vapor.
- Transpiration: the annual average portion of precipitation that is absorbed by roots of plants and returned to the atmosphere via the process of photosynthesis through the leaves of the plants.

Because evaporation and transpiration are very difficult (and often impossible) to measure, they are typically combined into a component referred to as "evapotranspiration" (ET) and used to represent the portion of precipitation that is not recharge or runoff.

Water budgets vary from watershed to watershed, depending on the geology, rainfall patterns during the period of record, topographic features such as slope, soils, and degree of development and impervious cover. The U.S. Geological Survey (USGS) has prepared watershed water budgets for several watersheds in Chester County. Because average water budgets are calculated by averaging each component over the period of record, the results are often not additive to the total average annual precipitation. The following is an average water budget for several watersheds of Chester County calculated by USGS:

- Precipitation 47.6 in/yr.
- Runoff 7.9 in/yr.
- Evapotranspiration 26.2 in/yr.
- Baseflow 13.5 in/yr.

A more detailed discussion of water budgets and those developed by USGS are presented in the *Compendium*.

Ground Water Balances

Ground water balances were developed for each subbasin to provide an indication of the sustainability of current and projected ground water use within the watershed. These budgets also assist in:

- Providing an understanding of the magnitude and use of water within each subbasin.
- Identifying subbasins where sufficient ground water resources are available to support all or a portion of projected future water demand.
- Identifying subbasins where ground water resources may already be stressed or approaching stressed conditions.
- Establish a framework of "ground water withdrawal management targets" that could be applied on a voluntary basis to assist in evaluating current or proposed ground water development projects.

To assess the "sustainability" of ground water to support current and projected withdrawals, it was necessary to establish a "target" of total withdrawals for each subbasin that would represent an acceptable volume of depletion of ground water resources. This "target" was then used for comparison with estimates of the total volume of current ground water withdrawals and for comparison with estimates of projected future water withdrawals to ascertain whether or not total net ground water withdrawals now or in the future will exceed that "target".

To maintain consistency with the current regulatory structure for ground water withdrawals, the methodology developed by USGS for use by the DRBC was used. The regulations for the DRBC Southeastern Pennsylvania Ground Water Protected Area (GWPA) have established the volume of the "1 in 25 year average annual baseflow" of the main tributary of each subbasin (at the downstream mouth of the subbasin) to represent the acceptable volume of ground water that can be consumed from a subbasin without causing significant impact to the aquifer and baseflow of the subbasin. The "1 in 25 year average annual baseflow" is a statistically derived flow and is expressed as cubic feet per second (cfs) or million gallons per year (MGY). It is used to represent the annual average flow that is expected to occur within the stream at the mouth of the subbasin during an extended dry weather period that would occur on average only once in every 25 years. This statistical flow could be described as the "1 in 25 year low flow" – the opposite of the "1 in 25 year flood flow." The volume of the 1 in 25 year average annual baseflow for the subbasins of this watershed are shown in column 3 of Table 6.

Watersheds further recommends that certain subbasins may contain "sensitive resources" that are dependent upon reliable stream baseflows, and for such subbasins a more protective ground water withdrawal management target may be appropriate. For this purpose, "sensitive resources" are defined to include Exceptional Value and/or High Quality streams, designated Scenic or Wild and Scenic Rivers, instream sources of community water supply systems (where instream withdrawals are not directly and continuously supported by reservoir storage), and state-designated instream fisheries. In addition, ***Watersheds*** recommends that drainage areas to first order streams also be evaluated to determine if more protective ground water withdrawal management targets are appropriate. For subbasins that contain "sensitive resources" and for drainage areas to first order streams, ***Watersheds*** recommends that the ground water withdrawal targets be set at 50% of the 1 in 25 year average annual baseflow, unless a hydrogeologic or other instream flow study has established that a larger volume can be withdrawn while sustaining the resources of the subbasin or drainage area. For this watershed, the recommended net ground water withdrawal management targets for the subbasins of this watershed are listed in column 4 of Table 6.

To evaluate the "sustainability" of current and future ground water withdrawals, the total volume of "net cumulative ground water withdrawals" was calculated for each subbasin and compared to the above net withdrawal targets. Data were taken from annual reports submitted to state agencies and river basin commissions by entities holding permits for ground water withdrawals and combined with estimates of individual residential well withdrawals that were based on current (1998) and projected (2020) population. The total volume of well withdrawals was summed. In addition, the total volume of estimated ground water recharges (from anthropogenic sources such as injection wells, land application systems for treated wastewater, estimated recharges from onlot septic systems, etc.) was also calculated from reports and records of regulatory agencies (for permitted activities) and from population estimates and projections (for estimating recharges from onlot septic systems). The total recharges were subtracted from the total withdrawals to calculate the "net cumulative ground water withdrawals" for each subbasin. The net cumulative ground water withdrawals for 1998 are listed in column 7 of Table 6.

Comparing the net volume of withdrawals to the target withdrawal volume yields a percentage that can be used to evaluate the overall "sustainability" of current withdrawals. When the percent of net withdrawals is less than 50% of the subbasin's targets, the ground water resources are considered non-stressed. Net withdrawals greater than 50% are considered potentially stressed. Net withdrawals near or exceeding 100% are considered stressed. For these subbasins, the net withdrawals are shown in Table 6 as a percent of the total 1 in 25 year average annual baseflow (column 8) and as a percent of the recommended withdrawal management target (column 9).

Net withdrawals in the subbasins are well below the recommended withdrawal targets. This indicates that substantial ground water resources are available to support future water demands throughout all other areas of the watershed. While this provides some perspective on overall subbasin ground water balances and availability, it is crucial to note that localized problems can occur from ground water withdrawals. Any proposed ground water withdrawal of significant size should be fully evaluated for its potential impacts to existing users and environmental resources as well as to the overall subbasin ground water balance.

The subbasin water balance data sheets (Appendix A) provide the detailed water balance data that were used in this analysis for each subbasin. Appendix B provides additional information on ground and surface water withdrawals and water needs for the watershed and subbasin. Figures 9 and 10 present the results of estimated net ground water withdrawals for 1998 and 2020 as a percent of the total 1 in 25 year average annual baseflow.

Table 6 summarizes the ground water balances for the subbasins in the watershed. These data show 1998 total ground water withdrawals and recharges, and the net ground water withdrawals as a percentage of each subbasin's withdrawal management target. For the watershed, an estimated 382 million gallons per year are withdrawn from the ground water supplies. There is an estimated 281 million gallons per year recharged back to the aquifers, for a net ground water withdrawal of 102 million gallons per year for the Chester Creek watershed in 1998. The methodology and data used to develop these estimates are presented in the *Compendium*.

Delaware River Basin Commission Southeastern PA Ground Water Protected Area

Much of the Chester Creek watershed is under special ground water protection status by the DRBC in the GWPA. More stringent regulations apply to ground water withdrawals than they do in the rest of the Delaware River Basin. The GWPA and its associated regulations were established by the Commission in 1980 at the request of the Commonwealth of Pennsylvania after it became evident that development was negatively impacting ground water levels. The purpose of the GWPA is to prevent depletion of ground water and protect the interests and rights of lawful

users of the same water source, as well as balance and reconcile alternative and conflicting uses of limited water resources in the region.

The DRBC applies a two-tiered system of water withdrawal limits to protect the ground water within the GWPA:

- The first tier serves as a warning that a subbasin is "potentially stressed." In potentially stressed subbasins, applicants for new or expanded ground water withdrawals are now required to implement one or more programs to mitigate adverse impacts of additional ground water withdrawals. Acceptable programs include: conjunctive use of ground water and surface water, expanded water conservation programs, programs to control ground water infiltration, and artificial recharge and spray irrigation.
- The second tier serves as the maximum withdrawal limit. Under the regulations, ground water withdrawals cannot exceed that limit.

The municipalities that are within the Ground Water Protected Area are all located in Chester County and include: Birmingham Township, East Goshen Township, Thornbury Township, West Chester Borough, West Goshen Township, West Whiteland Township, Westtown Township (Figure 11).

Ground Water Quality

The data used for the water quality analyses came from three sources, the Chester County Health Department (CCHD), the USGS, and USEPA's STORET database. Since the analysis centered on identifying trends, any source that had few data points was not included in this analysis. Where there were no data for total nitrate plus nitrite, individual nitrate and nitrite data were used, if available, then added together for each data point.

In the Chester Creek watershed, no ground water quality was available for biological oxygen demand (BOD), chemical oxygen demand (COD), and total kjeldahl nitrogen (TKN). Nitrate/Nitrite (NO_2/NO_3) is above background concentration at 4.4 mg/l, but not near the drinking water standard of 10 mg/l. Copper (Cu) is low. Total and dissolved phosphorus is relatively high. Lead (Pb) and zinc (Zn) are low.

Stream Water Quality

A snapshot of surface water quality in the watershed was done using available CCHD data. Since the analysis centered on identifying trends, any source that had few data points was not included in this analysis. Where there was no total nitrate plus nitrite, individual nitrate and nitrite data were used, if available, then added together for each data point.

Surface water quality data show relatively low concentrations of BOD. Nitrate/Nitrite concentrations are moderate at 5.5 mg/l. Copper is low. Zinc is low. Total Phosphorus (TP) is high, but no dissolved phosphorus data are available. Total suspended solids are low. Trend plots for most of the data do not suggest any upward or downward trend in water quality. Some exceptions might be a slight rise in BOD and nitrate, and a slight drop in phosphorus and TKN. Additional water quality issues are discussed below.

State Protected Water Use Designations

The designated uses of all surface waters are established by each State. Certain water quality criteria are established for each type of designated use, and these standards must be maintained and protected. It is these standards that are considered when withdrawal or discharge permits are

reviewed and in selection of land use management activities. There are programs in place to set guidelines if these standards, and corresponding uses, are not achieved. These programs, Total Maximum Daily Load programs, are outlined later in this plan. Table 7 presents the various water use designations for the Chester Creek watershed for Pennsylvania, which are illustrated in Figure 12. The categories of protected uses for each state are listed below:

- Pennsylvania (taken from Pennsylvania Code website, www.pacode.com, Pennsylvania Title 25, Chapter 93. Water Quality Standards, March 21, 1998 amended September 4, 1998) Water Uses Protected:

    - EV – Exceptional Value Waters
    - HQ – High Quality Waters
    - CWF – Cold Water Fishes
    - MF – Migratory Fishes
    - TSF – Trout Stocking
    - WWF – Warm Water Fishes.

These regulations are subject to change. It is important to check with the state for current regulatory information regarding the designated use for any of the streams within the watershed.

Stream Water Quality Assessments – Impaired Waters

Under the Clean Water Act, each state is required to assess all waters and list those that do not meet their designated uses even after pollution controls required by law are in place. For these waters, frequently called "impaired waters", the state must determine the cause of the impairment and the sources of that cause. Once the cause and sources of the impairment are identified, a total maximum daily load (TMDL) process is developed to address the impairment.

As part of the guidelines from the USEPA, states are required to submit lists of the impaired waters, also called "Section 303(d) lists" in reference to the Section of the Clean Water Act that requires the assessment. Table 8 and Figure 4 present the best available information, as listed, for the impaired waters within the Chester Creek Watershed that have been published on Section 303(d) lists in 1998 (or proposed for listing in 2000) by the Commonwealth of Pennsylvania.

Total Maximum Daily Load Regulations

As described above, each state is required to assess whether the existing stream water quality meets the designated water uses. If the stream does not meet the designated water uses, a TMDL is developed to determine what the allowable pollutant load that can be that will meet the water quality standard. The states are required to calculate the pollutant quantity that the stream is capable of receiving and still meet the standards. This quantity includes a wasteload allocation for point sources and/or a load allocation for non-point or background sources. The sum of the allocation is divided between the sources in the watershed and the final pollutant quantity includes a margin of safety.

At the time of this publication, there were no TMDLs established or under development in the Chester Creek watershed. However, because 17 miles of streams are listed as impaired on the Commonwealth's Section 303(d) list, TMDLs will be required to be developed in the future.

Nonpoint Source Pollutant Loads

A key tool used for characterizing surface water quality impacts across the study area is a pollutant loading model called the Watershed Management Model (WMM). WMM helps to

establish an overall "framework" for assessing pollution loading rates under existing and future land use scenarios, and to develop conceptual approaches for control strategies within the watersheds, subbasins, and municipalities. WMM is also the primary tool used for estimating the percent impervious of each subbasin and watershed, and for estimating annual average runoff.

Results of the WMM analyses are presented in the Water Quality Data Sheets for both the watershed and each subbasin (Appendix C). Chester Creek has over 65% of its land use in residential and wooded/open space in both the 1998 and 2020 scenarios. Most of the parameters are in the normal range relative to the other watersheds for all WMM model scenarios. It has a relatively low rate of TSS loading for both the 1998 and 2020 worst case scenarios because of its relatively higher percentage of developed land. Pb, TP and Zn have the greatest increase of any watershed in the 2020 worst case scenario but in the 2020 scenario with BMPs Pb drops 47%, TP increases only 6 percent and Zn drops 26 percent.

National Pollutant Discharge Elimination System (NPDES) Phase II Regulations

Phase II of the NPDES Stormwater Program was published in November 1999. The Phase II Rule requires NPDES permit coverage - mostly under general permits - for stormwater discharges from most small urbanized areas that are classified by USEPA as municipal small stormwater systems (MS4s) and construction activities that disturb from 1 to 5 acres of land. The Phase II Rule will require the NPDES permitting authority to develop a set of designation criteria and apply them, at a minimum, to all MS4s outside of an urban area located in an area with a population of at least 10,000 and a population density of at least 1,000 people per square mile. Any MS4 located in an area meeting the designation criteria would have to be brought into the program by the NPDES permitting authority and be required to obtain a permit.

The USEPA has provided a listing of those municipalities within the study area that will be required to have a stormwater management program (Figure 13). In the Chester Creek watershed, all 20 municipalities are expected to be required to meet the Phase II regulations. Those municipalities are Birmingham Township, East Goshen Township, Thornbury Township, West Chester Borough, West Goshen Township, West Whiteland Township, Westtown Township, Aston Township, Bethel Township, Brookhaven Borough, Chester City, Chester Heights Borough, Chester Township, Concord Township, Edgemont Township, Middletown Township, Parkside Borough, Thornbury Township, Upland Borough, and Upper Chichester Township.

Biological Diversity Monitoring

Biological diversity of streams is an excellent indicator of the cumulative impact of watershed influences on stream quality. Since 1969, the USGS, in cooperation with Chester County, has conducted a program to annually evaluate stream ecology and water-quality conditions using benthic macroinvertebrates and stream-water chemistry. The Stream Conditions of Chester County Program has sampled Chester County streams every fall for the past 32 years. The initial goals of the program were to evaluate stream-water quality and to further the understanding of changes in the stream ecosystem in response to urbanization. The current goals of the program are to use the data to monitor conditions in response to changing land uses and to determine long-term trends.

One permanent USGS sampling station is located in the Chester Creek watershed (Figure 14). Sampling has occurred at this and several other locations in the watershed between the years 1970 and 1997 on an annual basis. In order to present a year by year snapshot, the diversity index for all the stations have been averaged on an annual basis (Table 9). The index indicates that conditions in the Chester Creek watershed steadily improved between 1980 and 1987. A decrease in diversity occurred between 1988 and 1992 due to the addition of a sampling station near a

sewage treatment plant. Diversity increased again between 1993 and 1997. Brillouin's diversity values below 1.0 are associated with waters receiving heavy levels of organic wastes. Brillouin's diversity values between 1.0 and 3.0 are associated with waters receiving moderate levels of organic wastes and Brillouin's diversity values between 3.0 and 5.0 are associated with waters receiving little or no organic wastes. Overall the biological community indicates very good water quality in the upper reaches of the Chester Creek watershed, however, the water quality decreases down stream due to wastewater effluent. Historic biological diversity index results are presented in Table 9.

Results of the 1998 and 1999 biological diversity monitoring program indicate that:

- Overall the biological community indicates good water-quality in East Branch Chester Creek at Westtown but there are indications that the macroinvertebrates are slightly stressed and that some organic pollution is affecting the benthic macroinvertebrate community.

Pennsylvania Natural Diversity Index (PNDI)

There are a number of sensitive natural areas that are listed in the Natural Areas Inventory of Chester County, Pennsylvania (1994 with 2000 Update). Within the Chester Creek watershed, there is one area that contains or may contain rare and endangered species as noted in the PNDI (Figure 5). Land and habitat preservation efforts should be directed towards this area. The PNDI site within this watershed is presented below:

Hershey Mill Barrens SW (SP504, SP505, SP506, SP507, SP509)

- East Goshen Township
- All of these species are typical of the Eastern Serpentine Barrens communities and outcrops of PA. This outcrop is too small for natural community status and does not have the variety of habitats that are found on the large barrens; however the listed species have fairly sizeable populations. Although development is not a direct threat, it continues around this grassland and will make management to conserve the rare species here more difficult; easement recommended for monitoring and research.

Cultural, Recreational and Historic Resources

There are four identified historic structures, Goodwin Acres, William J. Barnard Residence, Kirkland Station, William Everhart House, and one identified historic district, West Chester Historic District, located within the watershed. There are no identified cultural or recreational areas. A detailed inventory of the resources is illustrated on Figure 15.

First Order Streams

First order streams are the "roots" of a watershed. They typically comprise over half of the total stream miles and drainage areas of any watershed. Yet individually they exhibit very small flows and are highly vulnerable to impacts of pollutants, stormwater flows, and ground water withdrawals. In an effort to provide information to assist in protecting these valuable resources, several analyses were conducted for first order streams:

- Analysis of total stream miles and total first order streams.
- Analysis of total drainage areas and total drainage areas of first order streams.
- Analysis of land use within one-quarter mile corridors of first order streams and one-quarter mile corridors of higher order streams.

Total Stream Miles of First Order Streams

Based on USGS mapped streams, a GIS (geographic information system) analysis was conducted to determine how many of the streams are first order streams. Presented in Table 10 are the breakdown of total stream miles, first order stream miles and the percent of first order stream miles in each subbasin. The final row sums each category for the watershed, and illustrates that of the 127 stream miles in the watershed, 57% or 73 miles are first order streams.

Drainage Area of First Order Streams

As described above, the first step of developing information on first order streams was to delineate the streams themselves. The study also used terrain models and GIS to compute the land areas draining to the first order streams (Table 11). Areas draining to first order streams are presented in Figure 16. The results indicate that over 55% of the land area within the Chester Creek watershed drains to first order streams.

Land Use Analysis within Stream Corridors

As discussed above, analyses of first order stream miles and drainage areas were conducted to gain a perspective on the vulnerability of headwater streams to the impacts of adjacent land uses. Tables 12 and 13 provide information on what type of land uses (as of 1995) exist within the quarter-mile corridor along each side of the first order streams and higher order streams by subbasin. This information is also presented in Figures 17 and 18. The table is shaded to highlight categories that comprise a significant portion of the corridor (typically 20% or more) and thus represent potential risks of stream impacts or potential opportunities for stream protection. Mapping of land uses along the corridors of all streams is presented in the *Compendium*.

Corridors of First Order Streams

Throughout the watershed, both of the subbasins have over 20% of the one-quarter mile corridor around first order streams classified as wooded and residential single-family.

Corridors of Higher Order Streams

Throughout the watershed, both of the subbasins have over 20% of the one-quarter mile corridor around higher order streams classified as wooded and residential single-family.

Sources of Water Supplies

As presented above (Ground Water Balances), substantial ground water resources exist within the watershed to serve as a significant source of water supplies to help meet future needs. In addition, two surface water intakes and treatment plant facilities for public supplies exist in the Chester Creek watershed. Such sources may offer opportunities for future supplies. Typically, these systems are designed and permitted with specific planning areas and needs in mind. However, as new needs arise, they should be evaluated to determine if they can be used or expanded to help meet those needs. Specific information for these intakes are as follows:

- East Branch Chester Creek (Fern Hill plant / West Chester Reservoir) (PSWC, current allocation is 1.3 MGD; current average daily withdrawal volume at this intake is approximately 0.6 MGD.)

In the Chester Creek watershed, the Downingtown Area Regional Authority, West Goshen Township Sewer Authority, and the Borough of West Chester Sewer Authority provide wastewater disposal for numerous municipalities. In addition, several other small community wastewater systems as well as individual packaged systems are in operation within the watershed.

Surface Water Withdrawals and Discharges

The Chester Creek watershed has two surface water withdrawals for public water supply. A total of eight surface water withdrawals are inventoried in the watershed, and in 1998, it was estimated that there were over 1,000 million gallons withdrawn from the watershed (Table 14).

There are 13 known discharges with NPDES permits in the watershed as of 1998. The total volume discharged to the watershed in 1998 is estimated to be 3.5 billion gallons annually.

Integrated Water Resources Planning to Meet Future Water and Wastewater Needs

Table 14 summarizes the total volumes of ground and surface waters withdrawn for public and individual water systems, and estimates of future (2020) water demand in each subbasin. This information provides a basis for understanding the magnitude of current water withdrawals and the volume of additional ground water resources available for future withdrawals in each subbasin. It is estimated that in 1998, total water withdrawals (including ground water, surface water, and individual residential wells) within the watershed were approximately 1,460 million gallons per year (MGY). The total volume of water used within the watershed in 1998 is 4,437 MGY. An increase of 759 MGY is projected to be needed for use in the watershed by 2020.

Planning to meet future water needs requires viewing water use by subbasins, as waters naturally occur within subbasin or watershed boundaries and not municipal borders. Strategies presented in the ***Watersheds*** Plan, recommend that multi-municipal Integrated Water Resource Plans (IWRP) be developed to determine future water and wastewater needs. Once the total additional water demand is determined, it must be compared against the available water sources. This should consider the amount of water currently being used from nearby ground water and streams and whether the additional need can be supported by those resources (either through existing or new infrastructure).

Considering water withdrawals and availability on a subbasin basis also allows for evaluating what demands are being placed on those resources by others. Most subbasins support water supplies to multiple municipalities. If a single municipality evaluates only their withdrawals of water, the available remaining resource may be significantly over-estimated. By looking at cumulative withdrawals on the entire subbasin, all municipalities supported by those subbasins can use consistent information for planning.

Municipalities, utilities and other relevant stakeholders located within the Chester Creek watershed are encouraged to consider developing IWRPs to link land use and water resources needs and management objectives together in a consistent planning framework. Guidance, tables of data, and other information for use in preparing IWRPs are presented in ***Watersheds***. Several of the aspects to be addressed within IWRPs are presented here in the following figures for the Chester County portion of the watershed. Mapping of this information should be developed for the remainder of the watershed if IWRPs are undertaken.

Figure 19 presents recommended IWRP planning regions within Chester County portions of the watershed. This figure suggests what municipalities should be involved in developing IWRPs for different subbasins. Figure 20 presents recommended thresholds for net ground water withdrawals (net total of all ground water withdrawals and recharges). This provides a planning framework for evaluating the availability of ground water resources for future withdrawals on a subbasin basis. It is important to understand that individual withdrawals may not contribute to the overall stress of ground water on a subbasin basis, but may contribute to localized impacts that should be evaluated and mitigated before approval is given for the withdrawal to occur.

Figures 21 and 22 present the identified growth areas of Chester County (as defined by ***Landscapes***) and areas where public water and wastewater services are currently in place. Also shown on these figures are locations of localized problems. Figure 23 presents the locations of community water supply systems within the watershed, and Table 15 presents a list of small community water systems that are illustrated on Figure 23.

These figures and information provide a context of the types of water and wastewater planning issues that confront the watershed. These issues need to be addressed jointly by the municipalities and utilities, as well as other relevant stakeholders. In addition, joint planning (or development of IWRPs) MUST address source water protection issues.

Public water and wastewater planning issues identified for Chester Creek include:

- A significant portion of watershed is served public water by the regional water systems of Philadelphia Suburban Water Co. and Chester Water Authority. A small portion of the lower watershed is provided water service by United Water Bethel system.
- The Chester County portion of the watershed is largely designated as growth areas. Future planning and decisions regarding new or expanded public water or wastewater systems should be consistent with local planning and zoning to guide growth into designated growth areas.
- Seventeen miles of Chester Creek are listed as impaired by PA; thus planning and implementation should address improvements to stream water quality to protect the downstream public water supply intake and instream uses.
- Proposed new ground water withdrawals should be evaluated to mitigate potential impacts to existing users and environmental resources, as well as for consistency with recommended net ground water withdrawal management targets.
- Because major water supply systems currently exist throughout nearly all of the watershed, the need for IWRP efforts maybe limited. However, if unmet needs are identified, it is recommended that planning efforts to address them involve the appropriate utility(ies), municipalities, and counties to insure needs are met and in a manner consistent with local planning and zoning.
- Source water assessments are underway for the 2 surface water supply intakes in the watershed by PADEP. These assessments, when completed, should be used to develop source water protection plans for the intakes, and should involve the owner utility as well as any dischargers, upstream municipalities, and owners/operators of key potential pollutant sources.
- Management strategies should be explored to help reduce the impacts of upstream treated wastewater effluent discharges on raw water supplies withdrawn in the lower portion of Chester Creek.

Section 4. Watershed Management Needs and Priorities

Inventory of Watershed Management Needs

Presented in Table 16 is an inventory of the specific management needs for the watershed. These management needs reflect the final conclusions of the data collection and analyses presented in the *Compendium* and ***Watersheds***, and summarized in Section 3. The inventory lists the specific characteristics, problems, and resources of the watershed that should be considered in restoration, protection, land use, and water use planning. This inventory can assist municipalities and other stakeholders in understanding the critical needs within the watershed. The following six categories of needs are presented:

- Resources to be Protected, lists the natural, cultural and recreational resources and related characteristics that may warrant particular attention.
- Growth and Land Use, presents statistics for subbasins and/or watersheds regarding density or rate of growth, and the extent of land uses that may impact the integrity of water resources.
- Water Availability and Use, describes what significant water uses and withdrawals currently exist, what additional resources exist that may be options for meeting future water demands, as well as particular constraints that exist that warrant consideration as additional water use is planned.
- Runoff, presents physical and natural characteristics that may contribute to or are caused by excessive stormwater and nonpoint source pollutant (NPS) runoff.
- Water Quality, lists the types of stream impairments and ground water quality problems found to exist in the watersheds that warrant restoration or that present potential concerns for protecting sources of drinking water supplies.
- Regional Prioritizations, present the results from the prioritization exercises that apply (if any) for each watershed or their subbasins.

This inventory provided the basis for defining the priority management objectives and management actions that are recommended in Section 5 of this plan.

In addition to the management needs identified in Table 16, the Chester Ridley Crum Watersheds Association has been in existence since 1970 providing community-based stewardship of the watershed resources for Chester Creek. This organization has a strong record of accomplishments and effective stewardship and education within the watershed. Continuing support for the administration, programs, initiatives, and activities of this organization is crucial to improve and sustain the overall health of the watershed. The Chester Ridley Crum Watersheds Association, along with the Delaware County Planning Department, Chester County Planning Commission, and the Pennsylvania Environmental Council, published a Rivers Conservation Plan (RCP) for the Chester Creek watershed in 2001. This allowed streams of the Chester Creek watershed to be included on the Pennsylvania Rivers Conservation Registry. Implementation of the RCP and it's action items should also be supported.

Watershed and Subbasin Priorities

To identify the most pressing needs in each watershed and across the region, a series of multi-criteria evaluations and prioritization exercises were conducted to identify regional priorities among the 21 watersheds, identify priorities among the subbasins within each watershed, and identify priorities among the 78 subbasins across the study region. The prioritizations addressed five categories of watershed needs:

- *Restoring Stream Water Quality* (*water quality conditions and resources at risk*) - Federal and State Law mandates three major programs dealing with reducing polluted stormwater runoff. These are: the development of TMDLs for water quality impaired stream segments, the new NPDES Phase II Stormwater Permitting Program, and the Section 319 (Federal Clean Water Act) Nonpoint Source Management Program. Because 70% of the watersheds are source waters for public water supply intakes, prioritization for source water protection planning and implementation is also critical. This prioritization exercise considered water quality conditions as well as "sensitive resources" and cultural features that are at risk from increased stream impairments. Both watersheds and subbasins were prioritized for water quality restoration.
- *Restoring Stream Water Quality* (*water quality conditions only*) – This prioritization is similar to the one described above except that the criteria representing the value of the stream in terms of sensitive resources or cultural/recreational values were not included. This prioritization focussed solely on water quality parameters, with more highly impaired streams ranked higher in the priority list. It provides information to help prioritize watersheds for implementation and funding for water quality related programs. Both watersheds and subbasins were prioritized for water quality restoration.
- *Reducing Stormwater Runoff and Flooding* – If conventional development following the historical sprawl pattern continues, the rate and volume of stormwater runoff will continue to increase, the magnitude and occurrence of flooding will increase, and the destruction of streams by the force of these waters will be exacerbated. Municipal comprehensive stormwater management is needed in all areas to minimize these problems. The study area watersheds and subbasins were prioritized to identify those areas in most critical need of stormwater management programs to reduce the rate and volume of runoff. This prioritization will also assist Chester County in determining the sequence of conducting stormwater management plans under Act 167.
- *Protecting Stream Resources* – Because of the extensive number of "sensitive resources" (i.e., designated habitats), the regional importance of the aesthetic, recreational and cultural values of the watersheds, and the widespread use of the streams for public water supply, it is important to focus preservation and protection efforts to maintain these vital resources. The study watersheds and the subbasins were prioritized for protecting resources.
- *Protecting Ground Water* (used for subbasin prioritization only) - Because of the high reliance on ground water to support water supply needs and stream baseflows throughout the region, ground water protection efforts are extremely important. This includes managing water use decisions to protect against over-withdrawal, protecting ground water from contamination attributable to land uses and septic wastewater disposal, and source water protection of public water supply wells. Only subbasins were prioritized for ground water protection because subbasins provide a more appropriate size of land area for evaluating impacts of ground water withdrawals.

The prioritization process compared each of the watersheds or subbasins against the other watersheds or subbasins using relevant evaluation criteria. Because of the number of criteria selected and the inherent subjectivity in attempting to weight criteria, all criteria were considered equally important and therefore were assigned equal weight. Final priorities were assigned based on the evaluation results and several discussions held with the Water Resources Task Force. Each evaluation resulted in a comparative ranking of the watersheds or subbasins, with the highest ranking ones recommended for immediate attention and funding.

Based on the final rankings of all 21 watersheds, each watershed was categorized as high, medium, or low priority for regional management decisions. The priorities are intended as a guide for deciding which watersheds should be targeted first. A "low" priority only means that other watersheds may require more pressing action, not that the "low priority" watershed should not come into consideration for restoration or protection measures. The following summarizes the overall ranking of this watershed among the 21 watersheds in the study area for each of the 4 categories used for ranking watersheds:

- Restoring Stream Water Quality (water quality conditions and resources at risk): High priority.
- Restoring Stream Water Quality (water quality conditions only): High priority.
- Reducing Stormwater Runoff and Flooding: High priority.
- Protecting Stream Resources: Medium priority.

Because this watershed has only 2 subbasins, they were not assigned as "high, medium, or low" priority. Table 17 presents how the various subbasins ranked when evaluated as part of the entire watershed. This was done to provide insight on how to direct limited resources to address the most pressing needs. The list indicates how each subbasin ranked within 5 categories. The lower the number, i.e., 1 or 2, the higher the relative need for action in that subbasin. It is important to stress that subbasins with lower priority rankings are not to be thought of as not in need of protection or improvements, but rather that the highest ranking subbasins are recommended for immediate action and funding. Figure 2 presents the location of subbasins and their corresponding subbasin code. The Upper East Branch Subbasin ranked first in all five categories.

Section 5. Priority Watershed Management Objectives and Actions

Goals and Objectives

As previously described, the Chester Creek watershed covers 66 sq. mi., 21 municipalities in two counties, and includes approximately 128 miles of flowing stream. Numerous watershed management needs were identified (Table 16). While the watershed has benefited for decades from the stewardship of many individuals and entities, there is much to be done. It is therefore necessary to establish priorities to help guide efforts to the most important problems and in a way that will provide the greatest overall benefits within the limits of the financial and human resources available.

The overall goals for watershed management of the Chester Creek watershed are:

- Engage and educate individuals, communities and governments in watershed stewardship.
- Enhance recreational and cultural resources.
- Preserve natural resources.
- Improve water quality.
- Reduce stormwater runoff and flooding.
- Protect watershed water balances.
- Integrate utility and municipal planning to meet future water supply and wastewater needs.

These seven goals are taken from and are consistent with the goals presented within ***Watersheds*** for all of Chester County's watersheds. However, they are particularly relevant to the Chester Creek, given the nature of the watershed, the extensive listing of watershed management needs, the presence of unique natural resources, the widespread reliance on the waters of the watershed for public and private water supplies, and the patterns and potential impacts of rapid development that is quickly advancing across the watershed.

To assist in focusing stewardship and restoration efforts within the framework of the goals listed above, a list of five priority management objectives was developed for the Chester Creek watershed:

1. Reduce stormwater runoff and flooding throughout the watershed.
2. Restore water quality of "impaired" streams and protect unimpaired streams from further degradation.
3. Protect and enhance vegetated riparian corridors, particularly for first order streams.
4. Increase public access to, and recreational uses of, streams.
5. Implement other source water protection measures for water supply intakes, reservoirs and wells.

While this list presents the overall priorities for the watershed, it should not be interpreted to preclude other efforts. Expanded efforts in public education and involvement in watershed stewardship should be considered a "routine" and ongoing need. Activities that promote or address any aspect of watershed stewardship should be supported and encouraged regardless of whether or not they address these specific management priorities. All watershed stewardship efforts are important.

Recommended Priority Management Actions

Achieving these management objectives will require implementation of several types of actions. Most actions will contribute to more than one management objective. A specific list of recommended management actions is provided in Table 18 to address the priority management objectives. Recommendations regarding lead entities to undertake the individual actions are also indicated. Management objectives and actions are listed in order of their recommended priority for implementation, although many will be (or are being) undertaken simultaneously by various entities. Locations of initial projects should be placed to afford maximum protection of existing sensitive resources of the watershed as shown on Figure 5.

Several other watershed planning efforts are underway for Chester Creek (including the Rivers Conservation Plan, and Act 167 Plan) as well as other initiatives underway by the watershed association. Thus, Table 18 provides a short listing of the highest priority actions needed that were identified from the ***Watersheds*** planning activities, and does not represent a complete list of watershed management actions. This list should be considered in conjunction with actions identified as a result of other planning efforts.

Generalized approximate costs for implementing each recommended action are given, but are intended to provide only an order of magnitude approximation of expected implementation costs and were not developed through any detailed cost estimating procedures. Approximate total costs for implementing all recommended actions for this watershed are $4,363,750. This translates to $66,117 per square mile of watershed, or $34,092 per stream mile. This total cost does NOT include costs of acquisition of easements or lands, or costs of maintaining, modifying or retrofitting built stormwater or other infrastructure systems. It is likely that a 15% to 25% cost reduction could be achieved by implementing multiple actions simultaneously. The costs reflected in Table 18 are for a 5 year planning period.

Other Recommended Management Actions

In addition to the priority management actions listed in Table 18, there are numerous other municipal, government and/or community based strategies that can contribute to addressing the watershed needs over time. Some recommendations of additional actions are presented in Appendix D.

Ongoing Initiatives

Numerous efforts and activities are underway or recently completed by a wide array of entities and stakeholders within the watershed. A partial listing of such activities is presented in Appendix E.

Section 6. Indicators of Progress

Consistent with the goals of ***Watersheds*** is the desire to measure progress towards achieving those goals over time. Like ***Landscapes***, ***Watersheds*** is a long-range plan that can only be realized over a period of years. To this end, ***Watersheds*** proposes to add measurable indicators to the *Landscapes Progress Report*, first published in 2000, to monitor trends and assist in water resources decision making.

The *Landscapes Progress Report* was developed to fulfill the County's commitment to review the "state of the County," including the desire to measure progress towards achieving the goals of ***Landscapes*** and the desire to keep the Plan active and functional. The intent of the *Report* is to review recent advancements, identify areas of success, and identify areas where work is needed.

Landscapes Indicators

The *Landscapes Progress Report* (*Report*) includes an overall Landscapes Index and an assessment of 18 indicators within seven categories. The *Report* provides a reliable account of the indicators measured so that long-term trends towards achieving the goals of ***Landscapes*** can be assessed. Positive trends indicate a measure of success while negative trends indicate where both deficiencies exist and where actions are needed. As a way of measuring cumulative progress, the Landscapes Index provides a generalized picture of overall progress based on the trends of all of the indicators. Individual indicators show trends for specific subjects and can show where the greatest progress is being made and where greater efforts should be focused.

The intent of the Landscapes Index is to show a trend line indicating the degree to which progress has been made towards achieving the goals of ***Landscapes***. At present, the indicators that monitor specific subjects are not a complete measure of all aspects of ***Landscapes***. To that end, indicators developed as part of ***Watersheds*** will further contribute to the value of the Landscapes Index as an overall tool for measuring change.

The existing 18 indicators that contribute to the Index were selected for their relevance to ***Landscapes***, their understandability by the general public, and their measurability on a yearly basis. Each indicator has a base year which serves as a starting point for measuring trends. In addition, the data for each indicator have been converted to a base year value of 100. This permits the calculation of a single index from different types of data, provides a common base year for each type of indicator, and allows for the comparison of yearly data to the base year. The Landscapes Index is calculated by combining all of the indicators into an average value. The current indicators used to develop the Landscapes Index are included in Table 19.

Watersheds Indicators

Several of the existing indicators included in the Landscapes Index will also serve as indicators for the ***Watersheds*** Plan, including: Protected Farmland, Eased Land, Park Land, Community Water & Sewer, Stream/Water Protection (Exceptional Value watersheds), Historic Resources and Plans, and municipalities with ordinances consistent with ***Landscapes*** and ***Watersheds***. Given the clear desire to create additional indicators that will further add to the value of the Landscapes Index, two additional ***Watersheds*** indicators will be established (Table 20) to expand the series of water resource-based indicators aimed at measuring progress towards both ***Landscapes*** and ***Watersheds*** goals.

Section 7. References

Chester County Water Resources Authority, *Chester County, Pennsylvania Water Resources Compendium – Part 1: Technical Report of Assessment of 21 Watersheds Originating in Chester County, Pennsylvania*, 2001.

Chester County Board of Commissioners and Chester County Water Resources Authority, ***Watersheds*** *– An Integrated Water Resources Management Plan for Chester County, Pennsylvania and Its Watersheds*, September 17, 2002.

Table 1. Subbasins within the Watershed

Subbasin Name	Subbasin Code	Size (in Square Miles)
Lower Chester Creek	Ch1	43.48
Upper East Branch Chester Creek	Ch2	22.8

Table 2. Snapshot of Watershed Characteristics

Land area	66 sq. miles
1995 Land Use as % of Total Land Area	
Agriculture	13%
Developed	50%
Other	37%
Total Stream Miles	128
1st Order Stream Miles	67
% 1st Order Stream	53%
Impaired Stream Miles	17
1998 Estimated Population	100,100
2020 Projected Population	117,700
% Population Increase by 2020	18%
1998 Estimated Withdrawals	1,500 MGY
1998 Population on Public Water	93%
Predominant Geology	Crystalline

Table 3. Population – 1998 Estimates and 2020 Projections by Subbasin

Subbasin Code	Subbasin Name	1998 Est. Population	2020 Est. Population	Area in Square miles	People per Sq. Mi. (1998)
Ch1	Lower Chester Creek	60,403	70,723	43.48	1,389
Ch2	Upper East Branch Chester Creek	39,680	46,979	22.8	1,740
Total		100,083	117,702	66.28	1,510

Table 4. Land Use in Chester Creek Watershed - 1995

Land Use	Percent
Agriculture	12.9%
Commercial/Services	3.5%
Community Service	2.7%
Industrial	1.8%
Large Confined Feeding Operation	0.0%
Mining	0.5%
Parking	1.9%
Recreation	2.2%
Residential - High Density	0.6%
Residential - Multi-family	2.0%
Residential - Single Family	35.8%
Transportation/Utility	1.7%
Urban	0.0%
Vacant	2.6%
Water	0.7%
Wetlands	0.0%
Wooded	31.2%

Table 5. Percent Impervious Cover by Subbasin

Subbasin Code	Subbasin	1998 % Impervious Cover	2020 % Impervious Cover	Change from 1998 to 2020
Ch1	Lower Chester Creek	17.18	20.18	3.00
Ch2	Upper East Branch Chester Creek	21.82	24.62	2.80
	Total	18.8	21.7	2.9

Table 6. Estimated 1998 Net Ground Water Withdrawals by Subbasins (in million gallons per year, MGY)

Subbasin Code and Name		1 in 25 Year Average Annual Base Flow	Ground Water Withdrawal Targets as % of 1 in 25 Yr Baseflow	Volume Withdrawn	Volume Recharged	Net Withdrawal	Net Withdrawal as % of 1 in 25 Year Baseflow	Net Withdrawal as % of Withdrawal Target
Ch1	Lower Chester Creek	4,745	50% (2373 MGY)	154	29	126	3%	5%
Ch2	Upper East Branch Chester Creek	2,488	100% (2488 MGY)	228	252	-24	-1%	-1%
	Total for Watershed:			382	281	102		

Table 7. Protected Water Use Designations

Stream	Zone	County	Water Uses Protected	Exceptions to Specific Criteria
2—Chester Creek	Basin, Source to East Branch Chester Creek	Chester	TSF	None
3—East Branch Chester Creek	Basin, Source to Unnamed Tributary at RM 0.4 (‘‘Goose Creek’’)	Chester	TSF	None
4—Unnamed Tributary to East Branch Chester Creek at RM 0.4 (‘‘Goose Creek’’)	Basin	Chester	WWF	None
3—East Branch Chester Creek	Basin, Unnamed Tributary at RM 0.4 to Mouth	Chester	TSF	None
2—Chester Creek	Basin, East Branch Chester Creek to Rocky Run	Delaware	TSF	None
3—Rocky Run	Basin	Delaware	HQ-CWF, MF	None
3—Chester Creek	Basin, Rocky Run to Confluence with West Branch	Delaware	TSF, MF	None
3—West Branch Chester Creek	Basin, Source to Green Creek	Delaware	TSF	None
4—Green Creek	Basin	Delaware	CWF, MF	None
3—West Branch Chester Creek	Basin, Green Creek to Mouth	Delaware	TSF, MF	None
2—Chester Creek	Basin, West Branch to Dutton Mills Road Bridge	Delaware	TSF, MF	None
2—Chester Creek	Nontidal Portions of Basin, Dutton Mills Road Bridge to Mouth	Delaware	WWF, MF	None

Table 8. PA List of Impaired Streams (Proposed 2000, from PA-DEP website 11-1-00)

Segment ID	Mile	Data Source	Source of Impairment	Cause of Impairment	Priority	*Year Listed	Targeted for TMDL Development by 2002?
Chester Creek (Stream Code: 520, SWP: 03G)							
981007-1430-AC	6.56	Unassessed Project	Habitat Modification	Other Habitat Alterations	Low	1996	No
		Unassessed Project	Hydromodification	Siltation	Medium	1996	No
981019-1600-AC	5.84	Unassessed Project	Flow Regulation/ Modification	Flow Alterations	Low	1996	No
		Unassessed Project	Municipal Point Source	Cause Unknown	Low	1996	No
		Unassessed Project	Urban Runoff/Storm Sewers	Water/Flow Variability	Low	1996	No
Chester Creek, Unt (Stream Code: 601, SWP: 03G)							
981007-1430-AC	0.04	Unassessed Project	Habitat Modification	Other Habitat Alterations	Low	1996	No
		Unassessed Project	Hydromodification	Siltation	Medium	1996	No
Chester Creek, Unt (Stream Code: 616, SWP: 03G)							
981019-1600-AC	0.59	Unassessed Project	Flow Regulation/Modification	Flow Alterations	Low	1996	No
		Unassessed Project	Municipal Point Source	Cause Unknown	Low	1996	No
		Unassessed Project	Urban Runoff/Storm Sewers	Water/Flow Variability	Low	1996	No

Table 8. PA List of Impaired Streams (Proposed 2000, from PA-DEP website 11-1-00)

Segment ID	Mile	Data Source	Source of Impairment	Cause of Impairment	Priority	*Year Listed	Targeted for TMDL Development by 2002?
Chester Creek, Unt (Stream Code: 617, SWP: 03G)							
981019-1600-AC	0.6	Unassessed Project	Flow Regulation/Modification	Flow Alterations	Low	1996	No
		Unassessed Project	Municipal Point Source	Cause Unknown	Low	1996	No
		Unassessed Project	Urban Runoff/Storm Sewers	Water/Flow Variability	Low	1996	No
Chester Creek, Unt (Stream Code: 618, SWP: 03G)							
981019-1600-AC	0.68	Unassessed Project	Flow Regulation/Modification	Flow Alterations	Low	1996	No
		Unassessed Project	Municipal Point Source	Cause Unknown	Low	1996	No
		Unassessed Project	Urban Runoff/Storm Sewers	Water/Flow Variability	Low	1996	No
Chester Creek, Unt (Stream Code: 619, SWP: 03G)							
981019-1600-AC	0.97	Unassessed Project	Flow Regulation/Modification	Flow Alterations	Low	1996	No
		Unassessed Project	Municipal Point Source	Cause Unknown	Low	1996	No
		Unassessed Project	Urban Runoff/Storm Sewers	Water/Flow Variability	Low	1996	No

Table 9. Average Yearly Brillouin's Diversity Index Values for the Watershed

Year	Number of Stations Sampled	Brillouin's Diversity Index		Year	Number of Stations Sampled	Brillouin's Diversity Index
1970	3	1.23		1984	4	3.17
1971	3	1.58		1985	4	2.77
1972	3	1.98		1986	4	2.83
1973	2	1.66		1987	4	3.02
1974	3	1.49		1988	5	2.75
1975	0	--		1989	5	2.55
1976	3	2.07		1990	5	2.44
1977	4	1.75		1991	5	2.39
1978	4	1.55		1992	5	2.57
1979	4	1.69		1993	5	2.71
1980	4	2.30		1994	5	2.59
1981	4	2.75		1995	5	2.89
1982	4	2.49		1996	3	3.22
1983	4	2.99		1997	3	2.97

Table 10. First Order Streams Miles

Subbasin Name	Subbasin Code	Total Stream Miles	1st Order Stream Miles	% of Total Stream Miles
Lower Chester Creek	Ch1	91.5	50.5	55.2
Upper East Branch Chester Creek	Ch2	35.9	22.4	62.3
Total		127.4	72.9	57.2%

Table 11. Drainage Areas in First Order Streams

Subbasin Name	Subbasin Code	Total Acres	Acres in 1st Order Drainage Areas	% of Total Acres
Lower Chester Creek	Ch1	27,826	14,421	51.8
Upper East Branch Chester Creek	Ch2	14,595	9,273	63.5
Total		42,421	23,694	55.9%

Table 12. Land Use Within Corridors of First Order Streams (Percent of Total Land Use)

Land Use Name	Lower Chester Creek	Upper East Branch Chester Creek
Agriculture	13	16
Commercial/Services	3	3
Community Service	2	3
Industrial	0	1
Mining	1	0
Parking	1	2
Recreation	3	2
Residential – High Density	0	0
Residential – Multi-family	2	1
Residential – Single Family	32	43
Transportation/Utility	2	2
Urban	0	0
Vacant	2	4
Water	1	0
Wooded	38	24

Table 13. Land Use Within Corridors of Higher Order Streams (Percent of Total Land Use)

Land Use Name	Lower Chester Creek	Upper East Branch Chester Creek
Agriculture	8	17
Commercial/Services	3	2
Community Service	2	2
Industrial	1	2
Mining	1	0
Parking	1	3
Recreation	2	2
Residential – High Density	1	0
Residential – Multi-family	2	3
Residential – Single Family	24	30
Transportation/Utility	2	1
Urban	0	0
Vacant	2	5
Water	2	2
Wooded	50	32

Table 14. Estimated Average Annual Water Withdrawals and Future Needs by Subbasin - 1998 and 2020 (MGY)

Subbasin Code and Name		1998 Withdrawals				2020 Projected Needs	
		Ground Water Withdrawals	Surface Water Withdrawals	Total Water Withdrawals	Total Water Used	Additional Water Demand	Additional Wastewater Capacity Needs
Chester Creek							
Ch1	Lower Chester Creek	154	844	998	2,669	441	397
Ch2	Upper East Branch Chester Creek	228	238	466	1,768	318	286
	Totals for Watershed:	**382**	**1,082**	**1,464**	**4,437**	**759**	**683**

Table 15. List of Small Community Water Systems (as shown in Figure 23)

No.	System Name	No.	System Name
1	Appleville Mobile Home Park	33	Londonderry Court
2	Avonwheel Estate Mobile Home Park	34	Longwood Gardens
3	Brandywine Terrace Mobile Home Park	35	Malvern Courts Inc.
4	Caln Mobile Home Park	36	Maplewood Mobile Home Park
5	Camp Hill Special School	37	Martin's Mobile Home Village
6	Camphill Village USA Inc.	38	Movern Mushroom Farms
7	CFS – School at Church Farm	39	Mount Idy Mobile Home Park
8	Chatham Acres Nursing Home	40	Nottingham Manor Mobile Home Court
9	Chatwood Water Company	41	Oxford Village Mobile Home Park
10	Coatesville Veterans Administration Hospital	42	Perry Phillips Mobile Homes
11	Cochranville Mobile Home Park	43	Phoenix Mobile Homes
12	Coventry Garden Apartments	44	Phoenixville Mobile Homes Inc.
13	Coventry Manor Nursing Home	45	Philadelphia Suburban Water Co. – Culbertson Run
14	Coventry Terrace	46	Philadelphia Suburban Water Co. – Brandywine Hospital
15	Devereux Foundation	47	Ridgeview Mobile Homes
16	East Fallowfield Utilities, Inc.	48	Riveredge
17	Echo Valley	49	S. E. PA Veterans Center
18	Gregory Courts Inc.	50	Shady Grove Mobile Home Park
19	Heatherwood Retirement	51	Shady Side Mobile Home Park
20	Hideaway Mobile Home Park	52	Springton Court Mobile Homes
21	Highland Court	53	St. Mary's of Providence
22	Icedale Mobile Home Courts	54	St. Stephens Green
23	Imperial Mobile Home Park	55	Stone Barn
24	Independence Park	56	Stony Run Mobile Home Park
25	Indian Run Village	57	Taylor's Mobile Home Park
26	Kendal Crosslands/Consiston	58	Tel Hai Rest Home
27	Keystone Court	59	Valley Springs Water Co.
28	Lake Road Mobile Home Park	60	Valley View Mobile Home Park
29	Lazy Acres Mobile Home Park	61	Warwick Mobile Home Park
30	Lincoln Crest Mobile Home Park	62	Wetherhill Estates
31	Loags Corner Mobile Home Park	63	Willowdale Water Company
32	London Grove Mobile Home Park		

Table 16. Inventory of Watershed Management Needs

RESOURCES TO BE PROTECTED

- Subbasin Ch1 – 1st Order Stream Corridors >35% Wooded and/or Wetlands
- West Chester Reservoir
- 2 Public Water Supply Intakes
- HQ Streams (Subbasin Ch1)
- 1 Historic Bridge
- 53% of Total Stream Miles are First Order Streams
- 5 Large Instream Wastewater Discharges

GROWTH AND LAND USE

- Substantial Projected Population Growth by 2020 (Subbasins Ch1 and Ch2)
- Subbasin Ch2 >60% Of Land Area In Drainage Areas To 1st Order Streams
- Increasing Numbers of New and Aging Septic Systems and Cumulative Septic Loadings

WATER AVAILABILITY AND USE

- Relatively High Volume of Surface Water Discharges from Wastewater Systems
- Wastewater Stream Discharges May Affect Water Quality and Introduce Pathogens and Taste and Odor Compounds at Water Supply Intake (Subbasin Ch1)
- Phosphorus NPS Loadings Causes Eutrophication in West Chester Reservoir (Subbasin Ch2)
- Low Flows During Drought Conditions Threaten Suspension of Public Water Supply Withdrawals, Possibly Exacerbated by Golf Course Withdrawals (Subbasin Ch1)

WATER AVAILABILITY AND USE (Cont)

- Subbasin Ch2 >60% of Total Stream Miles are 1st Order Streams
- Need for Source Water Protection for Public Water Supply Reservoir and Intakes
- Headwaters of Watershed Within DRBC GWPA

RUNOFF

- >20% Estimated Impervious Cover 2020 for Watershed
- >20% Estimated Impervious Cover – Subbasins Ch1 and Ch2
- Excessive Estimated Average Annual Rainfall Runoff (Subbasin Ch2)
- Development Located Within Floodplains Prior to Floodplain Regulations (Subbasin Ch1)
- Flooding at Several Lodations in/Near West Chester Borough
- Erosion of Stream Banks Along Almost All Tributaries in East Goshen Twp.
- Extensive Developed Areas with No Stormwater Management Facilities
- PA Act 167 Stormwater Management Plan to be Adopted and Implemented
- All Municipalities Required to Comply with NPDES Phase II Stormwater Management Regulations

WATER QUALITY

- 13% of Total Stream Miles Listed as Impaired on 303(d) List
- 303(d) Listed – Some Segments and Tributaries (flow variability from stormwater runoff and industrial point sources)

WATER QUALITY (continued)

- USGS/Chester Co Biological Monitoring Indicates Slightly Impacted Conditions in Chester Co.
- USGS/Chester Co Biological Monitoring Indicates Goose Cr. Moderately Impacted Conditions
- Widespread Areas of High Levels of Naturally Occurring Radon in Ground Water
- Exploding Populations of Resident and Migrating Geese Contributing to Nutrients in Reservoirs and Streams
- Concerns of Water Quality Impacts of Public, Small Package and Individual Wastewater Treatment Systems and Discharges
- Locations of Leaking Underground Storage Tanks
- Relatively High Mean COD and TP Concentrations for Watershed for Available Surface Water Quality Data
- Highest Estimated TKN, TP, and TSP Annual Loading Rates 1998 of All Watersheds (Due to Combined Point and Nonpoint Sources)

REGIONAL PRIORITIZATIONS

- Chester Creek Watershed Ranked Among Highest Overall Priority Watersheds for Water Quality Restoration and Stormwater Management
- Subbasin Ch2 Ranked As Overall Priority for Water Quality Restoration, Stormwater Management and Stream / Resources Preservation in Chester Creek Watershed

Table 17. Subbasin Priorities

Water Quality		Water Quality 303(d)		Stormwater		Stream Preservation		Ground Water	
Subbasin	**Priority**	**Subbasin**	**Priority**	**Subbasin**	**Priority**	**Subbasin**	**Priority**	**Subbasin**	**Priority**
Upper East Branch	1	Upper East Branch	1	Upper East Branch	1	Lower Chester Creek	1	Upper East Branch	1
Lower Chester Creek	2	Lower Chester Creek	2	Lower Chester Creek	2	Upper East Branch	2	Lower Chester Creek	2

Table 18. Recommended Priority Management Actions

Priority	Action	Description	Recommended Lead Entities	Total Generalized Estimated Cost
Reduce Stormwater Runoff to Reduce Flooding, Erosion and Sedimentation, to Improve Water Quality and to Restore Stream and Riparian Habitats.				
1	Implement Act 167 stormwater management plan ordinances throughout all 21 municipalities.	$3,000 per county for outreach and information exchange by County agencies; $10,000 per each of 13 municipalities all or mostly within watershed to revise ordinances.	Chester and Delaware County Planning Agencies, Chester and Delaware County Conservation Districts.	$136,000
2	Implement NPDES Phase II requirements in regulated municipalities (located primarily or solely within Chester Creek watershed).	Up to $50,000 to at least $150,000 per municipality, depending on size of existing municipal stormwater facilities, intensity of new development, and available staff resources to conduct work in-house versus need to hire consultants.	13 regulated PA municipalities (primarily or solely located within watershed), conservation districts, and PADEP.	$1,300,000
3	Implement stream bank fencing , livestock crossings and reforestation of riparian corridors along at least 2.5 miles (15%) of agricultural streams.	Installing treatments on 2.5 stream miles will improve approximately 61 acres of riparian corridor and eliminate unnecessary direct impacts of livestock to streams. ($10,000 for outreach and information exchange to land owners and farmers; $10 per linear foot for fencing, plant stock, materials, installation, and management plans).	NRCS, conservation districts, agricultural land operators.	$142,000
4	Prepare, update and implement soil and water conservation plans and practices on all crop farm lands.	Assuming 13% of agricultural lands in watershed are farmed for food crops, then approximately 5,500 acres (about 55 farms) would require plans and implementation ($15,000 per farm).	NRCS, conservation districts, agricultural land operators.	$825,000
5	Implement manure management plans and facilities to eliminate runoff from 2 barnyards to streams or infiltration to ground water and to avoid winter spreading of manure.	Approximately $60,000 per farm for plan and management facility.	NRCS, conservation districts, agricultural land operators.	$120,000

Table 18. Recommended Priority Management Actions

Priority	Action	Description	Recommended Lead Entities	Total Generalized Estimated Cost
6	Implement 2 pilot urban stormwater runoff improvement projects within or downstream of developed areas to reduce impacts of urban runoff .	1 project each in Chester and Delaware County to be designated. Prepare design plans, bid specifications, and pursue construction and installation of the projects, and development of long-term operation and maintenance plan. $50,000 to $500,000 per site for site. Additional costs of land or easement acquisitions not included.	Municipalities where projects are to be located, Chester and Delaware County Conservation Districts, and PADEP.	$300,000 (not including land acquisition or construction).
7	Implement residential pollutant runoff reduction programs.	Establish rain barrel and Home-Assist programs to educate and engage residential lawn owners in watershed stewardship practices ($2,500 per year).	Conservation districts, Chester Ridley Crum Watershed Assoc.	$12,500 (total for 5 years)
Protect and Expand Forested Riparian Buffer Networks, Particularly for First Order Streams				
8	Adopt forested riparian buffer requirements in ordinances of all municipalities to protect and/or establish buffers, with a priority emphasis on establishing forested buffer networks along first order streams.	$3,000 for outreach and information exchange to PA municipalities by County agencies; and $10,000 per municipality (all or mostly in watershed) to revise or develop ordinances.	Municipalities (13) and County agencies, USDA/NRCS.	$136,000
9	Establish and protect forested riparian buffers where they do not currently exist along at least 15% of first order streams in headwaters of the watershed; first order streams of tributaries to reservoirs; and immediately surrounding reservoir to protect watershed headwaters and downstream waters (including reservoirs) from impacts of runoff in watershed.	There are an estimated 67 stream miles of first order streams in the watershed. Establishing a total of 200 foot width (combined both sides of stream) buffer on 10 stream miles (15% of total) would create approximately 245 acres of buffer. Focus efforts in areas where new development is most likely to occur and opportunities for protection are therefore greatest. ($5,000 for outreach and information exchange to land owners and farmers for each county; $20 per linear foot for planting plans, plant stock and volunteer installation; $2,500 per acre to administratively establish easements or land owner participation, and management plans for 10% of treated riparian	USDA Natural Resources Conservation Service (NRCS), non-governmental land conservancies, county conservation districts, CRCWA.	$1,122,250

Table 18. Recommended Priority Management Actions

Priority	Action	Description	Recommended Lead Entities	Total Generalized Estimated Cost
		acreage).		
Water Supply/Wastewater Planning and Protection to Meet Future Needs				
10	Complete Source Water Assessments underway for 2 surface water supply intakes, and prepare Source Water Protection Plans.	Assessments are underway for 2 intakes in the Chester Creek watershed. Estimated $60,000 for development of each source water protection plan.	PA-DEP, water supplier, wastewater dischargers, county agencies.	$120,000
11	Prepare Wellhead Protection Plans for 2 community water supply wells.	Estimated $60,000 for development of wellhead protection plans for each well system to include inventories of existing and potential contaminant sources and current and projected land uses.	water supply well owner, municipality where well is located, county agencies, CRCWA.	$120,000
12	Provide ground water balance information to municipalities.	$10,000 for outreach and $10,000 to prepare guidance documents.	CCWRA	$20,000
Increase Public Access to and Recreational Uses of Streams				
13	Implement Chester Creek Rivers Conservation Plan.	Refer to RCP for recommendations.	(as per RCP)	(na)
14	Provide additional stream access locations in new developments and land preservation efforts.	Conduct outreach and information exchange to municipalities to emphasize the need for including stream access in subdivision plans, and incorporating stream access in parks, recreation lands, and land preservation activities. Estimated $10,000 for outreach efforts to municipalities.	County agencies.	$10,000
Total				**$4,363,750**

Table 19. Components of the Landscapes Index

Category	Indicators
Preserved Land Sub-Index	Protected Farmland *
	Eased Land *
	Park Land *
Proposed Development Sub-Index	Proposed Housing Units Consistent with Landscapes
	Non-Residential Development Consistent with Landscapes
	Community Water & Sewer *
Housing Sub-Index	Housing Affordability
	Residential Loans in Urban Areas
	Residential Lot Size
Transportation Sub-Index	Traffic Safety
	Public Transportation Use
	Travel Time
Economy Sub-Index	Farm Production
	Employment Performance
Resources Sub-Index	Stream/Water Protection *
	Historic Resources & Plans *
Municipal Initiatives Sub-Index	Municipal Ordinance Amendments Consistent with Landscapes *
	Municipal Volunteerism

* Will also be used as ***Watersheds*** indicators.

Table 20. New *Watersheds* Indicators for Landscapes Index

Indicator	Measurement Value	Source Data
Non-Impaired Streams	Miles	PADEP 303 (d) Assessments
Biological Diversity	Hilsonhoff Biotic Index	USGS

Appendix A:
Water Balance Data Sheet

Summary of Water Balance Data For Subbasin: Lower Chester Creek

Subbasin Code: Ch1

Watershed Chester Creek

Major Basin: Delaware River

Precipitation:

Average Annual Precipitation: 46.25 **inches**

Land Use:

Type	Area Sqm.
Agriculture	5.43
Commercial/Services	1.57
Community Service	1.16
Industrial	0.56
Military	0.01
Mining	0.30
Parking	0.57
Recreation	1.03
Residential - High Density	0.41
Residential - Multi-family	0.76
Residential - Single Family	13.61
Transportation/Utility	0.78
Vacant	0.95
Water	0.32
Wooded	16.01

Public Sewer Areas:

Facility Name	Area Sqm.
Temp Sewered	43.21
Unknown/None	0.26

Public Water Areas:

Facility Name	Area Sqm.
Bethel Water Co.	1.67
Chester Water Authority	24.45
PSWC - Philadelphia Suburban W	11.70
Unknown/None	5.50
West Mattson Co.	0.16

Population and Size:

Area (Sqm) 43.48

1998 Estimated Population: 60,403

Municipalities:

Name	Area (sqm)
Aston	4.66
Bethel	1.44
Birmingham	0.06
Chadds Ford	0.66
Brookhaven	1.01
Chester City	1.16
Chester Heights	2.22
Chester Twp	1.02
Concord	12.45
Edgmont	2.11
Middletown	8.62
Parkside	0.08
Thornbury	0.21
Thornbury	6.75
Upland	0.67
Upper Chichester	0.36

Base Flows (MGY):

Median: 7,955

10-Year: 4,585

25-Year: 4,745

50-Year: 3,127

Geology:

Rock type:	Sq. Miles
crystalline rocks	41.06
unconsolidated sed.	2.42

Withdrawals:

Total GW Withdrawals: 154 MGY

Total SW Withdrawals: 844 MGY

Estimated Domestic Withdrawals - On-Lot Wells: 24.8 MGY **EDW(in/yr):** 0.033

Ground and Surface Water Permited Withdrawals:

Total: 892,725,490 **gal/yr =** 1.1814 **in/yr**

ID	Facility Name	gal/day
30	Aston Sign- Withdraw Well	120
52	Brinton Manor Well #2	2,470
53	Brinton Manor Well #3	2,470
104	Country Press- Withdraw Well	124
143	Flextron Industries- Withdraw Well	160
158	Glenn Mills Schools-well #1	12,200
159	Glenn Mills Schools-well #2	12,200
160	Glenn Mills Schools-well #4	5,970
161	Glenn Mills Schools-well #5	5,970
162	Glenn Mills Schools-well #6	5,970
163	Glenn Mills Schools-well #7	17,900
246	Lenni Products- Withdraw Well	300
289	Milestone Materials-well#1	14,400
290	Milestone Materials-well#4	1,670
291	Milestone Materials-well#5	500
292	Miller Edge Inc - Withdraw Well	300
299	Moldcraft Co - Withdraw Well	150
339	Ohara Bros Machine - Withdraw Well	104
430	Rosehill School Well	4,000
454	Sleighton School Well#1	18,100
455	Sleighton School Well#2	4,540
456	Sleighton School Well#3	20,400
458	Southco Inc - Withdraw Well	4,790
537	Westlake Plastics-well #001	10,000
726	Milestone Materials-chester C Div	171,000
732	Pswco-media-chester Creek	1,830,000
771	Penn Oaks C C - Pond #11	86,200
772	Penn Oaks C C - Pond #5	70,100
797	Milestone Materials-glen Mills Wd	730,000

Note: Facility ID 1-599 are ground water withdrawal and 700+ are surface water withdrawal points

Recharges:

Total Ground Water Recharges: 29 MGY

Estimated Domestic Recharges - On-Lot Septic: 23.9 MGY **EDR(in/yr):** 0.032

Ground Water Permited Recharges:

Total: 4,757,290 **gal/yr =** 0.0063 **in/yr**

ID	Facility Name	gal/day
53	Aston Sign-0n-lot Septic	120
71	Country Press- On-lot Septic	120
72	Custom Compounding Inc - Septic	143
79	Dutchman Fountains Inc - Septic	200
86	Fibre Metal- On-lot Septic	1,440
99	H Majeske Co Inc - On Lot Septic	165
105	International Envelope- Septic	4,630
115	L & L Special Furnace - Septic	475
122	Lenni Products- On-lot Septic	300
125	Logtown Fence Co - On Lot Septic	308
134	Mcgee Industries Inc - Septic	165
139	Miller Edge Inc - On-lot Septic	300
140	Moldcraft Co - On Lot Septic	112
143	Nolu Plastics Inc - On-lot Septic	1,040
151	Perlite Corp - On Lot Septic	119
186	Westlake Plastics-on-lot Septic	5,430

Discharges:

Total Surface Water Discharges: 1,523.6 MGY

Total: 1,523,561,600 **gal/yr =** 2.0162 **in/yr**

ID	Facility Name	gal/day
25	Concord Beverage Co-loveless STP	41,800
36	Graseby Volkmann Corp -STPI	508
68	Southwest Delaware County Mun	4,120,000
121	Southco Inc-trib To W Br Chester Ck	4,620
126	Westlake Plastics-chester Creek Discharge	12,300

Summary of Water Balance Data For Subbasin: Upper East Branch Chester Creek

Subbasin Code: Ch2

Watershed Chester Creek

Major Basin: Delaware River

Precipitation:

Average Annual Precipitation: 46.25 **inches**

Land Use:

Type	Area Sqm.
Agriculture	3.12
Commercial/Services	0.74
Community Service	0.60
Industrial	0.61
Parking	0.71
Recreation	0.40
Residential - High Density	0.00
Residential - Multi-family	0.53
Residential - Single Family	10.15
Transportation/Utility	0.37
Vacant	0.74
Water	0.18
Wooded	4.64

Public Sewer Areas:

Facility Name	Area Sqm.
Boro. of West Chester SA	0.51
Downingtown Area Regional Authority	0.39
Ridley Creek STP	0.01
Temp Sewered	2.52
Unknown/None	4.97
West Goshen Twp. SA	10.37
Westtown-Chester WWTP	4.03

Public Water Areas:

Facility Name	Area Sqm.
Chester Water Authority	0.99
PSWC - Philadelphia Suburban W	18.76
Unknown/None	3.05

Population and Size:

Area (Sqm) 22.8

1998 Estimated Population: 39,680

Municipalities:

Name	Area (sqm)
East Goshen	3.23
Edgmont	0.02
Thornbury	2.91
Thornbury	2.50
West Chester	0.49
West Goshen	7.15
Westtown	6.12
West Whiteland	0.39

Base Flows (MGY):

Median: 4,362

10-Year: 2,514

25-Year: 2,488

50-Year: 1,715

Geology:

Rock type:	Sq. Miles
crystalline rocks	22.80

Withdrawals:

Total GW Withdrawals: 228 MGY

Total SW Withdrawals: 238 MGY

Estimated Domestic Withdrawals - On-Lot Wells: 16.6 MGY **EDW(in/yr):** 0.042

Ground and Surface Water Permited Withdrawals:

Total: 410,740,355 **gal/yr =** 1.0363 **in/yr**

ID	Facility Name	gal/day
76	Chatwood Water Company Well#1	14,200
77	Chatwood Water Company Well#2	987
172	Harowe Servo Controls -with Well	1,550
231	Lasko Metal Products - Well #5	1,050
232	Lasko Metal Products- Well #4	1,050
233	Lasko Metal Products- Well #6	1,050
234	Laskometal Products - Well #3	1,050
284	Metallurgical Products - Well North	1,190
354	Penn Oaks Country Club	11,500
373	Plas-tech Coatings Inc - Well	135
398	Pswco-gv Div-chateau Drive Well	103,000
400	Pswco-gv Div-grand Oak Well	210,000
421	Pswco-gv Div-pennwood Well#6	42,400
424	Pswco-gv Div-oakbourne Well	66,000
528	Wcc Industries Inc - Well	279
529	West Chester Chemical Co-with Well	346
538	Westtown School	14,000
539	Westtown School	14,000
700	Sartometer Co Inc -rain & Byproduct	5,790
757	PSWC - Fern Hill Plant (West Chest	638,400
788	Trans Materials Co-spring Fed Pond	12,500

Note: Facility ID 1-599 are ground water withdrawal and 700+ are surface water withdrawal points

Recharges:

Total Ground Water Recharges: 252 MGY

Estimated Domestic Recharges - On-Lot Septic: 93.8 MGY **EDR(in/yr):** 0.237

Ground Water Permited Recharges:

Total: 158,103,060 **gal/yr =** 0.3989 **in/yr**

ID	Facility Name	gal/day
1	Brandywine at Thornbury	103,000
3	Hersheys Mill	325,000
32	Penn Oaks C C - Gr Water Rch	16,800
61	C-k Systematics Inc - On-lot Septic	450
63	Chem Service Inc - On Lot Septic	531
107	J F Chobert Mfg - On Lot Septic	255
177	Trans Materials Co - On Lot Septic	385

Discharges:

Total Surface Water Discharges: 1,955.3 MGY

Total: 1,955,347,065 **gal/yr =** 4.9334 **in/yr**

ID	Facility Name	gal/day
12	Lasko Metal Products -waste Haulers	474
32	Fermtec Inc-wyeth Ayerst Lab Treat	119,000
63	Sartomer Co - Dupont Treat Plant	4,100
64	Sartomer Co Inc-chemical Waste Mgmt	3,230
81	West Chester Borough - Goose Creek	913,000
83	West Goshen Wastewater Treatment Plant	3,994,000
85	Westtown-Chester Creek WWTP	323,593
125	West Chester Chemical-goose Ck Discharge	237

12/16/02

Appendix B:
Watershed and Subbasin Data Sheets

Watershed Data Summary for: Chester Creek

Population:

Estimated 1998 Population	Estimated 2020 Population	1998-2020 Est. Population Percent Change
100,083	117,702	18

Estimated 1998 Population Density (People/acre)	Estimated 2020 Population Density (People/acre)
2.4	2.8

Utilities and Water Use:

1998 Est. Population on Individual Septic Systems	1998 Est. Population Connected to Public Sewer	1998 Est. Population on Private Wells	1998 Est. Population on Public Water
6,450	93,634	7,348	92,736

1998 Surface Water Withdrawals (mgal/yr)	1998 Ground Water Withdrawals (mgal/yr)	1998 Ground Water Recharges (mgal/yr)
1,082	382	281

Additional Public Water Needed (mgal/yr)	Additional Private Well Water Needed (mgal/yr)	Total Additional Water Needed (mgal/yr)	Add'l Wastewater Generated (mgal/yr)
717	41	#Name?	#Name?

Land Use:

1998 Percent Impervious	2020 Percent Impervious	1998-2020 Percent Change In Impervious
18.8%	22.3%	18.8

Percent Agriculture Lands in 1998	Percent Agriculture Lands in 2020	1998-2020 Difference in Percent Agriculture
12.9%	8.9%	-4.0%

Percent Developed Lands in 1998	Percent Developed Lands in 2020	1998-2020 Change In Percent Developed
50.5	63.6	13.1

Percent Not Developed Lands in 1998	Percent Not Developed Lands in 2020	1998-2020 Change In Percent Not Developed
36.6	27.6	-9.1

Notes: Agriculture Lands consist of agriculture and animal feeding operations
Developed lands are commercial, community, residential, urban, parking,transportation/utility, and industrial lands
Undeveloped lands are wetlands, water, wooded, vacant and recreation areas

Subbasin Data Summary for: Ch1 Lower Chester Creek
in Chester Creek Watershed

Population:

Estimated 1998 Population	Estimated 2020 Population	1998-2020 Est. Population Percent Change
60,403	70,723	17.1

Estimated 1998 Population Density (People/acre)	Estimated 2020 Population Density (People/acre)
2.2	2.5

Utilities and Water Use:

1998 Est. Population on Individual Septic Systems	1998 Est. Population Connected to Public Sewer	1998 Est. Population on Private Wells	1998 Est. Population on Public Water
1,308	58,963	4,813	55,458

1998 Surface Water Withdrawals (mgal/yr)	1998 Ground Water Withdrawals (mgal/yr)	1998 Ground Water Recharges (mgal/yr)
844	154	29

Additional Public Water Needed (mgal/yr)	Additional Private Well Water Needed (mgal/yr)	Total Additional Water Needed (mgal/yr)	Add'l Wastewater Generated (mgal/yr)
413	28	441	397

Ground Water Balance:

1 in 25 Yr. Annual Average Baseflow (mgal/yr)	1998 Net Ground Water Wthdrawals (mgal/yr)	Net Withdrawal as a Percent of 1 in 25 Yr Average Ann. Baseflow	Subbasin Withdrawal Target as a Percent of 1 in 25 Yr Baseflow
4,745	126	3%	50

Land Use:

1998 Percent Impervious	2020 Percent Impervious	1998-2020 Percent Change In Impervious
17.2	20.4	18.8

Percent Agriculture Lands in 1998	Percent Agriculture Lands in 2020	1998-2020 Difference in Percent Agriculture
12.5%	9.3%	-3.2%

Percent Developed Lands in 1998	Percent Developed Lands in 2020	1998-2020 Change In Percent Developed
45.4	56.9	11.5

Percent Not Developed Lands in 1998	Percent Not Developed Lands in 2020	1998-2020 Change In Percent Not Developed
42.1	33.7	-8.4

Notes: Agriculture Lands consist of agriculture and animal feeding operations
Developed lands are commercial, community, residential, urban, parking,transportation/utility, and industrial lands
Undeveloped lands are wetlands, water, wooded, vacant and recreation areas

Subbasin Data Summary for: Ch2 Upper East Branch Chester Creek

in Chester Creek Watershed

Population:

Estimated 1998 Population	Estimated 2020 Population	1998-2020 Est. Population Percent Change
39,680	46,979	18.4

Estimated 1998 Population Density (People/acre)	Estimated 2020 Population Density (People/acre)
2.7	3.2

Utilities and Water Use:

1998 Est. Population on Individual Septic Systems	1998 Est. Population Connected to Public Sewer	1998 Est. Population on Private Wells	1998 Est. Population on Public Water
5,142	34,469	2,535	37,076

1998 Surface Water Withdrawals (mgal/yr)	1998 Ground Water Withdrawals (mgal/yr)	1998 Ground Water Recharges (mgal/yr)
238	228	252

Additional Public Water Needed (mgal/yr)	Additional Private Well Water Needed (mgal/yr)	Total Additional Water Needed (mgal/yr)	Add'l Wastewater Generated (mgal/yr)
304	14	318	286

Ground Water Balance:

1 in 25 Yr. Annual Average Baseflow (mgal/yr)	1998 Net Ground Water Wthdrawals (mgal/yr)	Net Withdrawal as a Percent of 1 in 25 Yr Average Ann. Baseflow	Subbasin Withdrawal Target as a Percent of 1 in 25 Yr Baseflow
2,488	-24	-1%	100

Land Use:

1998 Percent Impervious	2020 Percent Impervious	1998-2020 Percent Change In Impervious
21.8	25.9	18.8

Percent Agriculture Lands in 1998	Percent Agriculture Lands in 2020	1998-2020 Difference in Percent Agriculture
13.7%	8.0%	-5.7%

Percent Developed Lands in 1998	Percent Developed Lands in 2020	1998-2020 Change In Percent Developed
60.2	76.3	16.1

Percent Not Developed Lands in 1998	Percent Not Developed Lands in 2020	1998-2020 Change In Percent Not Developed
26.1	15.8	-10.3

Notes: Agriculture Lands consist of agriculture and animal feeding operations
Developed lands are commercial, community, residential, urban, parking,transportation/utility, and industrial lands
Undeveloped lands are wetlands, water, wooded, vacant and recreation areas

Appendix C:
Watershed and Subbasin Nonpoint Source Loadings Data Sheets

WMM Pollutant Loading Results for: Chester Creek

BOD: Biologic Oxygen Demand	**1998 BOD lb/acre no**	**2020 BOD lb/acre no BMPS**	**2020 BOD lb/acre with BMPs**	**1998-2020 % Change BOD without BMPs**	**1998-2020 % Change BOD with BMPs**
	38.3	42.3	35.5	10.5%	-7.2%
COD: Chemical Oxygen Demand	**1998 COD lb/acre no**	**2020COD lb/acre no BMPS**	**2020COD lb/acre with BMPs**	**1998-2020 % Change COD without BMPs**	**1998-2020 % ChangeCOD with BMPs**
	141.2	157.4	142.5	11.5%	0.9%
TSS: Total Suspended Solids	**1998 TSS lb/acre no**	**2020 TSS lb/acre no BMPS**	**2020 TSS lb/acre with BMPs**	**1998-2020 % Change TSS without BMPs**	**1998-2020 % Change TSS with BMPs**
	293.3	305.3	113.5	4.1%	-61.3%
TKN: Total Kjeldahl Nitrogen	**1998 TKN lb/acre no**	**2020 TKN lb/acre no BMPS**	**2020 TKN lb/acre with BMPs**	**1998-2020 % Change TKN without BMPs**	**1998-2020 % Change TKN with BMPs**
	10.0	11.7	10.9	17.2%	9.8%
NO23: Nitrate/ Nitrite	**1998 NO23 lb/acre no BMPS**	**2020 NO23 lb/acre no BMPS**	**2020 NO23 lb/acre with BMPs**	**1998-2020 % Change NO23 without BMPs**	**1998-2020 % Change NO23 with BMPs**
	18.7	20.0	19.6	7.0%	4.8%
TP: Total Phosphorus	**1998 TP lb/acre no**	**2020 TP lb/acre no BMPS**	**2020 TP lb/acre with BMPs**	**1998-2020 % Change TP without BMPs**	**1998-2020 % Change TP with BMPs**
	2.12	2.53	2.26	19.0%	6.3%
TSP: Total Soluble Phosphorus	**1998 TSP lb/acre no**	**2020 TSP lb/acre no BMPS**	**2020 TSP lb/acre with BMPs**	**1998-2020 % Change TSP without BMPs**	**1998-2020 % Change TSP with BMPs**
	1.07	1.26	1.17	18.0%	9.8%
CU: Copper	**1998 CU lb/acre no**	**2020 CU lb/acre no BMPS**	**2020 CU lb/acre with BMPs**	**1998-2020 % Change CU without BMPs**	**1998-2020 % Change CU with BMPs**
	0.20	0.21	0.20	8.1%	2.1%
PB: Lead	**1998 PB lb/acre no**	**2020 PB lb/acre no BMPS**	**2020 PB lb/acre with BMPs**	**1998-2020 % Change PB without BMPs**	**1998-2020 % Change PB with BMPs**
	0.03	0.03	0.02	17.8%	-47.2%
ZN: Zinc	**1998 ZN lb/acre no**	**2020 ZN lb/acre no BMPS**	**2020 ZN lb/acre with BMPs**	**1998-2020 % Change ZN without BMPs**	**1998-2020 % Change ZN with BMPs**
	0.38	0.45	0.28	20.3%	-25.8%
RO: Runoff	**1998 RO (in/yr) no BMPS**	**2020 RO (in/yr) no BMPS**	**2020 RO (in/yr) with BMPs**	**1998-2020 % Change RO without BMPs**	**1998-2020 % Change RO with BMPs**
	9.7	10.4	10.4	6.8%	6.8%

Note: Relative estimated indicators of loading for comparitive puposes only

WMM Pollutant Loading Results for: Ch1 Lower Chester Creek in Chester Creek Watershed

BOD: Biologic Oxygen Demand	**1998 BOD lb/acre no**	**2020 BOD lb/acre no**	**2020 BOD lb/acre with BMPs**	**1998-2020 % Change BOD without BMPs**	**1998-2020 % Change BOD with BMPs**
	36.8	40.6	34.4	10.5%	-6.5%
COD: Chemical Oxygen Demand	**1998 COD lb/acre no**	**2020COD lb/acre no**	**2020COD lb/acre with BMPs**	**1998-2020 % Change COD without BMPs**	**1998-2020 % ChangeCOD with BMPs**
	128.4	142.6	124.0	11.0%	-3.4%
TSS: Total Suspended Solids	**1998 TSS lb/acre no**	**2020 TSS lb/acre no**	**2020 TSS lb/acre with BMPs**	**1998-2020 % Change TSS without BMPs**	**1998-2020 % Change TSS with BMPs**
	271.9	286.7	108.1	5.5%	-60.2%
TKN: Total Kjeldahl Nitrogen	**1998 TKN lb/acre no**	**2020 TKN lb/acre no**	**2020 TKN lb/acre with BMPs**	**1998-2020 % Change TKN without BMPs**	**1998-2020 % Change TKN with BMPs**
	7.9	9.0	8.3	14.1%	5.4%
NO23: Nitrate/ Nitrite	**1998 NO23 lb/acre no**	**2020 NO23 lb/acre no BMPS**	**2020 NO23 lb/acre with BMPs**	**1998-2020 % Change NO23 without BMPs**	**1998-2020 % Change NO23 with BMPs**
	17.4	18.4	18.0	5.3%	3.2%
TP: Total Phosphorus	**1998 TP lb/acre no**	**2020 TP lb/acre no**	**2020 TP lb/acre with BMPs**	**1998-2020 % Change TP without BMPs**	**1998-2020 % Change TP with BMPs**
	1.62	1.87	1.62	15.5%	0.3%
TSP: Total Soluble Phosphorus	**1998 TSP lb/acre no**	**2020 TSP lb/acre no**	**2020 TSP lb/acre with BMPs**	**1998-2020 % Change TSP without BMPs**	**1998-2020 % Change TSP with BMPs**
	0.86	0.97	0.89	13.6%	4.2%
CU: Copper	**1998 CU lb/acre no**	**2020 CU lb/acre no**	**2020 CU lb/acre with BMPs**	**1998-2020 % Change CU without BMPs**	**1998-2020 % Change CU with BMPs**
	0.22	0.24	0.23	9.8%	4.8%
PB: Lead	**1998 PB lb/acre no**	**2020 PB lb/acre no**	**2020 PB lb/acre with BMPs**	**1998-2020 % Change PB without BMPs**	**1998-2020 % Change PB with BMPs**
	0.03	0.03	0.01	16.9%	-46.3%
ZN: Zinc	**1998 ZN lb/acre no**	**2020 ZN lb/acre no**	**2020 ZN lb/acre with BMPs**	**1998-2020 % Change ZN without BMPs**	**1998-2020 % Change ZN with BMPs**
	0.36	0.43	0.27	20.2%	-23.9%
RO: Runoff	**1998 RO (in/yr) no BMPS**	**2020 RO (in/yr) no BMPS**	**2020 RO (in/yr) with BMPs**	**1998-2020 % Change RO without BMPs**	**1998-2020 % Change RO with BMPs**
	9.2	9.9	9.9	7.4%	7.4%

Note: Relative estimated indicators of loading for comparitive puposes only

WMM Pollutant Loading Results for: Ch2 Upper East Branch Chester Creek in Chester Creek Watershed

BOD: Biologic Oxygen Demand	**1998 BOD lb/acre no**	**2020 BOD lb/acre no**	**2020 BOD lb/acre with BMPs**	**1998-2020 % Change BOD without BMPs**	**1998-2020 % Change BOD with BMPs**
	41.3	45.7	37.7	10.7%	-8.5%
COD: Chemical Oxygen Demand	**1998 COD lb/acre no**	**2020COD lb/acre no**	**2020COD lb/acre with BMPs**	**1998-2020 % Change COD without BMPs**	**1998-2020 % ChangeCOD with BMPs**
	165.6	185.8	177.8	12.2%	7.4%
TSS: Total Suspended Solids	**1998 TSS lb/acre no**	**2020 TSS lb/acre no**	**2020 TSS lb/acre with BMPs**	**1998-2020 % Change TSS without BMPs**	**1998-2020 % Change TSS with BMPs**
	334.2	340.6	124.0	1.9%	-62.9%
TKN: Total Kjeldahl Nitrogen	**1998 TKN lb/acre no**	**2020 TKN lb/acre no**	**2020 TKN lb/acre with BMPs**	**1998-2020 % Change TKN without BMPs**	**1998-2020 % Change TKN with BMPs**
	14.0	16.8	16.0	20.5%	14.5%
NO23: Nitrate/ Nitrite	**1998 NO23 lb/acre no**	**2020 NO23 lb/acre no BMPS**	**2020 NO23 lb/acre with BMPs**	**1998-2020 % Change NO23 without BMPs**	**1998-2020 % Change NO23 with BMPs**
	21.2	23.2	22.7	9.6%	7.3%
TP: Total Phosphorus	**1998 TP lb/acre no**	**2020 TP lb/acre no**	**2020 TP lb/acre with BMPs**	**1998-2020 % Change TP without BMPs**	**1998-2020 % Change TP with BMPs**
	3.09	3.78	3.47	22.4%	12.3%
TSP: Total Soluble Phosphorus	**1998 TSP lb/acre no**	**2020 TSP lb/acre no**	**2020 TSP lb/acre with BMPs**	**1998-2020 % Change TSP without BMPs**	**1998-2020 % Change TSP with BMPs**
	1.47	1.80	1.70	22.9%	16.1%
CU: Copper	**1998 CU lb/acre no**	**2020 CU lb/acre no**	**2020 CU lb/acre with BMPs**	**1998-2020 % Change CU without BMPs**	**1998-2020 % Change CU with BMPs**
	0.16	0.17	0.15	3.5%	-4.8%
PB: Lead	**1998 PB lb/acre no**	**2020 PB lb/acre no**	**2020 PB lb/acre with BMPs**	**1998-2020 % Change PB without BMPs**	**1998-2020 % Change PB with BMPs**
	0.03	0.04	0.02	19.3%	-48.7%
ZN: Zinc	**1998 ZN lb/acre no**	**2020 ZN lb/acre no**	**2020 ZN lb/acre with BMPs**	**1998-2020 % Change ZN without BMPs**	**1998-2020 % Change ZN with BMPs**
	0.42	0.50	0.30	20.4%	-28.8%
RO: Runoff	**1998 RO (in/yr) no BMPS**	**2020 RO (in/yr) no BMPS**	**2020 RO (in/yr) with BMPs**	**1998-2020 % Change RO without BMPs**	**1998-2020 % Change RO with BMPs**
	10.7	11.3	11.3	6.0%	6.0%

Note: Relative estimated indicators of loading for comparitive puposes only

Appendix D:
Additional Recommendations of Management Actions

Appendix D
Additional Recommendations of Management Actions

Manage stormwater runoff

Priority Subbasin(s): Upper East Branch Chester Creek Subbasin

Rationale: While high risk to life is not a problem in the watershed, there is damage to property and the stream channel as a result of stormwater runoff. Also, the presence of a water supply intake in the lower portion of the watershed makes it imperative to manage stormwater to reduce the sediment in runoff and to treat runoff for pollutants with biological features, i.e. wetlands or biofiltration strips. The Upper East Branch Chester Creek subbasin is currently estimated to be at 21% impervious cover while the Lower Chester Creek subbasin is estimated to be at 17%. Careful design of new stormwater management and utilizing new stormwater management strategies and retrofit approaches can help reduce flooding and stream degradation due to stormwater runoff. In addition to current concerns, a large percentage of the municipalities in the watershed are expected to be required to comply with NPDES Phase II requirements for stormwater management.

Focus Location: Throughout subbasin

Other Areas of Need: Lower Chester Creek Subbasin

Recommended Actions

Municipal Stormwater Management for New Construction

Example: Implement Comprehensive Stormwater Management Criteria – for new construction, implement criteria that is being developed in the Chester Creek Act 167 study to reduce the quantity of stormwater generated, increase the quantities of runoff infiltrated and improve the quality of stormwater runoff.

Example: Review/Revise municipal ordinances – review/revise ordinances to reduce unnecessary requirements for impervious cover.

Example: Restoration of floodplains – When possible, efforts should be made to reclaim floodplains if they have been developed, and the floodplains could be utilized as recreation/parkland.

Example: Wet detention ponds – a combination of a permanent pool of water with extended detention or shallow wetlands. These require a minimum drainage area of 10 acres or more to remain wet.

Example: Bioretention/Biofiltration – these BMP's combine open space with stormwater treatment. Instead of a sand filter, the water is stored in an area of soil and plantings, with an underdrain to collect water not used in the root zone.

Example: Provide Incentives for Conservation Design – Provide incentives for subdivisions incorporating conservation design practices and stormwater reduction/treatment BMP's.

Example: Limited Pavement in Turnarounds - Most ordinances require that cul de sacs have a paved radius of 45 to 50 feet. This is intended to give adequate space for emergency vehicles to turn around. Developers could be required to provide paved radius for vehicles, but leave a vegetated area in the center of the turnaround. Runoff could be treated in this vegetated area.

Example: Smaller front yard setbacks - By allowing smaller setbacks, driveway and walkway lengths can be reduced for each house, thus reducing the amount of impervious cover.

Example: Runoff Management System - A system for controlling excess runoff caused by construction operations at development sites, changes in land use, or other land disturbances. This is done to minimize such undesirable effects as flooding, erosion, sedimentation and to maintain or improve water quality.

Landscape Management

Example: Natural Area Conservation – Leaving areas in the natural setting will help reduce stormwater generation, can help infiltrate overland flow and reduce pollutant loadings.

Example: Open Grass Channel – Using grass channels and swales to carry runoff to biofiltration systems and infiltration systems allow for infiltration and pollutant removal.

Example: Utilizing wetlands and other biofiltration systems in landscape design – Making stormwater systems attractive and part of landscape designs is preferable to isolating them. Utilizing wetlands and other biofiltration/infiltration BMP's can provide for both stormwater management and landscape amenities.

Homeowner/Residential Management

Example: Disconnect Downspouts from Driveways or other Impervious Cover - Re-direct downspouts away from driveways and sidewalks and onto grassed areas or flower gardens. Put a few small rocks at the end of the downspout to help dissipate the velocity and energy from the running water, and therefore help avoid creating erosion rivulets in your yard.

Example: Install a Rain Barrel - Install a rain barrel at one or more downspouts. These are available from gardening and arborist supply companies. New designs nearly eliminate the problems with odors and bugs, but put it away from the doors to your house to be sure. Rain barrels are made of recycled plastic and have valves to use to fill watering cans for watering your flower beds.

Example: Create Rain Gardens - Convert small depression areas into rain gardens. These can be small gardens consisting of water tolerant plants and bushes that will help retain runoff and allow it to be used beneficially. Planting water tolerant plants in areas where erosion is winning the battle may also help solve an unsightly problem.

Multi-Municipal Coordination

Example: Municipal involvement/coordination through ongoing Act 167 Stormwater Study – Involvement in the ongoing Act 167 Study will allow for multi-municipal communication on stormwater concerns and solutions.

Example: Coordinated stormwater management strategies – With numerous municipalities within the watershed expected to be under the forthcoming NPDES Phase II requirements, joint cooperation between adjoining municipalities can improve stormwater management on a watershed basis.

Example: Catch Basin Clean-out - maintaining the volume of catch basins as well as their infiltration capacity improves the quality of the stormwater released to the streams. It also avoids re-suspension of fine material during larger storm events.

Additional examples of BMP's that mange stormwater can be found throughout Section 13 of the Compendium.

Restore surface water quality

Priority Subbasin(s): Upper East Branch Chester Creek Subbasin

Rationale: A number of stream segments within the Chester Creek watershed are currently listed by the Commonwealth of Pennsylvania on the Proposed Year 2000 303(d) list. Also, biological diversity monitoring suggests that water quality and biological diversity declines below the outfall of the Goose Creek wastewater treatment plant.

Focus Location: All areas draining or discharging to 303(d) listed segments (reference Figure 13- 2), particularly lands adjacent to first order streams.

Other Areas of Need: Lower Chester Creek Subbasins

Priority Actions:

Manage stormwater to reduce stream erosion and siltation

Example: Implement Comprehensive Stormwater Management Criteria – for new construction, implement criteria to reduce the quantity of stormwater generated and increase the quantities of runoff infiltrated.

For additional examples of reducing stormwater and the resulting damage caused by stormwater, please refer to Priority Management Objective #1: Manage Stormwater Runoff.

Implement Urban BMP's

Example: Street sweeping - more frequent street sweeping has been shown to reduce nutrient loading to streams from wash-off during storm events to a limited degree. Research has shown, however, that street sweeping is most effective at removing floatable trash from storm water.

Example: Periodic storm drain clean-outs – Removing debris from storm drains to make certain that the debris does not flush into the receiving streams.

Example: Catch Basin Clean-out - maintaining the volume of catch basins as well as their infiltration capacity improves the quality of the stormwater released to the streams. It also avoids re-suspension of fine material during larger storm events.

Example: Solid Waste Management - in addition to street sweeping, programs to provide litter baskets (with frequent pickup) can reduce litter that eventually finds its way into the streams via the storm sewers.

Example: Storm Sewer Inlet Labeling - many communities are identifying and labeling entry points of storm drainage systems with permanent stencils. The purpose is to educate the public about where stormwater goes, and to limit dumping of household pollutants into storm drains.

A more complete description of best management practices that can be effective in improving water quality in urban and suburban areas can be found in Section 13.3.9.3: "Approved Recommended" BMPs to Achieve Quality/Quantity Criteria Best Management Practices.

Utility Management

Example: Evaluate land application of treated effluent - Opportunities to reduce the volume of treated effluent discharged to Chester Creek should be evaluated to determine whether new technologies can be utilized. Reduction of volume, and the associated pollutants, would help improve the water quality of the creek.

Expand forested riparian buffer networks, particularly along first order streams

Example: Education Programs - Throughout the Chester Creek watershed, groups that provide educational materials to home-owners, such as watershed associations, governmental agencies, etc., should stress the role that riparian corridors play in the health of the stream. Landowners should be given guidance on establishing or preserving a forested riparian buffer, no-mow zones, use of native species and other tips that improve the riparian corridor management.

Example: Incorporate Forester Riparian Buffer Incentives – Within subdivision ordinances, incorporate forested riparian buffer incentives and requirements.

Example: Conservation Site Design - Provide incentives for developers to utilize conservation design principles to allow for creating a site development plan that protects riparian corridors and still allows for appropriate densities consistent with local zoning, as well as equitable value per unit.

Source Water Protection

Priority Subbasins: Upper East Branch Chester Creek & Lower Chester Creek Subbasins

Rationale: There are two surface water withdrawals in the Chester Creek watershed for public drinking water supply. One withdrawal is at the West Chester Reservoir while the other is in the Lower Chester Creek subbasin as a water intake. There are also a number of water supply wells for public water supply and community systems in the watershed.

Focus Location: All areas draining or discharging to the reservoir and surface intake, and all areas in the ground water capture zone for the supply wells.

Other Areas of Need: N/A

Priority Actions:

Utility Management

Example: Watershed based cooperation – Since utilities, municipalities and other interested parties have similar goals for source water protection, efforts should be coordinated to maximize benefits of protection efforts.

Example: Develop and/or implement a source water protection program – Guidance is available from PA-DEP and professional organizations, such as AWWA, to develop and implement a source water protection programs.

Example: Potential Contaminant Source Inventory – Potential contaminant source inventories include activities that use, store, transport or dispose of contaminants such as Giardia & Cryptosporidium, the EPA contaminant candidate list, and others.

Local Government

Example: Watershed based cooperation - Since many utilities, municipalities and other interested parties have similar goals for source water protection, efforts should be coordinated to maximize benefits of protection efforts.

Example: Integration of Water Supply Protection with Municipal Comprehensive Plan, Subdivision Ordinance and Zoning Ordinance – Programs that protect supply wells, surface intakes or reservoirs should be integrated with municipal plans and ordinances to provide for their protection.

Watershed-wide Needs

In addition to actions that can be accomplished through individual projects in individual watersheds or municipalities, there are a number of programs that are of high-priority and that require the efforts of various groups working together. These projects that require coordinated efforts are often more difficult to achieve due to the challenges of moving diverse groups towards a common goal, but these projects are also important towards linking the watersheds and municipalities together. The following were identified for the Chester Creek watershed:

- Promote Protection of Heritage Regions (Quaker and Welsh),
- Need for municipal involvement to achieve regional recreation trail linkages and biodiversity corridors (e.g., linkages among Paoli Battlefield trail, Ridley trail and Great Valley trail).

Appendix E:
Ongoing Initiatives

Appendix E
Ongoing Initiatives

Pennsylvania Rivers Conservation Program

The Pa Rivers Conservation Program has been developed to conserve and enhance river resources through preparation and accomplishment of locally initiated plans. The program provides technical and financial assistance to municipalities and river support groups to carry out planning, implementation, acquisition and development activities. A registry is established to recognize local river conservation efforts. This program is administered by the Pennsylvania Department of Natural Resources Conservation and more information regarding the program can be found at their website: http://www.dcnr.state.pa.us/rivers/.

The initial step within the Rivers Conservation Program is to prepare a Rivers Conservation Plan (RCP) for the watershed. This plan is prepared by local groups that best understand local needs and opportunities. Some issues typically found in a RCP include:

- Background information;
  Brief history of planning activities.
  The Steering Committee; and the roles played.
  Processes used to gather and evaluate resource data.
- A map of the planning area.
- An inventory of resources gathered.
- An analyses of the appropriate resources.
- Listing of issues, concerns, opportunities and threats to river values.
  Management options (issues, opportunities and concerns solution);
- Other appropriate information.

For the Chester Creek watershed a rivers conservation plan is being prepared by Pennsylvania Environment Council. The DCNR identification number is RCP 1996-01.

Pennsylvania's Stormwater Management Program (Act 167 Program)

The Pennsylvania legislature enacted the Storm Water Management Act (No.167) in 1978 to authorize a program of comprehensive watershed stormwater management which retains local implementation and enforcement of stormwater ordinances similar to local responsibility of administration of subdivision and land development regulations. Under the Act, the Department of Environmental Protection (DEP) provides grant money to counties to develop storm water management plans for designated watersheds. This planning effort results in the incorporation of sound engineering standards and criteria into local codes and ordinances to manage runoff from new development in a coordinated, watershed-wide approach.

Currently, a stormwater management plan is under development for the Chester Creek watershed. The lead County on the plan is Delaware County, with assistance from Chester County.

Existing Framework for Watershed Based Planning

The watershed is part of the Delaware River Basin Commission and that Commission has various programs that result in planning opportunities and actions in the watershed.

There are two sets of sources that were used to compile the list of ongoing initiatives: 1) the Watershed Restoration Action Strategy for Subbasin 03G (Draft – DEP Bureau of Watershed Conservation) and 2) synthesis of correspondence and grant materials. There may be some overlap between the two lists.

Initiatives listed in the Watershed Restoration Action Strategy for Subbasin 03G (Draft – DEP Bureau of Watershed Conservation)

Pennsylvania Growing Greener:

- $18,700 (1999) to Cheyney University of Pennsylvania to restore the portion of Chester Creek on the university property. Streambank buffers will be restored to protect the stream corridor.

Pennsylvania Watershed Restoration Assistance Program (WRAP):

- $1,000 (1998) to Delco Anglers and Conservationists for riparian enhancement of Darby, Ridley and Goose Creeks
- $1,522 (1998) to Chester Ridley Crum Watershed Association for a seminar on improving Tanguy Run (East Branch Chester Creek)

DCNR Rivers Conservation Grants:

- $60,000 (1996) to Chester Ridley Crum Watershed Association/Greenspace Alliance to develop a conservation plan for restoring, maintaining, and enhancing Chester Creek

Pennsylvania Stormwater Management Act 167 Plans:

- Delaware County has petitioned DEP for funds to develop a stormwater management plan for the county.
- Approved plans for Ridley Creek; plans under development for Chester Creek and Darby Creek

PENNVEST:

- $184,950 loan (1998) to Upland Borough, Delaware County, to construct collection and conveyance facilities to eliminate ponding, flooding, and icing that cause property damage and public safety hazards.
- $5 million loan to the Delaware County Regional Water Control Authority to upgrade the central Delaware County area pump station and construct force mains to divert flow to the treatment plant in Chester.

League of Women Voters (WREN) Mini-grants:

- $2,810 to the Partnership for the Delaware Estuary to develop a traveling educational display which will highlight the relationship between human behavior and the quality of the community's drinking water source, the Delaware River.

Initiatives synthesized from correspondence and other materials:

- City of Chester: $25,500 for Ridley and Chester Creek watershed improvement study (Growing Greener Grant – Dec. 2000)
- Chester Creek Watershed Conservation Plan
- Ongoing or planned project: Goose Creek culvert replacement and stream bank stabilization
- Ongoing or planned project: Stream bank restoration & wetland restoration on Goose Creek

- Potential park and rec project: Stream bank restoration at Rt. 926 and S. Westtown Rd (Thronbury Twp)
- Potential park and rec project: Stream bank restoration at Rt. 926 and Westtown Thorton Rd - Goose Creek (Thronbury Twp)
- Potential park and rec project: Stream greenway along Goose Creek (West Chester Boro)
- Potential park and rec project: Trail System along Goose Creek (Westtown Twp)
- Riparian Corridor Improvement
- Chester Creek Act 167 Stormwater Plan
- Pennsylvania Watershed Restoration Strategy (WRAS)
- Envirothon – an environmental education program for school students throughout Chester County
- Riparian Resource Plans and Demonstration Projects – grant application by CCP&RD
- States are requiring environmental education by 2002.
- Music video made on non-point source, contact Ed Magargee Delaware County Conservation District.