

The sediment TMDLs in this TMDL document have been superseded by the Kiskiminetas-Conemaugh River TMDL completed by EPA on January 29, 2010. The TMDL can be viewed by following the link [http://www.epa.gov/reg3wapd/tmdl/pa\\_tmdl/Kiskiminetas/index.html](http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/Kiskiminetas/index.html). The nutrient TMDLs in this document are still applicable.

# **Nutrient and Sediment Total Maximum Daily Loads For**

## **Stonycreek River**

*Stream Code - 45084*

*Segment ID – 5112*

**Somerset County, PA (18-E)**

**Prepared by  
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## I. TMDL Overview

The TMDL development process is a nationwide effort to inventory and improve the health of our waters. Each water body in Pennsylvania has water quality standards that define the amount of substances with pollution-potential that can exist therein. The attainment of these standards is essential to ensure that the quality of each water body can support its “protected use.” Water quality may be protected to support coldwater fishes, recreational activities, potable water, or many other “protected uses.” When the water quality standards of a water body are not met, the water is classified as being “impaired.” Section 303(d) of the Clean Water Act requires all impaired waters to be identified and documented. Consequently, the Pennsylvania Department of Environmental Protection is assessing all of its water bodies, and listing those that are impaired on its own 303(d) list. Furthermore, regulations require that a TMDL study must be completed for each impaired water body on this list. The goal of such a study is to determine how to restore impaired water bodies.

Identifying and eliminating all sources of the pollutant would of course be the optimal method of restoration; however, this is rarely feasible or possible. Instead, a TMDL study is directed at determining the total maximum daily load of a pollutant that a water body can assimilate (uptake) and still maintain its water quality standards. Once a TMDL is determined in terms of a pollutant load (e.g., lbs nitrogen/yr), this value is compared to the existing load. In general, the difference between the TMDL and the existing load constitutes the targeted load reduction.

To reach this targeted load, reductions from the loads of both point (e.g., sewage treatment facility discharge) and non-point (e.g., farmland runoff) sources are considered. Pollutant contributions from non-point sources often comprise the majority of the total load. To reduce these loads, Best Management Practices (BMPs) are reviewed and recommended to land owners. Stream-bank stabilization and vegetated buffers are examples of BMPs. Proper implementation of these land management strategies can cause substantial reductions of pollutants, and consequently can have a meaningful and positive effect on the health of our waters.



Figures 1 and 2 (left to right). Photographs of areas where BMPs have been implemented to reduce nutrient leaching. Fig. 1 – Riparian buffer strip, and Fig 2. – Contour buffer strip.

## II. Executive Summary

This TMDL was developed for segment ID 5112 of Stonycreek River (Stream Code – 45084), Somerset County (18-E). This segment is the stream area extending from the origin of the headwaters of Stonycreek River to the point where it joins with Reitz Creek (Stream Code - 45804). It is listed as being impaired by agriculture in Pennsylvania's 1996 303-d list, whereby nutrients and sedimentation were stated to be the causes of impairment.

Using AVGWLF®, a watershed that currently attains its water quality standards, and has several relevant similarities with the impaired watershed was identified: Sandy Hollow. This watershed is adjacent to the impaired watershed, and is similar except that it is more buffered from runoff due to a forested zone that runs contiguously with the stream.

Using the GWLF® model, the existing loads of sediment and phosphorus from non-point sources were determined for both the impaired and reference watersheds; no point sources exist within either watershed. Based upon this data, the loading rate of the reference watershed was used to determine an acceptable load for the impaired watershed, and this acceptable load was then allocated among the various non-point pollution sources. The required pollutant reductions were then determined (Table i).

Targeted load reductions could be reached by implementing Best Land Management Practices (BMP). Proper implementation of BMPs can cause substantial reductions of pollutants. Based on the causes of impairment of this watershed, the following BMPs were recommended: 1) Field Border, 2) Nutrient Management, and 3) Streambank and Shoreline Protection. Information sheets about each of these BMPs are included in the appendices of this report.

Table i. Parameters of the TMDL development and required load reductions of Stonycreek River segment ID 5112 determined using existing land-use conditions.

<b>Parameter</b>	<b>Sediment (tons/acre)</b>	<b>Phosphorus (lbs/acre)</b>
Reference Loading Rate	0.077	0.264
Total Daily Maximum Load	236.13	809.58
Margin of Safety (10%)	23.61	80.96
Load Allocation	212.52	728.62
Loads Not Reduced	2.13	8.34
Adjusted Load Allocation	210.39	720.28
<b>Required Reduction (%)</b>		
Hay/ Pasture	43	40
Cropland	43	40
Transitional Land	43	40
Streambank	43	-
Groundwater	N/A	40

### III. Introduction

#### A. Watershed Description

##### 1. Location and General Description

The Stonycreek River watershed is located in northern Somerset County, and lies within state water plan 18-E (Figure 1). The entire watershed is vast, as it expands approximately 43 miles from end to end, and has a total drainage area of 467 mi<sup>2</sup>. From its headwaters located in Berlin, PA, Stonycreek River (Stream Code – 45084) receives water from more than 60 tributaries before joining with Little Conemaugh River to form the Conemaugh River. The scope of this TMDL, however, is limited to segment 5112. This segment is the stream area extending from the origin of the headwaters of Stonycreek River in Berlin to the point where it joins with Reitz Creek (Stream Code - 45804), excluding tributaries (Figure 1).

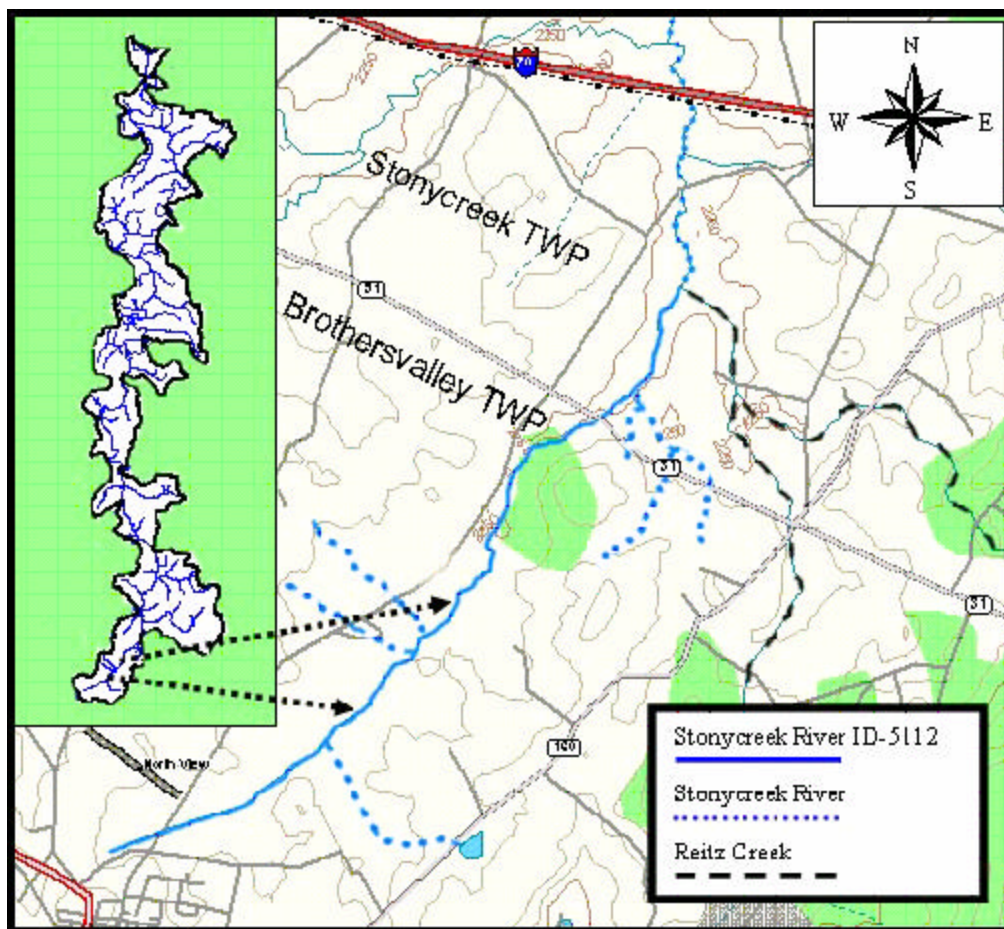


Figure 1. Illustration of the Stonycreek River watershed (not all tributaries shown), Segment ID 5112 of Stonycreek River, and Reitz Creek (Berlin, Somerset County).

From its origin in Berlin, PA (USGS quadrangle -Berlin), segment 5112 flows northeasterly through Brothersvalley and Stonycreek Townships for approximately 4 miles before joining with Reitz Creek (Figures 1 and 2). It receives water from four first-order unnamed tributaries, and all together its 5 mi<sup>2</sup> watershed encompasses a total of 7.7 miles of stream (Figure 2).

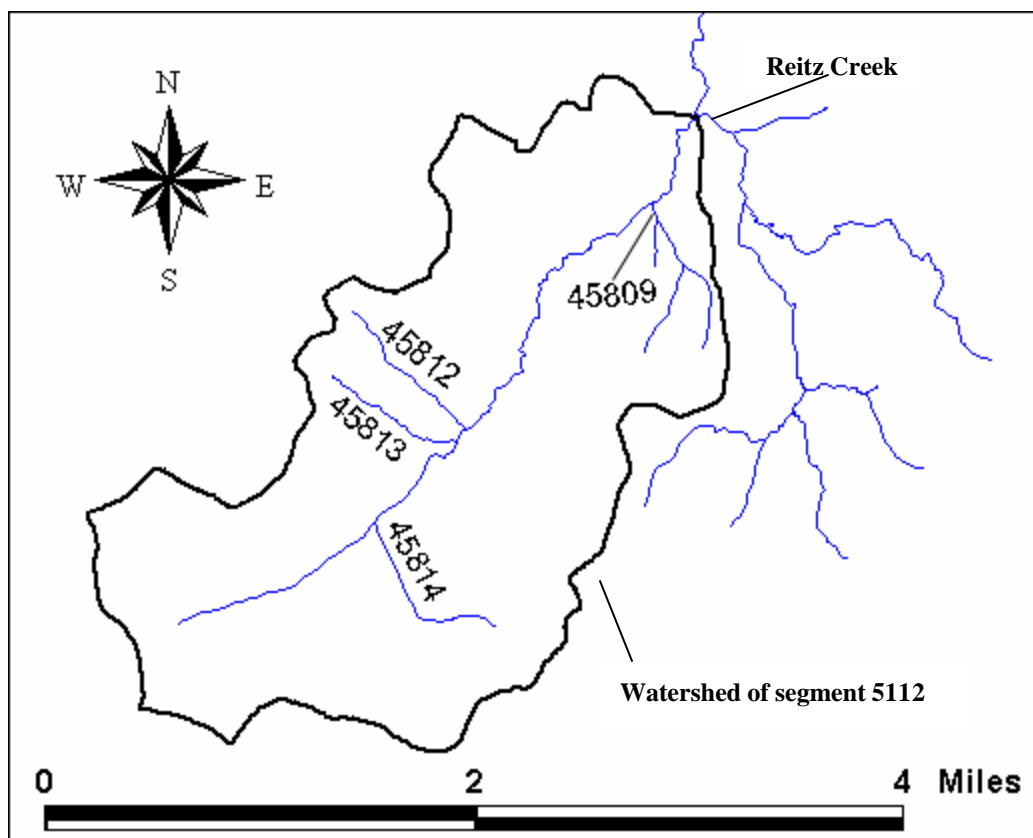


Figure 2. Watershed of Stonycreek River segment ID 5112. Tributaries labeled on figure by stream code, not by segment ID.

## 2. Topography and Geology

The watershed of Stonycreek River segment 5112 lies within the Allegheny Mountain Section of the Appalachian Plateau Province. This section consists of wide ridges separated by broad valleys. Elevation ranges from 699 to 701 m above sea level. Rocks within the watershed are entirely interbedded sedimentary, and the dominant underlying bedrock group is the Casselman Formation. The strata of this group vary by area, but typically consist of coal, claystone, limestone, shale, and sandstone. The second largest bedrock group is the Monongahela Group, which lies at the mid-western and south-western corners of the watershed. This group contains strata of limestone, shale, sandstone, and coal.

The sole soil association of the watershed is Gilpin-Wharton-Ernest. This association consists of areas of soils on moderately broad to narrow ridges on hills that are dissected by drainage ways. These soils are moderately deep, steep, and well-drained. The Gilpin soils formed in residuum from acid shale and sandstone. The Ernest soils formed in colluvium from acid shale, siltstone, and sandstone, and are on foot slopes of hills and ridges as well as in concave areas on ridge tops. Wharton soils are deep and well drained, and formed in residuum from acid clay, shale and siltstone. The dominant hydrologic soil group is C; this soil group is characterized as having a slow infiltration rate when thoroughly wetted.

### 3. Land Use

Land-use coverage was computed by the AVGWLF model version 5.0.2 (Figure 2) (see Appendix A for model description), and was verified by a physical survey of the area conducted in February 2004. Model computations revealed that the greatest overall land-use was cropland, followed by hay/pasture (Figure 3). Collectively, agricultural land-uses comprise 83% of the area, followed by forest and development at 8% each. The headwaters are exposed to some low intensity development (Figure 4), but mostly are surrounded by crop and hay/pasture fields as well as small plots of forest (Figure 5). Downstream the stream channel meanders through open fields and cropland, wherein a few livestock farms exist.

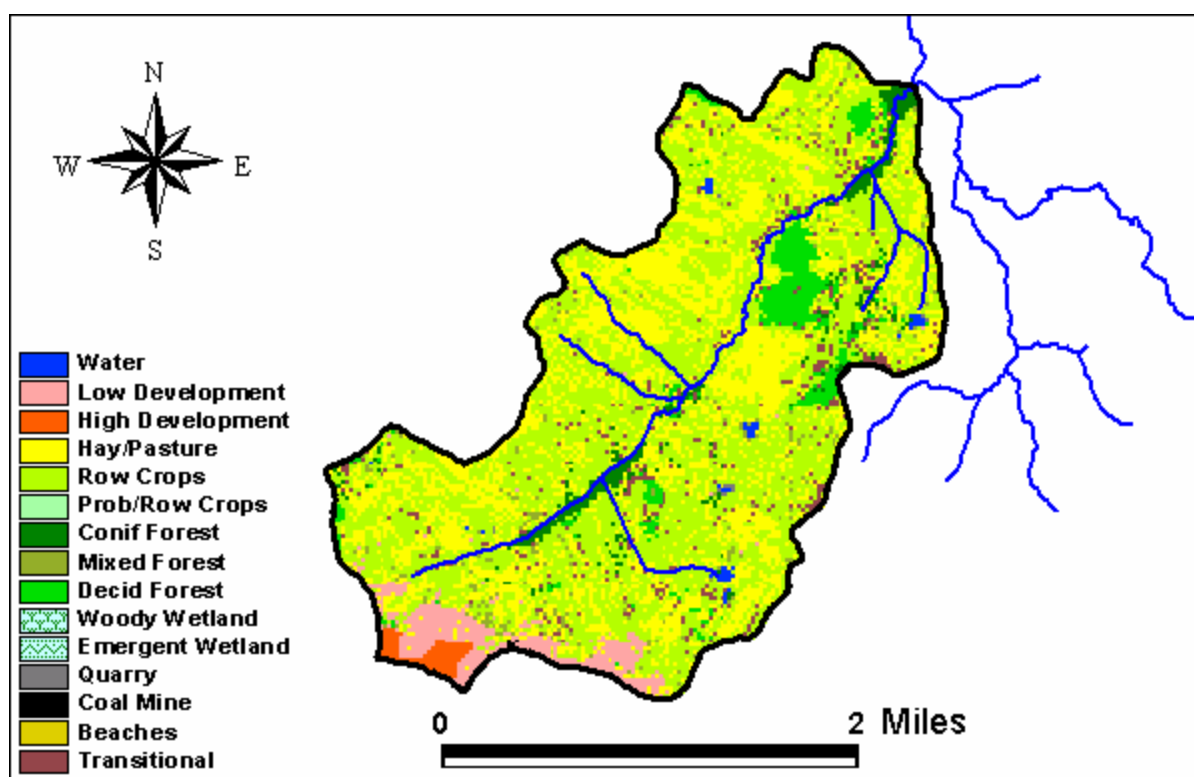


Figure 3. Illustration of land-uses within watershed of Stonycreek River segment 5112. Transitional land depicts land that is currently being developed.



Figure 4. Low-intensity development in the headwaters of Stonycreek River segment 5112.



Figure 5. Pasture, cropland, and forest plots along Stonycreek River segment 5112

## B. Nature of Impairment and Water Quality Standards

Stonycreek River segment 5112 is impaired, meaning that the health of its water does not meet the standards that have been established for its protected use: Cold Water Fishery. Figure 6 illustrates the waters in its watershed that are impaired. None of the encompassed tributaries are impaired, and therefore they are not considered to be a part of segment 5112. Nevertheless, the whole watershed will be considered in this TMDL.

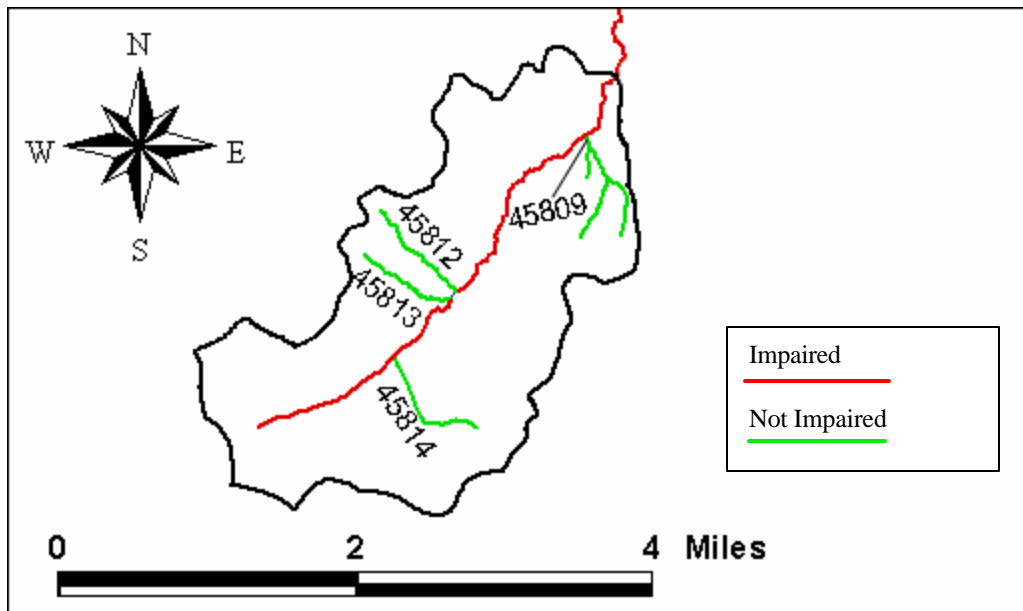


Figure 6. Illustration of impaired and non-impaired waters within the watershed of seg. 5112.

No point sources of pollution, including MS4s (municipal separate storm sewer systems), exist within the watershed. Two causes of impairment from non-point sources have been identified within the watershed. These along with their respective segment IDs are listed in PA’s 1996 303(d) list, and table 1 illustrates those listings that this TMDL will address. Pennsylvania’s 1998 list (dated August 11, 1998) incorrectly lists segment ID 5112 as being 5113. This is a confirmed typographical error, and the completion of this TMDL should warrant the removal of that particular listing from the 1998 list.

Table 1. Information taken from PA’s 1996 303(d) list showing impaired segments of Stonycreek River (Somerset County) that this TMDL shall address.

Stream Name	Segment ID	Source	Cause	Mile s
Stonycreek River	5112	Agriculture	Suspended Solids	3.9
	5112	Agriculture	Nutrients	

Although no in-stream water quality criteria exist for these parameters, placement of segment ID 5112 on the 303(d) list was supported by assessments conducted as a part of the Surface Water Monitoring Program (SSWAP). In this protocol, a biologist collects data to assess the conditions of water chemistry, in-stream as well as surrounding habitat, and invertebrate life. Based on the findings, a professional decision is made as to whether impairment exists to its aquatic life. All warm-water and cold-water fisheries within Pennsylvania are protected to support indigenous aquatic life, and if it is determined that aquatic life is degraded, the stream is deemed impaired.

Surveys conducted in February and April 2004 revealed that runoff from agricultural land and lack of riparian buffer thereof cause excess sediment and nutrients to enter the stream. The stream channel has lost significant volume due to sedimentation (Figure 7). Moreover, accelerated run-off coming from this land has caused some areas of the stream-bank to collapse and enter the stream. Spatial data from the AVGWL model complement these findings by showing that hay/pasture and cropland were the largest land-use contributors of sediment and nutrient pollution in the watershed.



Figure 7. Diminished stream channel volume of Stonycreek River segment 5112 caused by sedimentation.

## C. Pollutant Backgrounds, Linkage Analysis, and Endpoints

Impairments within the watershed were addressed by targeting sediment and nutrient loading. “Suspended solids”, which is listed as a cause of impairment in the watershed, is simply a category of sediment pollution. This category refers to small particles of sediment that are carried within the stream flow, and usually originate from the erosion of land outside the channel.

Because nutrients, especially phosphorus, are often adsorbed to sediment, an increase in sediment loading to a water body often correlates with an increase in nutrients (USEPA 1992, 1999). Thus, a reduction in sediment loading can address nutrient problems to some extent; however, the exact relationship between these two substances is not well defined, as many factors are involved in their relationship. Therefore, sediment will be addressed in addition to nutrients in this TMDL; although, land management practices that will be recommended to reduce nutrient loading will be similar to those for reducing sediment.

### 1. Nutrients

Nutrients are essential components of any aquatic ecosystem. The two most recognized nutrients are nitrogen (N) and phosphorus (P), which fuel photosynthetic growth of aquatic vegetation such as aquatic plants and algae. The existence of aquatic vegetation is crucial, as it provides food and habitat for animals such as aquatic insects, fish, frogs, and waterfowl. More importantly, it provides (via photosynthesis) the key substance that most aquatic organisms must have to survive: dissolved oxygen.

Among other elements, N and P play a direct role in governing growth of aquatic plants; a shortage of either can impede growth, and an excess can accelerate growth to undesirable proportions (Stickney 1994). Because of their ability to proliferate and out-compete aquatic plants, infestations of algae are typically more problematic and receive more attention than do aquatic plants. In most circumstances, however, algae are not problematic, but when nutrients become over-abundant, problems result.

Nitrogen and phosphorus also fuel growth of farm crops and lawn grasses, and therefore are often used to increase crop production and produce fertile lawns. Unfortunately, it is difficult to retain these nutrients, and they often are washed into nearby water bodies during rainy events. Moreover, agricultural land is typically comprised of short grasses or no grasses at all; therefore, little buffer exists to impede the flow of water across the land. Resultantly, dissolved nutrients or nutrients bound to soil are washed into streams uninterruptedly. Algae in the receiving waters exploit these nutrients, and their populations often explode sometimes engulfing all available substrate.

Although they produce oxygen during the day via photosynthesis, algae uptake oxygen from the water during the night; this process is termed *respiration*. If the algal population becomes dense, dissolved oxygen levels can fall below the requirements of fish and other aquatic inhabitants during the night. Organisms that can directly withstand low levels of oxygen may survive temporarily, however face a

constant diurnal fluctuation of dissolved oxygen that may prove to be lethal. In addition to directly causing dissolved oxygen shortages, dense aquatic plant establishments can also render habitat unsuitable for indigenous organisms by slowing the movement of water, which consequently increases thermal loading and decreases dissolved oxygen renewal.

Although many short-term methods exist for controlling algae, the only true solution is to limit their food supply: nutrients. A reduction in both N and P can impede algal growth; however, a more practical approach is to reduce the nutrient that most limits growth. Phosphorus is essential to all living organisms, and is often the most growth-limiting element in freshwater ecosystems due to its limited supply (Horne and Goldman 1994). Unlike nitrogen, phosphorus has no gaseous phase, and therefore rainwater carries little or no phosphorus. Furthermore, the little P that is weathered from rocks is quickly absorbed by the root zone on land, or is adsorbed onto particles making it unavailable for uptake by aquatic plant. Although in some circumstances P may not be the limiting nutrient, our analysis shows that it is for this watershed. A common N:P ratio is 10:1, and an increase in this ratio indicates a limitation of P (Horne and Goldman 1994). The ratio for this watershed was determined to be 32:1, which indicates a limitation of P. When phosphorus is limited, a direct and linear relationship exists between the concentrations of P and algae (Horne and Goldman 19964). Therefore, our endpoint was the reduction in P required to render the watershed unimpaired.

## 2. Sediment

Like nutrients, sediment is an essential component of aquatic ecosystems, as it often contains minerals used by many aquatic organisms, and also provides habitat. Sedimentation is a natural process that is caused by the weathering of landscape, whereby wind and water erode the surfaces of rocks and soils creating small particles. When these particles enter streams, they may flow with the current (suspended solids), or be deposited on the stream-bed. Typically, natural inputs of sediment to streams do not cause problems; however, when landscape is modified whereby soils become unstable, excessive amounts of sediment can enter streams and cause undesirable effects (Bryan and Rutherford 1995).

Agricultural practices such as row cropping involve the tilling of landscapes to make the soil porous and fertile, which consequently loosens soil directly, as well as indirectly by removing plants whose roots once held soil in place. During rainy events, loosened soil is directed toward nearby streams via surface runoff, and depending upon the density of vegetation along the streambank, sediment enters into the water. The soil of hay/pasture land is often more stable than that of cropland, yet sediment runoff is still an inherent problem. Grasses grown within hay/pasture land have water retention ability, and furthermore are sometimes overgrazed. In either case, little ability exists to impede the movement of surface water, especially when grasses are grazed to the edge of a streambank. The velocity of surface runoff is often high in these areas, and can erode and carry with it large quantities of sediment.

Eroded sediment can cause numerous problems for aquatic organisms. Suspended sediment causes turbidity, which can interfere with predation efficiency; cause respiration problems by clogging gills of

aquatic organisms (Horne and Goldman 1994); and also reduces sunlight penetration which affects plant photosynthesis (Waters 1995). Causing a higher magnitude of problems, deposited sediment can 1) suffocate eggs of fish and other organisms, 2) suffocate small organisms, 3) severely reduce habitat and habitat diversity, and 4) alter flow patterns (USEPA 1999). Therefore, our endpoint was the reduction in sediment required to render the watershed of Stonycreek River segment 5112 unimpaired.

## IV. TMDL Development Methods

### A. Reference Watershed Approach: Setting the Standard

Neither Pennsylvania nor EPA currently has in-stream water quality criteria for phosphorus (P) or sediment. Hence, in order to determine our targeted loads, we used what is termed the “Reference Watershed Approach.” (USEPA 1999b).

The first step of this approach is to find a non-impaired watershed that is similar to the impaired watershed in terms of land-use, soil associations, drainage area, precipitation, physiographic province, and geology. If both the impaired and reference watershed are closely matched, our model should indicate that both have similar phosphorus and sediment loads. However, by default the model does not account for in-stream nutrient and sediment reductions that may be occurring in the reference watershed in response to existing land management practices. Implementation of these practices is often the reason why the reference watershed is not impaired, whereas the similarly natured impaired watershed is. Ultimately, once land management practices are identified within the reference watershed, the model is adjusted accordingly to reflect the actual loadings. Once an appropriate reference is found, the objective becomes to reduce the loading rate of the impaired watershed to or slightly below that of the reference watershed.

### B. Watershed Assessment Approach and Modeling

#### 1. Reference Watershed Loading Rate

The ArcView® Generalized Watershed Loading Function (AVGWLF®) model version 5.0.2 (described in Appendix A) was used to acquire pertinent information about the watersheds. This model was used to generate the total areas as well as non-point phosphorus and sediment loads of the reference and impaired watersheds. Adjustments were made within the model to account for the land management practices observed to be occurring in the reference watershed, and its loading rate was then determined by dividing its P or sediment load by the total area of its watershed.

$$\text{Reference Watershed Loading Rate} = \text{Total P Load (lbs)} / \text{Total Area (Acres)} = \text{Lbs P / Acre}$$

## 2. Total Maximum Daily Load

This resulting value was then multiplied by the total area of the impaired watershed. This value constitutes the “total maximum daily load” (TMDL) that the impaired watershed should be able to uptake and still maintain water quality standards, as it is proportional to the load of the reference watershed relative to total area. However, it does not represent the total allowable load; two steps of precaution were employed: a “margin of safety” (MOS) reduction, and “loads not reduced” (LNR) reductions.

$$TMDL = Ref\ Watershed\ Loading\ Rate\ (lbs/acre) \times Total\ Area\ Impaired\ Watershed\ (acres)$$

## 3. Margin of Safety and Load Allocation

A “margin of safety” is a percent of the TMDL that will not be included in the total load that we will allocate among the various pollutant sources. This step is implemented to recognize and account for any uncertainty that may exist between the impairment and what we believe is causing it. Use of a 10% MOS is standard practice in most TMDL reports where water quality criteria are not explicitly defined for the targeted pollutant; this MOS level was used herein. When the MOS and WLA (wasteload allocation) are subtracted from the TMDL, the resulting value constitutes the load allocation (LA), which represents the total load that will be allocated to non-point sources of pollution. Conversely, the wasteload allocation represents the total load that will be allocated to point sources of pollution.

$$MOS\ (Margin\ of\ Safety) = 0.10 \times TMDL$$

$$LA\ (load\ allocation) = TMDL\ (total\ max\ daily\ load) - WLA - MOS\ (margin\ of\ safety)$$

$$thus,\ TMDL\ (total\ max\ daily\ load) = LA + WLA + MOS\ (margin\ of\ safety)$$

## 4. Adjusted Load Allocation and Loads Not Reduced

“Loads not reduced” (LNRs), are also precluded from the total allowable load. The loads of some pollution sources are uncontrollable; since we cannot control, i.e., reduce the sources’ load contributions, we must subtract them from the total load that we will allow other sources to emit. We also may preclude a load of a source because its contribution to the total load may be minute, and therefore implementing a land management practice to this source to achieve a load reduction would not be practical, or meaningful. If LNR reductions are implemented, the LA must be adjusted accordingly, consequently producing the ALA (adjusted load allocation). This value constitutes the total load that we will allow, and allocate among the various pollutant sources.

$$ALA\ (adjusted\ load\ allocation) = TMDL - MOS\ (margin\ of\ safety) - LNRs$$

## **5. Load Allocation Distribution and Required Reductions**

The adjusted load allocation (ALA) was allocated among the pollutant sources using the Equal Marginal Percent Reduction (EMPR) spreadsheet. The computations within this spreadsheet determine the percentage of the ALA that the load of each source constitutes (percent reduction allocation). Each source's load reduction is then produced by multiplying its percent reduction allocation by the ALA. The source's load reduction is then subtracted from its initial load, and its allocated load is produced. For more detail, see Appendix B.

### **C. Quality Assurance**

#### **1. Consideration of Critical Conditions**

The AVGWLF model is a continuous simulation model that uses daily time-steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads based upon the daily water balance accumulated to monthly values. Therefore, all flow conditions are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of sediment and nutrients to a water-body and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the water-body.

#### **2. Consideration of Seasonal Variations**

The continuous simulation model used for this analysis considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions by the model accounts for seasonal variability.

## V. TMDL Results

### A. Reference Watershed Selection

Using GIS imagery through ArcView®, we were able to find a closely matched reference watershed: Sandy Hollow, Somerset County (Figure 8). Pennsylvania's 303(d) list indicates that this stream is not impaired. Its watershed is adjacent to the watershed of Stonycreek River segment 5112. The boundaries of its watershed lie within Brothersvalley and Stonycreek Townships (USGS quadrangle – Berlin).

Its watershed is part of State Water Plan 18-E, and has a total drainage area of 4.8 mi<sup>2</sup>. The main branch (Stream Code – 45781) flows northeasterly for approximately 3 miles before coalescing with Glades Creek (Stream Code – 45777), which is a major tributary of the Stonycreek River. Sandy Hollow receives water from six first-order unnamed tributaries, and all together its watershed encompasses a total of 9.5 miles of stream.

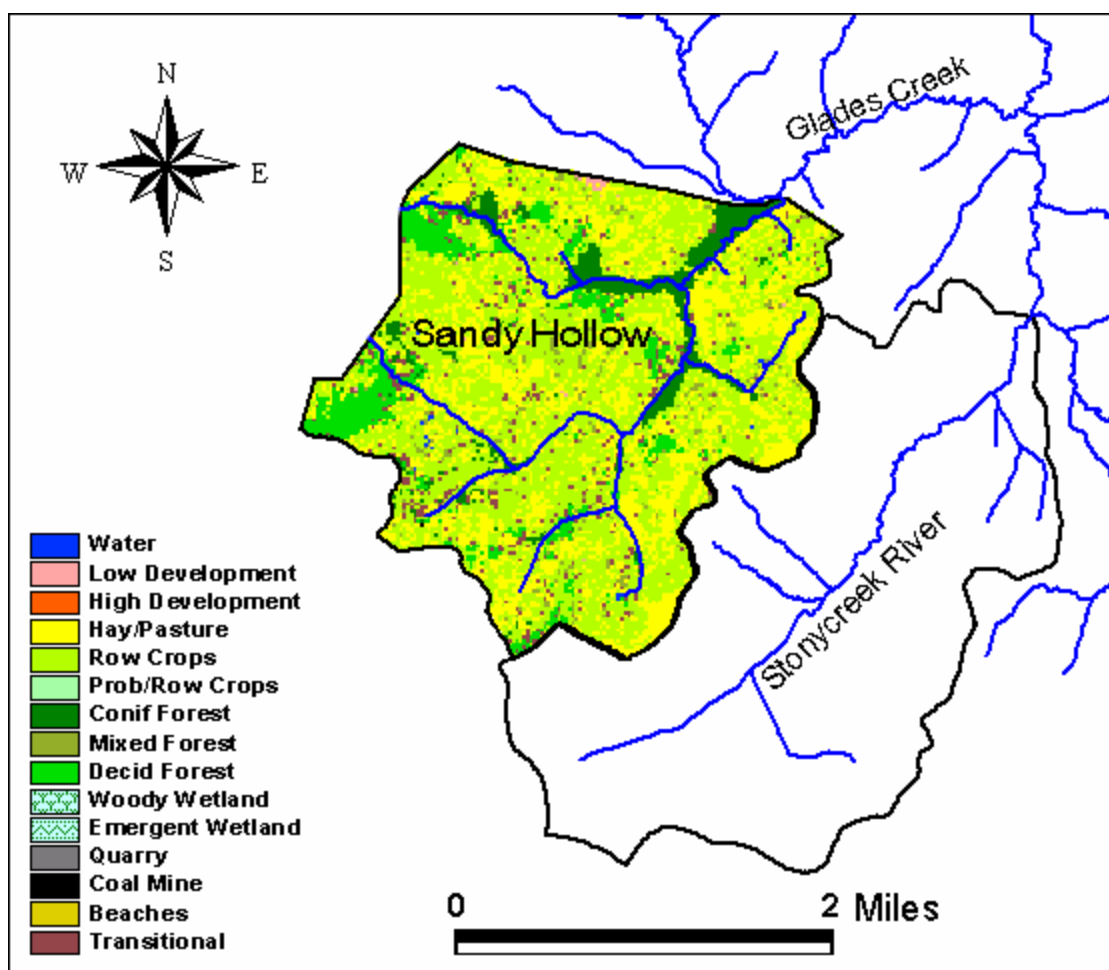


Figure 8. Location of the Sandy Hollow watershed (Somerset Co.) and illustration of land-uses.

Both GIS imagery through ArcView®, and a physical survey (April 2004) indicate that the watershed of Sandy Hollow is similar to that of Stonycreek River segment 5112. Table 2 illustrates the similarities between the watersheds. The watershed of segment 5112 is listed as being impaired by agriculture, and model computations (shown later) complement these findings by indicating that only agricultural land-uses are generating significant loads of sediment and phosphorus. Because of this, it was important to find a reference watershed in which agriculture comprised a majority of the land-use. Figure 8 illustrates the distribution of the land-uses within the watershed of Sandy Hollow. Also, because the watershed of segment 5112 lacks sloping terrain, it was important to find a similarly low gradient watershed. The elevation of both the impaired and reference watersheds is relatively uniform, and ranges from 699 to 701 meters above sea level.

Table 2. A comparison of the attributes used to deem Sandy Creek a suitable reference watershed to be used in the TMDL development of Stonycreek River segment 5112.

ATTRIBUTE	WATERSHED	
	<i>Stonycreek River SEGMENT ID 5112 State Water Plan – 18E Stream Code - 45084</i>	<i>Sandy Hollow  State Water Plan – 18E Stream Code - 45781</i>
Physiographic Province	Appalachian Plateau Province (Allegheny Mountain Section)	Appalachian Plateau Province (Allegheny Mountain Section)
Drainage Area (mi <sup>2</sup> )	5.0	4.8
Land-use Distribution	Agriculture – 83% Forested – 8% Development – 8%	Agriculture – 83% Forested – 12% Development – 5%
Geology	Interbedded Sedimentary (100%)	Interbedded Sedimentary (100%)
Soil Associations	Gilpin-Wharton-Ernest (100%)	Gilpin-Wharton-Ernest (100%)
Dominant Hydro Soil Group	C	C
23-Year Average Rainfall (in)	42.9	42.9
23-Year Average Runoff (in)	3.69	3.53

Although both the impaired and reference watersheds are similar, Sandy Hollow is encompassed by a forested strip that runs contiguous with the stream (Figure 9). This strip contains a dense formation of trees, but also consists of thick grasses that border the trees (Figure 10). This strip acts as a buffer zone, and appears to significantly impede the movement of runoff from adjacent agricultural land into the stream. Resultantly, although the loads of sediment and nutrients that are produced by both watersheds may be similar, the amount that enters Sandy Hollow is lesser. This is likely why Sandy Hollow has been found to not be impaired, whereas segment 5112 was found to be impaired.



Figure 9. Illustrating a forested strip that runs contiguous with Sandy Hollow.



Figure 10. Illustrating the surrounding forest and grasses that surround Sandy Hollow.

## B. Pollutant Loads and Reference Watershed Loading Rates

### 1. Pollutant Loads

Table 3. Pollutant loads of sources within watersheds of Stonycreek River segment 5112, and Sandy Hollow (Somerset County).

	Stonycreek River segment 5112			Sandy Hollow (Reference)		
Pollutant Source	Area (Acres)	Sediment (Tons/yr)	Total P (Pounds/yr)	Area (Acres)	Sediment (Tons/yr)	Total P (Pounds/yr)
Hay/Pasture	993.4	9.22	166.07	941.5	12.84	77.48
Cropland	1566.6	206.15	631.52	1462.9	88.23	304.49
Conif_forest	39.5	0.02	0.12	37.1	0.06	0.15
Mixed_forest	64.2	0.04	0.20	79.1	0.06	0.26
Decid_forest	153.2	0.10	0.49	242.2	0.52	1.07
Quarry	2.5	0.48	0.41	-	-	-
Coal Mine	-	-	-	2.5	0.48	0.40
Transitional	101.3	38.71	63.77	128.5	19.83	55.86
Low_Dev	121.1	1.30	0.05	4.9	0.03	0
High_Dev	24.7	0.19	0.02	-	-	-
Streambank	-	117.47	5.17	-	101.92	4.48
Groundwater	-	-	338.55	-	-	320.11
Point Source	-	0	0	-	-	0
Septic Sys	-	0	1.88	-	-	1.88
<b>TOTAL</b>	<b>3066.6</b>	<b>373.7</b>	<b>1208.26</b>	<b>2898.5</b>	<b>223.9</b>	<b>766.18</b>

### 2. Reference Watershed Loading Rates

*Reference Watershed Loading Rate = Total P Load (lbs) / Total Area (Acres) = Lbs P / Acre*

1. (Sediment) = 223.9 tons / 2898.5 Acres = 0.077 tons/acre

2. (Phosphorus) = 766.18 lbs / 2898.5 Acres = 0.264 lbs/acre

### C. Total Maximum Daily Loads

$TMDL = \text{Ref Watershed Loading Rate (lbs/acre)} \times \text{Total Area Impaired Watershed (acres)}$

1. (Sediment) =  $0.077 \text{ tons/acre/yr} \times 3066.6 \text{ Acres} = \underline{236.128 \text{ tons/yr}}$
2. (Phosphorus) =  $0.264 \text{ lbs/acre/yr} \times 3066.6 \text{ Acres} = \underline{809.582 \text{ lbs/yr}}$

### D. Margins of Safety

$MOS (\text{Margin of Safety}) = 0.10 \times TMDL$

1. (Sediment) =  $0.10 \times 236.128 \text{ tons/yr} = \underline{23.613 \text{ tons/yr}}$
2. (Phosphorus) =  $0.10 \times 809.582 \text{ lbs/yr} = \underline{80.958 \text{ lbs/yr}}$

### E. Load Allocations

$LA (\text{load allocation}) = TMDL (\text{total max daily load}) - WLA - MOS (\text{margin of safety})$

1. (Sediment) =  $236.128 \text{ tons/yr} - 0 \text{ tons/yr} - 23.613 \text{ tons/yr} = \underline{212.515 \text{ tons/yr}}$
2. (Phosphorus) =  $809.582 \text{ lbs/yr} - 0 \text{ lbs/yr} - 80.958 \text{ lbs/yr} = \underline{728.624 \text{ lbs/yr}}$

## F. Adjusted Load Allocations and Loads Not Reduced

Table 4. Loads of pollutant sources that will not be reduced (LNRs).

Loads Not Reduced (LNRs)	Sediment (Tons/yr)	Total P (Pounds/yr)
Conif_forest	0.02	0.12
Mixed_forest	0.04	0.20
Decid_forest	0.10	0.49
Quarry	0.48	0.41
Low Dev	1.3	0.05
High_Dev	0.19	0.02
Streambank	Reduced	5.17
Septic Systems	N/A	1.88
<b>TOTAL</b>	<b>2.13</b>	<b>8.34</b>

*ALA (adjusted load allocation) = TMDL – MOS (margin of safety) – LNRs*

$$1. \text{ (Sediment) } = 236.128 \text{ tons/yr} - 23.613 \text{ tons/yr} - 2.13 \text{ tons/yr} = \underline{210.385 \text{ tons/yr}}$$

$$2. \text{ (Phosphorus) } = 809.582 \text{ lbs/yr} - 80.958 \text{ lbs/yr} - 8.34 \text{ lbs/yr} = \underline{720.284 \text{ lbs/yr}}$$

## G. Load Allocation Distribution and Required Reductions

Table 5. Current and allowable loads and loading rates of SEDIMENT for pollutant sources.

Pollutant Source	Current Loading Rate (tons/yr)	Current Load (tons)	Allowable Loading Rate (tons/yr)	Allowable Load (tons)	Percent Load Reduction
Hay Pasture	0.01	9	0.01	5	43%
Cropland	0.13	206	0.07	117	43%
Transitional	0.38	39	0.22	22	43%
Streambank	0.04	117	0.02	67	43%
TOTAL	-	372	-	211	Average = 43%

Table 6. Current and allowable loads and loading rates of PHOSPHORUS for pollutant sources.

Pollutant Source	Current Loading Rate (lbs/yr)	Current Load (lbs)	Allowable Loading Rate (lbs/yr)	Allowable Load (lbs)	Percent Load Reduction
Hay Pasture	0.17	166	0.1	100	40%
Cropland	0.40	632	0.24	379	40%
Transitional	0.63	64	0.38	38	40%
Groundwater	0.11	339	0.07	204	40%
TOTAL	-	1201	-	74	Average = 40%

## **VI. Reasonable Assurance and Recommendations**

Required reductions of sediment and phosphorus loads for non-point pollutant sources in the watershed of Stonycreek River segment 5112 are shown in tables 5 and 6, respectively. If these reductions were attained, the loading level of sediment and phosphorus would become similar to that of the Sandy Hollow watershed, which is currently meeting its water quality standards. Reductions of pollutants from non-point sources can be attained by implementing Best Management Practices (BMPs). These land management practices are techniques that can be employed by land owners to either reduce the production of a pollutant, or prevent a pollutant from entering a water body. Each BMP is equipped to handle a unique type of pollutant; although, implementation of a single BMP can sometimes address multiple pollutant problems. Nevertheless, each has its own reduction efficiency, and the optimal BMP is a consideration of its efficiency as well as the feasibility of employing it. Information sheets describing the implementation procedures of BMPs that could be used in the restoration process of this watershed can be found in appendix H.

DEP will support local efforts to develop and implement watershed restoration plans based on the reduction goals specified in this TMDL. Interested parties should contact the appropriate Watershed Coordinator in the Department's Southwestern Regional Office (412-442-4149) for information regarding technical and financial assistance that is currently available. Individuals and/or local watershed groups interested in the reclamation of the watershed of Stonycreek River segment 5112 are strongly encouraged to exploit funding sources available through DEP and other state and federal agencies (e.g., Growing Greener or 319 Program).

## VII. Public Participation

## VIII. References

- USEPA (United States Environmental Protection Agency). 1992. TMDL case study: Sycamore Creek, Michigan. EPA841-F-92-012. U.S. Environmental Protection Agency, Office of Water, Assessment and Watershed Protection Division, Washington, DC
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- Waters, T.F. 1995. Sediment in streams: Sources, biological effects, and control. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, Maryland. 251 p.

## **XI. Appendices**

### **Appendix A. AVGWLF Model Overview & GIS-Based Derivation of Input Data.**

TMDLs for the watershed of Stonycreek River segment 5112 were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, sediment, and nutrient (N and P) loadings from watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values.

GWLF is a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios. Each area is assumed to be homogenous in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but aggregates the loads from each area into a watershed total. In other words, there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

GWLF models surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (e.g., land cover/soil type combination). The KLSCP factors are variables used in the calculations to depict changes in soil loss erosion (K), the length slope factor (LS) the vegetation cover factor (C) and conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacities based on average daily runoff are applied to the calculated erosion to determine sediment yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges can also contribute to dissolved losses to the stream and are specified in terms of kilograms per month. Manured areas, as well as septic systems, can also be considered. Urban nutrient inputs are all assumed to be solid-phase, and the model uses an exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P coefficients for shallow groundwater contributions to stream nutrient loads, and the sub-surface sub-model only considers a single, lumped-parameter contributing area. Evapotranspiration is determined using daily weather data and a cover factor dependent upon land use/cover type. Finally, a water balance is performed daily using supplied or computed precipitation, snowmelt, initial unsaturated zone storage, maximum available zone storage, and evapotranspiration values.

All of the equations used by the model can be viewed in GWLF Users Manuel, available from the Department's Bureau of Watershed Conservation, Division of Assessment and Standards.

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather (WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

The primary sources of data for this analysis were geographic information system (GIS) formatted databases. A specially designed interface was prepared by the Environmental Resources Research Institute of the Pennsylvania State University in ArcView (GIS software) to generate the data needed to run the GWLF model, which was developed by Cornell University. The new version of this model has been named AVGWLF (ArcView Version of the Generalized Watershed Loading Function).

In using this interface, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background N and P concentrations and cropping practices. Complete GWLF-formatted weather files are also included for eighty weather stations around the state. The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

<b>GIS Data Sets</b>	
<b>DATASET</b>	<b>DESCRIPTION</b>
<b>Censustr</b>	Coverage of Census data including information on individual homes septic systems. The attribute <i>usew_sept</i> includes data on conventional systems, and <i>sew_other</i> provides data on short-circuiting and other systems.
<b>County</b>	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
<b>Gwnback</b>	A grid of background concentrations of N in groundwater derived from water well sampling.
<b>Land-use5</b>	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
<b>Majored</b>	Coverage of major roads. Used for reconnaissance of a watershed.
<b>MCD</b>	Minor civil divisions (boroughs, townships and cities).
<b>Npdespts</b>	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
<b>Padem</b>	100-meter digital elevation model. This used to calculate landslope and slope length.
<b>Palumrlc</b>	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
<b>Pasingle</b>	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
<b>Physprov</b>	A shapefile of physiographic provinces. Attributes <i>rain_cool</i> and <i>rain_warm</i> are used to set recession coefficient
<b>Pointsrc</b>	Major point source discharges with permitted N and P loads.
<b>Refwater</b>	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
<b>Soilphos</b>	A grid of soil Phosphorus loads, which has been generated from soil sample data. Used to help set phosphorus and sediment values.
<b>Smallsheds</b>	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
<b>Statsgo</b>	A shapefile of generalized soil boundaries. The attribute <i>mu_k</i> sets the k factor in the USLE. The attribute <i>mu_awc</i> is the unsaturated available capacity., and the <i>mu_hsg_dom</i> is used with land-use cover to derive curve numbers.
<b>Strm305</b>	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
<b>Surfgeol</b>	A shapefile of the surface geology used to compare watersheds of similar qualities.
<b>T9sheds</b>	Data derived from a DEP study conducted at PSU with N and P loads.
<b>Zipcode</b>	A coverage of animal densities. Attribute <i>aeu_acre</i> helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
<b>Weather Files</b>	Historical weather files for stations around Pennsylvania to simulate flow.

## Appendix B. Equal Marginal Percent Reduction Method

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Load Allocations (ALAs) between the appropriate contributing non-point sources. The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix F. The 5 major steps identified in the spreadsheet are summarized below:

**Step 1:** Calculation of the TMDL based on impaired watershed size and unit area loading rate of reference watershed.

**Step 2:** Calculation of Adjusted Load Allocation based on TMDL, Margin of Safety, and existing loads not reduced.

**Step 3:** Actual EMPR Process.

- a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving water-body. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.
- b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

**Step 4:** Calculation of total loading rate of all sources receiving reductions.

**Step 5:** Summary of existing loads, final load allocations, and % reduction for each pollutant source.

### Appendix C. GWLF Output for Stonycreek River segment ID 5112.

#### GWLF Total Loads for Stonycreek\_River\_5112

Period of analysis: 21 years, from Apr 1975 to Mar 1996

Source	(Acres) Area	(in) Runoff	(Tons)		Total Loads (Pounds)			
			Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	993.4	2.36	50.94	9.22	1410.33	1465.65	158.36	166.07
CROPLAND	1566.6	4.37	1138.96	206.15	4116.30	5353.21	459.18	631.52
CONIF_FOR	39.5	1.97	0.11	0.02	3.36	3.48	0.11	0.12
MIXED_FOR	64.2	1.97	0.20	0.04	5.46	5.68	0.17	0.20
DECID_FOR	153.2	1.97	0.55	0.10	13.02	13.62	0.41	0.49
QUARRY	2.5	8.28	2.66	0.48	0.06	2.94	0.01	0.41
TRANSITION	101.3	6.84	213.88	38.71	455.40	687.67	31.41	63.77
LO_INT_DEV	121.1	4.77	7.18	1.30	0.00	0.40	0.00	0.05
HI_INT_DEV	24.7	12.66	1.05	0.19	0.00	0.20	0.00	0.02
<b>Stream Bank</b>				117.47		11.75		5.17
<b>Groundwater</b>					30593.13	30593.13	338.55	338.55
<b>Point Sources</b>					0.00	0.00	0.00	0.00
<b>Septic Syst.</b>					647.81	647.81	1.88	1.88
<b>Totals</b>	<b>3066.6</b>	<b>3.70</b>	<b>1415.5</b>	<b>373.7</b>	<b>37244.87</b>	<b>38785.55</b>	<b>990.07</b>	<b>1208.26</b>

### Appendix D. GWLF Output for Sandy Hollow Watershed.

#### GWLF Total Loads for **Sandy\_Hollow**

Period of analysis: 21 years, from Apr 1975 to Mar 1996

Source	(Acres) Area	(in) Runoff	(Tons)		Total Loads (Pounds)			
			Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	941.5	1.49	70.94	12.84	700.00	777.05	67.11	77.48
CROPLAND	1462.9	2.36	487.45	88.23	2076.90	2606.27	233.20	304.49
CONIF_FOR	37.1	1.97	0.36	0.06	3.15	3.54	0.10	0.15
MIXED_FOR	79.1	1.97	0.33	0.06	6.72	7.08	0.21	0.26
DECID_FOR	242.2	1.97	2.85	0.52	20.58	23.68	0.65	1.07
COAL_MINES	2.5	6.84	2.66	0.48	0.05	2.93	0.01	0.40
TRANSITION	128.5	6.84	109.57	19.83	577.59	696.58	39.83	55.86
LD_INT_DEV	4.9	4.77	0.15	0.03	0.00	0.00	0.00	0.00
<b>Stream Bank</b>				101.92		10.19		4.48
<b>Groundwater</b>					27215.95	27215.95	320.11	320.11
<b>Point Sources</b>					0.00	0.00	0.00	0.00
<b>Septic Syst.</b>					629.56	629.56	1.88	1.88
<b>Totals</b>	<b>2898.5</b>	<b>2.20</b>	<b>674.3</b>	<b>223.9</b>	<b>31230.50</b>	<b>31972.83</b>	<b>663.10</b>	<b>766.18</b>

## Appendix E. Equal Marginal Percent Reduction Calculations for Stonycreek River 5112 Watershed

### SEDIMENT

Step 1: TMDL Total Load  
Load = T loading rate in ref. \* Acres in Impaired  
**236**

Step 2: Adjusted LA = (TMDL total load - MOS) - uncontrollable  
**211      211**

Step 3:

Source	Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres
Hay/Past.	9.22	215.37	good	9	ADJUST	0.02	4	5	993
Cropland	206		good	206	161	0.55	89	117	1567
Transitional Land	39		good	39		0.10	17	22	101
Streambank	117		good	117		0.32	51	67	3067
				<b>372</b>		<b>1</b>		<b>211</b>	

Step 4: All Ag. Loading Rate **0.05**

Step 5:

	Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
Final Hay/Past. LA	993	0.01	5	0.01	9	43%
Final Cropland LA	1567	0.07	117	0.13	206	43%
Transitional Land	101	0.22	22	0.38	39	43%
Streambank	3067	0.02	67	0.04	117	43%
			<b>211</b>		<b>372</b>	

## Appendix F. Equal Marginal Percent Reduction Calculations for Stonycreek River 5112 Watershed

### PHOSPHORUS

Step 1: TMDL Total Load  
Load = TP loading rate in ref. \* Acres in Impaired  
**809**

Step 2: Adjusted LA = (TMDL total load - MOS) - uncontrollable  
**721**      **721**

Step 3:

	Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres
Hay/Past.	166	798	good	166	ADJUST	0.14	66	100	993
Cropland	632		good	632	480	0.53	253	379	1567
Transitional Land	64		good	64		0.05	26	38	101
Groundwater	339		good	339		0.28	135	204	3067
				1201		1		721	

Step 4: All Ag. Loading Rate      **0.19**

Step 5:

	Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
Final Hay/Past. LA	993	0.10	100	0.17	166	40%
Final Cropland LA	1567	0.24	379	0.40	632	40%
Transitional Land	101	0.38	38	0.63	64	40%
Groundwater	3067	0.07	204	0.11	339	40%
			721		1201	

## **Appendix G. TMDL Information Sheet for Stonycreek River segment 5112**

### ***What is being proposed?***

Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the watershed of Stonycreek River segment 5112.

### ***Who is proposing the plans? Why?***

The Pennsylvania Department of Environmental Protection (PADEP) is proposing to submit the plans to the U.S. Environmental Protection Agency (U.S. EPA) for review and approval as required by federal regulation. In 1995, U.S. EPA was sued for not developing TMDLs when Pennsylvania failed to do so. PADEP has entered into an agreement with U.S. EPA to develop TMDLs for certain specified waters over the next several years. These TMDLs have been developed in compliance with the state/U.S. EPA agreement.

### ***What is a TMDL?***

A TMDL sets a ceiling on the pollutant loads that can enter a water-body so that it will meet water quality standards. The Clean Water Act requires states to list all waters that do not meet their water quality standards even after pollution controls required by law are in place. For these waters, the state must calculate how much of a substance can be put in the water without violating the standard, and then distribute that quantity to all sources of the pollutant on that water body. A TMDL plan includes waste load allocations for point sources, load allocations for non-point sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to U.S. EPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that U.S. EPA must do so.

### ***What is a water quality standard?***

The Clean Water Act sets a national minimum goal that all waters are to be “fishable” and “swimmable.” To support this goal, states must adopt water quality standards. Water quality standards are state regulations that have two components. The first component is a designated use, such as “warm water fishes” or “recreation.” States must assign a “use” or several uses to each of their waters. The second component relates to the in-stream conditions necessary to protect the designated use(s). These conditions or “criteria” are physical, chemical, or biological characteristics such as temperature and minimum levels of dissolved oxygen, and maximum concentrations of toxic pollutants. It is the combination of the “designated use” and the “criteria” to support that use that make up a water quality standard. If any criteria are being exceeded, then the use is not being met and the water is said to be in violation of water quality standards.

### ***What is the purpose of the plans?***

Stonycreek River segment 5112 is impaired by excess sediment and nutrients. These TMDL plans include a calculation of sediment and nutrient loadings that will meet water quality objectives.

### ***Why was this watershed selected for TMDL development?***

In 1996, PADEP listed Stonycreek River segment 5112 under Section 303(d) of the federal Clean Water Act as impaired due to excess nutrients and sediment.

***What pollutants do these TMDLs address?*** The proposed plans provide calculations of the stream’s total capacity to accept sediment and phosphorus. Based on an evaluation of concentrations of nutrients in

the watershed of Stonycreek River segment 5112, phosphorus is the cause of nutrient impairment to the stream. Sediment loading is being used to address suspended solid impairments.

***Where do the pollutants come from?***

The sediment and nutrient related impairments in the watershed of Stonycreek River segment 5112 come from non-point sources (NPS) of pollution, primarily overland runoff from areas of agriculture and stream-bank erosion.

***How was the TMDL developed?***

PADEP used a reference watershed approach to estimate the necessary loading reduction of sediment and phosphorus that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a non-impaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's ArcView based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the non-impaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading rates of the non-impaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvanian nor U.S. EPA has water quality criteria for sediment or phosphorus.

***How much pollution is too much?***

The allowable amount of pollution in a water body varies depending on several conditions. TMDLs are set to meet water quality standards at the critical flow condition. For a free flowing stream impacted by non-point source pollution loading of sediment and nutrients, the TMDL is expressed as an annual loading. This accounts for pollution contributions over all stream flow conditions. PADEP established the water quality objectives for sediment and phosphorus by using the reference watershed approach. This approach assumes that the impairment is eliminated when the impaired watershed achieves loadings similar to the reference watershed. Reducing the current loading rates for sediment and phosphorus in the impaired watershed to the current loading rates in the reference watershed will result in meeting the water quality objectives.

***How will the loading limits be met?***

Best Management Practices (BMPs) will be encouraged throughout the watershed to achieve the necessary load reductions.

***How can I get more information on the TMDL?***

To request a copy of the full report, contact Joseph Boylan at 412-442-4049 during the business hours of 8:00 a.m. to 4:00 p.m., Monday through Friday. One may also contact Mr. Boylan by e-mail at [joboylan@state.pa.us](mailto:joboylan@state.pa.us), or mail at: Pennsylvania Department of Environmental Protection; Water Management Program; Southwest Regional Office; 400 Waterfront Drive; Pittsburgh, PA 15222-4745

***How can I comment on the proposal?*** You may provide e-mail or written comments postmarked no later than **XX, XX, XX** to the above address.

## **Appendix H. Best Management Practices (BMPs) Information Sheets.**

### **1. Field Border**

#### **DEFINITION**

A strip of permanent vegetation established at the edge or around the perimeter of a field.

#### **PURPOSES**

- Reduce erosion from wind and water
- Soil and water quality protection
- Management of harmful insect populations
- Provide wildlife food and cover

#### **CONDITIONS WHERE PRACTICE APPLIES**

At the edges of cropland fields and to connect other buffer practices within the field. May also apply to recreation land or other land uses where agronomic crops are grown.

#### **CRITERIA**

##### **General Criteria Applicable To All Purposes**

Minimum field border widths shall be based on local design criteria specific to the purpose or purposes for installing the practice.

The field borders will be established to adapted species of permanent grass, legumes, and/or shrubs.

Field borders will be established around the field edges to the extent needed to meet the resource needs and producer objectives.

Plant material, seedbed preparation, seeding rates, dates, depths, and planting methods will be consistent with approved local criteria.

Ephemeral gullies and rills present in the planned border area will be smoothed as part of seedbed preparation.

##### **Additional Criteria To Reduce Erosion From Wind And Water**

###### Wind Erosion Reduction

Locate borders around the entire perimeter of the field, or as a minimum, provide a stable area on the upwind edge of the field as determined by prevailing wind direction data.

Plant stiff-stemmed, upright grasses to trap saltating soil particles.

Minimum height of grass shall be one foot during the critical erosion period.

### Water Erosion Reduction

Locate borders around entire perimeter of the field, or as a minimum, install borders to eliminate sloping end rows, headlands, and other areas where concentrated water flows will enter or exit the field.

### **Additional Criteria To Protect Soil And Water Quality**

#### Reducing Runoff and Increasing Infiltration

Locate borders around entire perimeter of the field, or as a minimum, install borders to eliminate sloping end rows, headlands and other areas where concentrated water flows will enter or exit the field.

#### Maintaining Field Setback Distances For Manure and Chemical Applications

Border widths will be designed to conform to minimum field application setback widths established by state or local regulations.

#### Sediment Trapping

Locate borders around the entire perimeter of the field, or as a minimum, in areas where runoff enters or leaves the field.

#### Reducing Soil Compaction from Equipment Parking and Traffic

Border widths will be designed to accommodate equipment parking, loading/unloading equipment, grain harvest operations, etc.

### **Additional Criteria For Management Of Harmful Insect Populations.**

#### Provide a Harbor For Beneficial Insects

Include herbaceous plants that attract beneficial insects. See planning considerations for including shrubs.

Mowing, harvesting, and pesticide applications will be scheduled to accommodate life cycle requirements of the beneficial insects.

or

#### Provide a Habitat to Cause Pest Insects to Congregate

Select plants for the field border that attract pest insects.

Use mechanical, cultural, and/or chemical techniques to reduce pest populations when and where they congregate in the field border.

### **Additional Criteria To Provide Wildlife Food And Cover**

Plants that provide wildlife food and cover shall be used.

Mowing, harvest, and weed control activities within the field border will be scheduled to accommodate reproduction and other requirements of target wildlife species.

## **PLANNING CONSIDERATIONS**

Field borders are more effective and provide more environmental benefits when planted around the entire field.

Field borders enhance the aesthetics and provide stability around the field edge. They also provide turn and travel areas for equipment and reduce airborne dust

To increase trapping efficiency, consider establishing a narrow strip of stiff-stemmed upright grass at the crop/field border interface.

Field borders can be used to comply with required field setback distances applicable to manure and chemical applications.

Wildlife enhancement and other benefits of native plants should be discussed during planning.

Native species should be used when feasible and meet producer objectives.

Consider overseeding the border with legumes for plant diversity and wildlife benefits.

Schedule mowing, harvesting, and weed control to accommodate wildlife nesting needs and other special requirements or purposes.

Waterbars or berms may be needed to breakup or redirect concentrated water flows within the borders.

If bank stabilization is a concern, select fibrous deep-rooted plants.

Consider plants tolerant to sediment deposition and chemicals planned for application.

Rows of shrubs (windbreak/shelterbelt, 380) adjacent to field borders will often enhance field borders ability to harbor beneficial insects, and may also provide additional wildlife benefits.

If installation or maintenance of the practice has potential of affecting cultural resources (Archaeological, historic, historic landscape, or traditional cultural properties), follow NRCS state policy for considering cultural resources.

## **PLANS AND SPECIFICATIONS**

Plans and specifications are to be prepared for the practice site. The following items should be specified. A job sheet is available to document these items:

- Border widths and lengths based on local design criteria
- Location within the field or farm boundary
- Vegetation to be used
- Site preparation
- Planting method
- Liming or fertilizer requirements
- Operation and maintenance requirements

## **OPERATION AND MAINTENANCE**

Field borders require careful management and maintenance for performance and longevity.

The following will be planned and applied as needed:

- Storm damage repair
- Sediment removal - when 6 inches of sediment have accumulated at the field border/cropland interface
- Shut off sprayers and raise tillage equipment to avoid damage to field borders
- Shape and reseeded border areas damaged by chemicals, tillage or equipment traffic
- Fertilize, mow, harvest, and control noxious weeds to maintain plant vigor
- Ephemeral gullies and rills that develop in the border will be filled and reseeded.

## **2. Nutrient Management**

### **DEFINITION**

Managing the amount, source, placement, form and timing of the application of nutrients and soil amendments.

### **PURPOSES**

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To maintain or improve the physical, chemical and biological condition of soil.

### **CONDITIONS WHERE PRACTICE APPLIES**

This practice applies to all lands where plant nutrients and soil amendments are applied.

### **CRITERIA**

#### **General Criteria Applicable to All Purposes**

Plans for nutrient management shall comply with all applicable Federal, state, and local laws and regulations.

Plans for nutrient management shall be developed in accordance with policy requirements of the NRCS General Manual Title 450, Part 401.03 (Technical Guides, Policy and Responsibilities) and Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy); technical requirements of the NRCS Field Office Technical Guide (FOTG); procedures contained in the National Planning Procedures Handbook (NPPH), and the NRCS National Agronomy Manual (NAM) Section 503.

Persons who review or approve plans for nutrient management shall be certified through any certification program acceptable to NRCS within the state.

Plans for nutrient management that are elements of a more comprehensive conservation plan shall recognize other requirements of the conservation plan and be compatible with its other requirements.

A nutrient budget for nitrogen, phosphorus, and potassium shall be developed that considers all potential sources of nutrients including, but not limited to animal manure and organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water.

Realistic yield goals shall be established based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soil, cropping systems, and soil and manure/organic by-products tests. For new crops or varieties, industry yield recommendations may be used until documented yield information is available.

Plans for nutrient management shall specify the form, source, amount, timing and method of application of nutrients on each field to achieve realistic production goals, while minimizing nitrogen and/or phosphorus movement to surface and/or ground waters.

Erosion, runoff, and water management controls shall be installed, as needed, on fields that receive nutrients.

### **Soil Sampling and Laboratory Analysis (Testing)**

Nutrient planning shall be based on current soil test results developed in accordance with Land Grant University guidance or industry practice if recognized by the Land Grant University. Current soil tests are those that are no older than five years.

Soil samples shall be collected and prepared according to the Land Grant University guidance or standard industry practice. Soil test analyses shall be performed by laboratories that are accepted in one or more of the following programs:

- State Certified Programs,
- The North American Proficiency Testing Program (Soil Science Society of America), or
- Laboratories whose tests are accepted by the Land Grant University in the state in which the tests will be used.

Soil testing shall include analysis for any nutrients for which specific information is needed to develop the nutrient plan. Request analyses pertinent to monitoring or amending the annual nutrient budget, e.g. pH, electrical conductivity (EC), soil organic matter, nitrogen, phosphorus, and potassium.

### **Plant Tissue Testing**

Tissue sampling and testing, where used, shall be done in accordance with Land Grant University standards or recommendations.

### **Nutrient Application Rates**

Soil amendments shall be applied, as needed, to adjust soil pH to the specific range of the crop for optimum availability and utilization of nutrients.

Recommended nutrient application rates shall be based on Land Grant University recommendations (and/or industry practice when recognized by the university) that consider current soil test results, realistic yield goals and management capabilities. If the Land Grant University does not provide specific recommendations, application shall be based on realistic yield goals and associated plant nutrient uptake rates.

The planned rates of nutrient application, as documented in the nutrient budget, shall be determined based on the following guidance:

- **Nitrogen Application** - Planned nitrogen application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- **Phosphorus Application** - Planned phosphorus application rates shall match the recommended rates as closely as possible, except when manure or other organic by-products are a source of nutrients. When manure or other organic by-products are a source of nutrients, see "Additional Criteria" below.
- **Potassium Application** - Excess potassium shall not be applied in situations in which it causes unacceptable nutrient imbalances in crops or forages. When forage quality is an issue associated with excess potassium application, state standards shall be used to set forage quality guidelines.
- **Other Plant Nutrients** - The planned rates of application of other nutrients shall be consistent with Land Grant University guidance or industry practice if recognized by the Land Grant University in the state.
- **Starter Fertilizers** - Starter fertilizers containing nitrogen, phosphorus and potassium may be applied in accordance with Land Grant University recommendations, or industry practice if recognized by the Land Grant University within the state. When starter fertilizers are used, they shall be included in the nutrient budget.

#### **Nutrient Application Timing**

Timing and method of nutrient application shall correspond as closely as possible with plant nutrient uptake characteristics, while considering cropping system limitations, weather and climatic conditions, and field accessibility.

#### **Nutrient Application Methods**

Nutrients shall not be applied to frozen, snow-covered, or saturated soil if the potential risk for runoff exists.

Nutrient applications associated with irrigation systems shall be applied in accordance with the requirements of Irrigation Water Management (Code 449).

#### **Additional Criteria Applicable to Manure or Organic By-Products Applied as a Plant Nutrient Source**

Nutrient values of manure and organic by-products (excluding sewage sludge) shall be determined prior to land application based on laboratory analysis, acceptable "book values" recognized by the NRCS and/or the Land Grant University, or historic records for the operation, if they accurately estimate the nutrient content of the material. Book values recognized by NRCS may be found in the Agricultural Waste Management Field Handbook, Chapter 4 - Agricultural Waste Characteristics.

#### **Nutrient Application Rates**

The application rate (in/hr) for material applied through irrigation shall not exceed the soil intake/infiltration rate. The total application shall not exceed the field capacity of the soil.

The planned rates of nitrogen and phosphorus application recorded in the plan shall be determined based on the following guidance:

- **Nitrogen Application** - When the plan is being implemented on a phosphorus standard, manure or other organic by-products shall be applied at rates consistent with the phosphorus standard. In

such situations, an additional nitrogen application, from non-organic sources, may be required to supply the recommended amounts of nitrogen.

Manure or other organic by-products may be applied on legumes at rates equal to the estimated removal of nitrogen in harvested plant biomass.

- **Phosphorus Application** - When manure or other organic by-products are used, the planned rates of phosphorus application shall be consistent with any one of the following options:
  - **Phosphorus Index (PI) Rating.** Nitrogen based manure application on Low or Medium Risk Sites, phosphorus based or no manure application on High and Very High Risk Sites.\*\*
  - **Soil Phosphorus Threshold Values.** Nitrogen based manure application on sites on which the soil test phosphorus levels are below the threshold values. Phosphorus based or no manure application on sites on which soil phosphorus levels equal or exceed threshold values.\*\*
  - **Soil Test.** Nitrogen based manure application on sites on which there is a soil test recommendation to apply phosphorus. Phosphorus based or no manure application on sites on which there is no soil test recommendation to apply phosphorus.\*\*

\*\* Acceptable phosphorus based manure application rates shall be determined as a function of soil test recommendation or estimated phosphorus removal in harvested plant biomass. Guidance for developing these acceptable rates is found in the NRCS General Manual, Title 190, Part 402 (Ecological Sciences, Nutrient Management, Policy), and the National Agronomy Manual, Section 503.

A single application of phosphorus applied as manure may be made at a rate equal to the recommended phosphorus application or estimated phosphorus removal in harvested plant biomass for the crop rotation or multiple years in the crop sequence.

When such applications are made, the application rate shall:

- not exceed the recommended nitrogen application rate during the year of application, or
- not exceed the estimated nitrogen removal in harvested plant biomass during the year of application when there is no recommended nitrogen application.
- not be made on sites considered vulnerable to off-site phosphorus transport unless appropriate conservation practices, best management practices, or management activities are used to reduce the vulnerability.

### Field Risk Assessment

When animal manures or other organic by-products are applied, a field-specific assessment of the potential for phosphorus transport from the field shall be completed. This assessment may be done using the Phosphorus Index or other recognized assessment tool. In such cases, plans shall include:

- a record of the assessment rating for each field or sub-field, and
- information about conservation practices and management activities that can reduce the potential for phosphorus movement from the site.

When such assessments are done, the results of the assessment and recommendations shall be discussed with the producer during the development of the plan.

## Heavy Metals Monitoring

When sewage sludge is applied, the accumulation of potential pollutants (including arsenic, cadmium, copper, lead, mercury, selenium, and zinc) in the soil shall be monitored in accordance with the US Code, Reference 40 CFR, Parts 403 and 503, and/or any applicable state and local laws or regulations.

### **Additional Criteria to Minimize Agricultural Non-point Source Pollution of Surface and Ground Water Resources**

In areas with an identified or designated nutrient-related water quality impairment, an assessment shall be completed of the potential for nitrogen and/or phosphorus transport from the field. The Leaching Index (LI) and/or Phosphorus Index (PI), or other recognized assessment tools, may be used to make these assessments. The results of these assessments and recommendations shall be discussed with the producer and included in the plan.

Plans developed to minimize agricultural nonpoint source pollution of surface or ground water resources shall include practices and/or management activities that can reduce the risk of nitrogen or phosphorus movement from the field.

### **Additional Criteria to Improve the Physical, Chemical, and Biological Condition of the Soil.**

Nutrients shall be applied in such a manner as not to degrade the soil's structure, chemical properties, or biological condition. Use of nutrient sources with high salt content will be minimized unless provisions are used to leach salts below the crop root zone.

Nutrients shall not be applied to flooded or saturated soils when the potential for soil compaction and creation of ruts is high.

## CONSIDERATIONS

Consider induced deficiencies of nutrients due to excessive levels of other nutrients.

Consider additional practices such as Conservation Cover (327), Grassed Waterway (412), Contour Buffer Strips (332), Filter Strips (393), Irrigation Water Management (449), Riparian Forest Buffer (391A), Conservation Crop Rotation (328), Cover and Green Manure (340), and Residue Management (329A, 329B, or 329C, and 344) to improve soil nutrient and water storage, infiltration, aeration, tilth, diversity of soil organisms and to protect or improve water quality.

Consider cover crops whenever possible to utilize and recycle residual nitrogen.

Consider application methods and timing that reduce the risk of nutrients being transported to ground and surface waters, or into the atmosphere. Suggestions include:

- split applications of nitrogen to provide nutrients at the times of maximum crop utilization,
- avoiding winter nutrient application for spring seeded crops,
- band applications of phosphorus near the seed row,
- applying nutrient materials uniformly to application areas or as prescribed by precision agricultural techniques, and/or
- immediate incorporation of land applied manures or organic by-products,
- delaying field application of animal manures or other organic by-products if precipitation capable of producing runoff and erosion is forecast within 24 hours of the time of the planned application.

Consider minimum application setback distances from environmentally sensitive areas, such as sinkholes, wells, gullies, ditches, surface inlets or rapidly permeable soil areas.

Consider the potential problems from odors associated with the land application of animal manures, especially when applied near or upwind of residences.

Consider nitrogen volatilization losses associated with the land application of animal manures. Volatilization losses can become significant, if manure is not immediately incorporated into the soil after application.

Consider the potential to affect National Register listed or eligible cultural resources.

Consider using soil test information no older than one year when developing new plans, particularly if animal manures are to be a nutrient source.

Consider annual reviews to determine if changes in the nutrient budget are desirable (or needed) for the next planned crop.

On sites on which there are special environmental concerns, consider other sampling techniques. (For example: Soil profile sampling for nitrogen, Pre-Sidedress Nitrogen Test (PSNT), Pre-Plant Soil Nitrate Test (PPSN) or soil surface sampling for phosphorus accumulation or pH changes.)

Consider ways to modify the chemistry of animal manure, including modification of the animal's diet to reduce the manure nutrient content, to enhance the producer's ability to manage manure effectively.

## **PLANS AND SPECIFICATIONS**

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose(s), using nutrients to achieve production goals and to prevent or minimize water quality impairment.

The following components shall be included in the nutrient management plan:

- aerial photograph or map and a soil map of the site,
- current and/or planned plant production sequence or crop rotation,
- results of soil, plant, water, manure or organic by-product sample analyses,
- realistic yield goals for the crops in the rotation,
- quantification of all nutrient sources,
- recommended nutrient rates, timing, form, and method of application and incorporation,
- location of designated sensitive areas or resources and the associated, nutrient management restriction,
- guidance for implementation, operation, maintenance, recordkeeping, and
- complete nutrient budget for nitrogen, phosphorus, and potassium for the rotation or crop sequence.
- If increases in soil phosphorus levels are expected, plans shall document:
  - the soil phosphorus levels at which it may be desirable to convert to phosphorus based implementation,
  - the relationship between soil phosphorus levels and potential for phosphorus transport from the field, and
  - the potential for soil phosphorus drawdown from the production and harvesting of crops.

When applicable, plans shall include other practices or management activities as determined by specific regulation, program requirements, or producer goals.

In addition to the requirements described above, plans for nutrient management shall also include:

- discussion about the relationship between nitrogen and phosphorus transport and water quality impairment. The discussion about nitrogen should include information about nitrogen leaching into shallow ground water and potential health impacts. The discussion about phosphorus should include information about phosphorus accumulation in the soil, the increased potential for phosphorus transport in soluble form, and the types of water quality impairment that could result from phosphorus movement into surface water bodies.
- discussion about how the plan is intended to prevent the nutrients (nitrogen and phosphorus) supplied for production purposes from contributing to water quality impairment.
- a statement that the plan was developed based on the requirements of the current standard and any applicable Federal, state, or local regulations or policies; and that changes in any of these requirements may necessitate a revision of the plan.

## **OPERATION AND MAINTENANCE**

The owner/client is responsible for safe operation and maintenance of this practice including all equipment. Operation and maintenance addresses the following:

- periodic plan review to determine if adjustments or modifications to the plan are needed. As a minimum, plans will be reviewed and revised with each soil test cycle.
- protection of fertilizer and organic by-product storage facilities from weather and accidental leakage or spillage.
- calibration of application equipment to ensure uniform distribution of material at planned rates.
- documentation of the actual rate at which nutrients were applied. When the actual rates used differ from or exceed the recommended and planned rates, records will indicate the reasons for the differences.
- Maintaining records to document plan implementation. As applicable, records include:
  - soil test results and recommendations for nutrient application,
  - quantities, analyses and sources of nutrients applied,
  - dates and method of nutrient applications,
  - crops planted, planting and harvest dates, yields, and crop residues removed,
  - results of water, plant, and organic by-product analyses, and
  - dates of review and person performing the review, and recommendations that resulted from the review.

Records should be maintained for five years; or for a period longer than five years if required by other Federal, state, or local ordinances, or program or contract requirements.

Workers should be protected from and avoid unnecessary contact with chemical fertilizers and organic by-products. Protection should include the use of protective clothing when working with plant nutrients. Extra caution must be taken when handling ammonia sources of nutrients, or when dealing with organic wastes stored in unventilated enclosures.

The disposal of material generated by the cleaning nutrient application equipment should be accomplished properly. Excess material should be collected and stored or field applied in an appropriate manner. Excess material should not be applied on areas of high potential risk for runoff and leaching.

The disposal or recycling of nutrient containers should be done according to state and local guidelines or regulations.

### 3. Streambank and Shoreline Protection

#### DEFINITION

Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries.

#### PURPOSE

- To prevent the loss of land or damage to land uses, or other facilities adjacent to the banks, including the protection of known historical, archeological, and traditional cultural properties.
- To maintain the flow or storage capacity of the water body or to reduce the offsite or downstream effects of sediment resulting from bank erosion.
- To improve or enhance the stream corridor for fish and wildlife habitat, aesthetics, recreation.

#### CONDITIONS WHERE PRACTICE APPLIES

This practice applies to streambanks of natural or constructed channels and shorelines of lakes, reservoirs, or estuaries where they are susceptible to erosion. It applies to controlling erosion where the problem can be solved with relatively simple structural measures, vegetation, or upland erosion control practices. It does not apply to erosion problems on main oceanfronts and similar areas of complexity not normally within the scope of NRCS authority or expertise.

#### CRITERIA

##### General Criteria Applicable to All Purposes

Measures must be installed according to a site-specific plan and in accordance with all applicable local, state, and federal laws and regulations.

Protective measures to be applied shall be compatible with improvements planned or being carried out by others.

Protective measures shall be compatible with the bank or shoreline materials, water chemistry, channel or lake hydraulics, and slope characteristics both above and below the water line.

End sections shall be adequately bonded to existing measures, terminate in stable areas, or be otherwise stabilized.

Protective measures shall be installed on stable slopes. Bank or shoreline materials and type of measure installed shall determine maximum slopes.

Designs will provide for protection from upslope runoff.

Internal drainage for bank seepage shall be provided when needed. Geotextiles or properly designed filter bedding shall be used on structural measures where there is the potential for migration of material from behind the measure.

Measures applied shall not adversely affect threatened and endangered species nor species of special concern as defined by the appropriate state and federal agencies.

Measures shall be designed for anticipated ice action and fluctuating water levels.

All disturbed areas around protective measures shall be protected from erosion. Disturbed areas that are not to be cultivated shall be protected as soon as practical after construction.11.

Vegetation shall be selected that is best suited for the soil/moisture regime.

#### **Additional Criteria for Streambanks**

The channel grade shall be stable based on a field assessment before any permanent type of bank protection can be considered feasible, unless the protection can be constructed to a depth below the anticipated lowest depth of streambed scour.

A protective toe shall be provided based on an evaluation of stream bed and bank stability.

Channel clearing to remove stumps, fallen trees, debris, and bars shall only be done when they are causing or could cause detrimental bank erosion or structural failure. Habitat forming elements that provide cover, food, and pools, and water turbulence shall be retained or replaced to the extent possible.

Changes in channel alignment shall not be made unless the changes are based on an evaluation that includes an assessment of both upstream and downstream fluvial geomorphology. The current and future discharge-sediment regime shall be based on an assessment of the watershed above the proposed channel alignment.

Measures shall be functional for the design flow and sustainable for higher flow conditions based on acceptable risk.

Measures shall be designed to avoid an increase in natural erosion downstream.

Measures planned shall not limit stream flow access to the floodplain.

Stream segments to be protected shall be classified according to a system deemed appropriate by the state. Segments that are incised or contain the 5-year return period (20 percent probability) or greater flows shall be evaluated for further degradation or aggradation.

When water surface elevations are a concern, the effects of protective measures shall not increase flow levels above those that existed prior to installation.

#### **Additional Criteria for Shorelines**

All revetments, bulkheads, or groins are to be no higher than 3 feet (1 meter) above mean high tide, or mean high water in non-tidal areas

Structural shoreline protective measures shall be keyed to a depth to prevent scour during low water.

For the design of structural measures, the site characteristics below the waterline shall be evaluated for a minimum of 50 ft (15 meters) horizontal distance from the shoreline measured at the design water surface.

The height of the protection shall be based on the design water surface plus the computed wave height and freeboard. The design water surface in tidal areas shall be mean high tide.

When vegetation is selected as the protective treatment, a temporary breakwater shall be used during establishment when wave run up would damage the vegetation.

### **Additional Criteria for Stream Corridor Improvement**

Stream corridor vegetative components shall be established as necessary for ecosystem functioning and stability. The appropriate composition of vegetative components is a key element in preventing excess long-term channel migration in re-established stream corridors.

Measures shall be designed to achieve any habitat and population objectives for fish and wildlife species or communities of concern as determined by a site-specific assessment or management plan. Objectives are based on the survival and reproductive needs of populations and communities, which include habitat diversity, habitat linkages, daily and seasonal habitat ranges, limiting factors and native plant communities. The type, amount, and distribution of vegetation shall be based on the requirements of the fish and wildlife species or communities of concern to the extent possible.

Measures shall be designed to meet any aesthetic objectives as determined by a site-specific assessment or management plan. Aesthetic objectives are based on human needs, including visual quality, noise control, and microclimate control. Construction materials, grading practices, and other site development elements shall be selected and designed to be compatible with adjacent land uses.

Measures shall be designed to achieve any recreation objectives as determined by a site-specific assessment or management plan. Recreation objectives are based on type of human use and safety requirements.

### **CONSIDERATIONS**

An assessment of streambank or shoreline protection needs should be made in sufficient detail to identify the causes contributing to the instability (e.g. watershed alterations resulting in significant modifications of discharge or sediment production). Due to the complexity of such an assessment an interdisciplinary team should be utilized.

When designing protective measures, consider the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider utilizing debris removed from the channel or streambank into the treatment design.

Use construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, climate controls, buffers, etc. Avoid excessive disturbance and compaction of the site during installation.

Utilize vegetative species that are native and/or compatible with local ecosystems. Avoid introduced or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests. Species on noxious plant lists should not be used.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within state and local regulations.

Measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered.

Consider maintaining or improving the habitat value for fish and wildlife, including lowering or moderating water temperature, and improving water quality.

Consideration should be given to protecting side channel inlets and outlets from erosion.

Toe rock should be large enough to provide a stable base and graded to provide aquatic habitat.

Consider maximizing adjacent wetland functions and values with the project design and minimize adverse effects to existing wetland functions and values.

When appropriate, establish a buffer strip and/or diversion at the top of the bank or shoreline protection zone to help maintain and protect installed measures, improve their function, filter out sediments, nutrients, and pollutants from runoff, and provide additional wildlife habitat.

Consider conservation and stabilization of archeological, historic, structural and traditional cultural properties when applicable.

Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank.

Protective measures should be self-sustaining or require minimum maintenance.

## **PLANS AND SPECIFICATIONS**

Plans and specifications for streambank and shoreline protection shall be prepared for specific field sites and based on this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

## **OPERATION AND MAINTENANCE**

An operation and maintenance plan shall be prepared for use by the owner or others responsible for operating and maintaining the system. The plan shall provide specific instructions for operating and maintaining the system to insure that it functions properly. It shall also provide for periodic inspections and prompt repair or replacement of damaged components or erosion.



