South Branch Middle Creek TMDL

Snyder and Mifflin Counties, Pennsylvania

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TABLE OF CONTENTS

Executive Summary

A Total Maximum Daily Load (TMDL) for sediment was developed for the South Branch Middle Creek Watershed (Figure 1) to address the siltation impairments noted in the 2016 Final Pennsylvania Integrated Water Quality Monitoring and Assessment Report (Integrated Report), including the Clean Water Act Section 303(d) List. Agriculture has been identified as the cause of these impairments. Because Pennsylvania does not have numeric water quality criteria for sediment, the loading rate from a similar unimpaired watershed was used to calculate the TMDL.

Existing sediment loading in the South Branch Middle Creek Watershed is estimated to be 2,926,047 pounds per year or 8,017 pounds per day. To meet water quality objectives, sediment loading should be reduced by 18% to 2,400,681 pounds per year or 6,577 pounds per day. Allocation of sediment loading among the TMDL variables is summarized in Table 1. To achieve this reduction while maintaining a 10% margin of safety and minor allowance for point sources, loading from croplands, hay/pasture lands and streambanks should each be reduced by 27%.

Table 1. Summary of TMDL for South Branch Middle Creek Watershed

lbs/yr:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	2,400,681	240,068	44,447	2,116,166	31,575	2,084,592
lbs/d:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	6,577	658	122	5,798	87	5,711

TMDL=Total Maximum Daily Load; MOS = Margin of Safety; WLA=Wasteload Allocation (point sources); LA = Load Allocation (nonpoint sources). The LA is further divided into LNR = Loads Not Reduced and ALA=Adjusted Load Allocation.

Introduction

South Branch Middle Creek is a tributary of Middle Creek, with the confluence approximately 1.3 miles northwest of the village of Beaver Springs. This Total Maximum Daily Load (TMDL) calculation has been prepared to address siltation impairments per the 2016 Final Integrated Report (see Appendix A for a description of assessment methodology). The South Branch Middle Creek Watershed is approximately 13.6 square miles and occurs primarily in Snyder County, though a small portion extends into Mifflin County as well. It contains approximately 23 stream miles, with various segments designated for Cold Water Fishes (CWF) or Trout Stocking (TSF) per PA Code 25 § 93.9n (Table 2). All of these stream segments have also been designated for Migratory Fishes (MF).

Agriculture was identified as the source of the siltation impairments. The removal of natural vegetation and disturbance of soils associated with agriculture increases soil erosion leading to sediment deposition in streams. Excessive fine sediment deposition may destroy the coarse-substrate habitats required by many stream organisms. While Pennsylvania does not have numeric water quality criteria for sediment, it does have applicable narrative criteria:

> *Water may not contain substances attributable to point or nonpoint source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life. (25 PA Code Chapter 93.6 (a)); and,*
>
> *In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits. (25 PA Code, Chapter 93.6 (b))*.

While agriculture has been identified as the source of the impairments, this TMDL document is applicable to all significant sources of solids that may settle to form deposits.

According to the "Model My Watershed" application, land use in this watershed is estimated to be 59% forest/naturally vegetated lands, 33% agriculture, and 8% mixed development. The agricultural lands are approximately 13% croplands and 20% hay/pasture (Appendix B, Table B1). There was only one NPDES permitted point source discharge in the watershed that had limits relevant to sedimentation (total suspended solids), and its expected contribution to sediment loading was approximately 20,440 lbs/yr (Table 3, Figure 2).

Table 2. Impaired Stream Segments in the South Branch Middle Creek Watershed per the 2016 Final Pennsylvania Integrated Report

HUC: 02050301 – Lower Susquehanna-Penns				
Source	EPA 305(b) Cause Code	Miles	Designated Use	Use Designation
Agriculture	Siltation	23	TSF or CWF, MF	Aquatic Life

HUC= Hydrologic Unit Code; TSF= Trout Stocking; CWF=Cold Water Fishes; MF= Migratory Fishes
The use designations for the stream segments in this TMDL can be found in PA Title 25 Chapter 93.
See Appendix C for a listing of each stream segment and Appendix A for more information on the listings and listing process

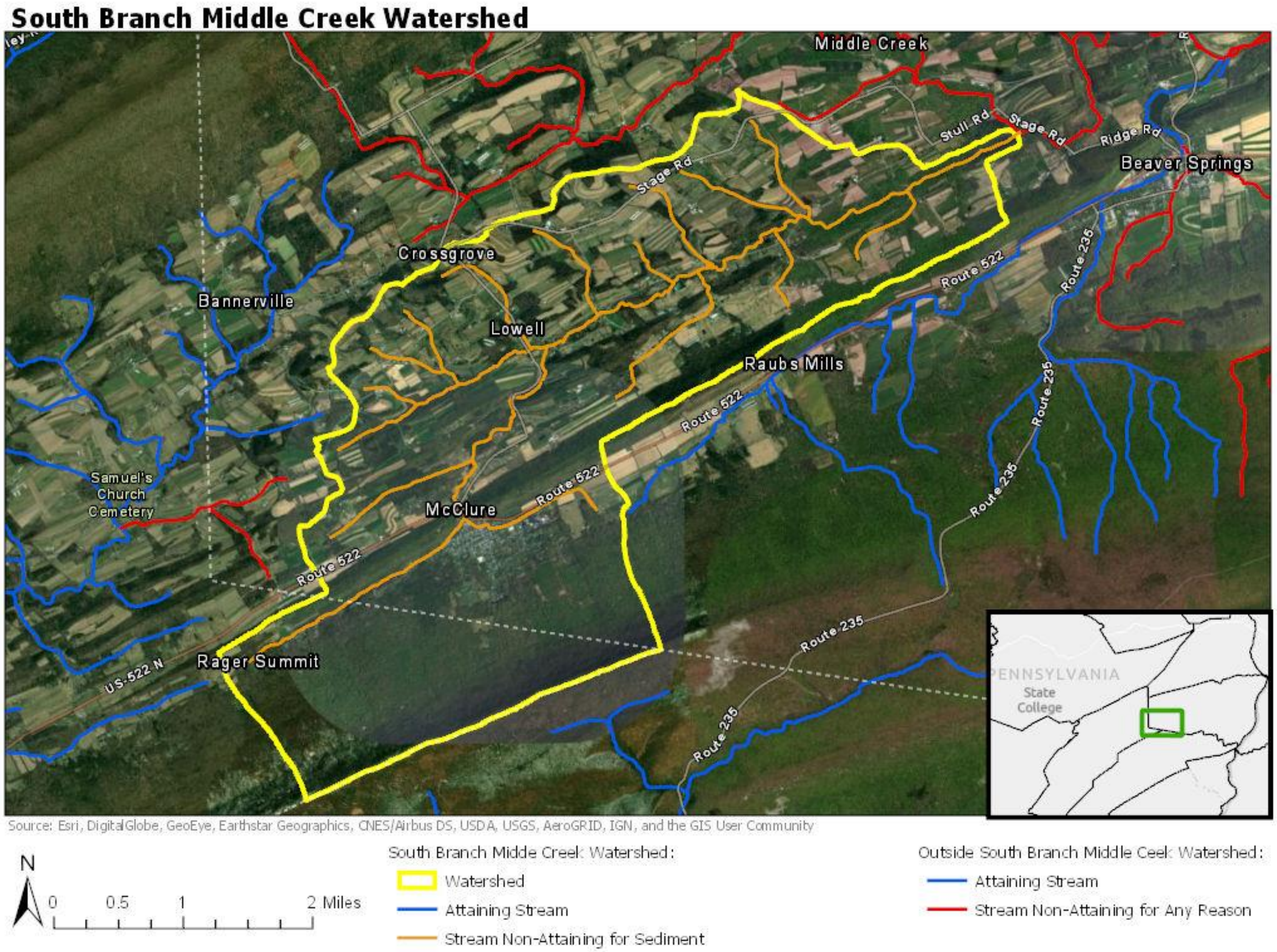


Figure 1. South Branch Middle Creek Watershed, Snyder and Mifflin Counties. All stream segments within the study watershed were listed as impaired for sediment per the 2016 Final Pennsylvania Integrated Report.

Table 3. Existing NPDES Permits in the South Branch Middle Creek Watershed and their Potential Contribution to Sediment Loading.			
Permit No.	Facility Name	Load, lb/yr	Load, lb/day
PA0024627	McClure Municipal Authority	20,440	56[1]
PAR204805	Lozier McClure Plt.	NA	NA[2]
PAG124839	Ridge Valley Farm II	NA	NA[3]

[1]The NPDES permit issued Oct. 15, 2015 includes a 56 lbs/d total suspended solids effluent limit as a monthly average. NA – Not applicable. NPDES permit did not include numerical effluent limitations relevant to sediment loading.

[2]Permit for industrial stormwater facilities. Note that sediment loading associated with development is accounted for in Model My Watershed.

[3] In Pennsylvania, routine, dry-weather discharges from concentrated animal feeding operations (CAFOs) are not allowed. Wet weather discharges are controlled through best management practices, which result in infrequent discharges from production areas and reduced sediment loadings associated with lands under the control of CAFOs owner or operators, such as croplands where manure is applied. Although not quantified in this table, sediment loadings from CAFOs is accounted for in the modeling of land uses, with the assumption of no additional CAFO-related BMPs.

Figure 2. Permitted discharges in the South Branch Middle Creek Watershed. The discharges are indicated by pink triangles, and the watershed is shown in blue. The outfall on the northern side of McClure is associated with a wastewater treatment plant with permit limits for total suspended solids. This figure was made in EPA's Watershed Resource Registry for Pennsylvania, available at: https://watershedresourcesregistry.org/states/pennsylvania.html

TMDL Approach

Although watersheds must be handled on a case-by-case basis when developing TMDLs, there are basic processes that apply to all cases. They include:

1. Collection and summarization of pre-existing data (watershed characterization, inventory contaminant sources, determination of pollutant loads, etc.);
2. Calculation of a TMDL that appropriately accounts for any critical conditions and seasonal variations;
3. Allocation of pollutant loads to various sources;
4. Submission of draft reports for public review and comments; and
5. EPA approval of the TMDL.

Because Pennsylvania does not have numeric water quality criteria for sediment, the “Reference Watershed Approach” was used. This method estimates sediment loading rates in both the impaired watershed as well as a similar watershed that is not impaired for sediment. Then, the loading rate in the unimpaired watershed is scaled to the area of the impaired watershed so that necessary load reductions may be calculated. It is assumed that reducing loading rates in the impaired watershed to the levels found in the unimpaired watershed will result in the impaired stream segments attaining their designated uses.

Selection of the Reference Watershed

In addition to anthropogenic influences, there are many other natural factors affecting sediment loading rates. Thus, selection of a reference watershed with similar natural characteristics to the impaired watershed is crucial. Failure to use an appropriate reference watershed could result in problems such as the setting of sediment reduction goals that are unattainable, or nonsensical TMDL calculations that suggest that sediment loading in the impaired watershed should be increased.

To determine the suitability of the reference site, the Department’s Integrated Report GIS-based website (available at http://www.depgis.state.pa.us/integrated_report/index.html) was used to search for nearby watersheds that were of similar size as the South Branch Middle Creek Subwatershed, but lacked stream segments listed as impaired for sediment.

Considering that it is just on the other side of Shade Mountain from the study watershed and lacked stream segments impaired for sediment (Figure 3), the upper Cocalamus Creek watershed, located in Juniata and Snyder Counties, was explored for use as a reference. Since it is required that the reference watershed be +/-30% of the impaired watershed’s area, a delineation point was chosen upstream of the mouth to yield a subwatershed of Cocalamus Creek that was of similar size as the study watershed (Table 4).

To confirm the suitability of the reference site, Model My Watershed, DEP’s internal GIS databases, and various other GIS based applications were used to compare factors such as land cover/use, geology, soil drainage and slope (Table 4). Both watersheds were visited to explore conditions, and it was ultimately concluded that the Cocalamus Creek Subwatershed was a suitable reference.

Table 4. Comparison of South Branch Middle Creek Watershed and Cocalamus Creek Sub-watershed		
	S. Br. Middle Cr. Watershed	Cocalamus Cr. Subwatershed
Physiographic Province	Ridge and Valley	Ridge and Valley
Area, ac	8,672	9,156
Land Use Distribution	33% Agriculture 59% Forest/Natural Vegetation 8% Other	28% Agriculture 68% Forest/Natural Vegetation 5% Other
Soil Infiltration	21% Group A 16% Group B 3% Group B/D 5% Group C 16% Group C/D 39% Group D	19% Group A 33% Group B 2% Group B/D 11% Group C 12% Group C/D 24% Group D
Bedrock type by dominant lithology	73% Shale 15% Siltstone 7% Limestone 6% Quartzite 0% Sandstone	62% Shale 0% Siltstone 16% Limestone 10% Quartzite 12% Sandstone
Average Annual Precipitation, inches	41.5	41.5
Average Annual Surface Runoff, inches	2.71	2.48
Average Elevation (ft)	846	1052
Average % Slope	14	14

Based on the summaries of landcover reported by the "Model My Watershed" application, land cover/use distributions in these two watersheds were similar. Both were dominated by natural vegetation, but the impaired watershed did have a slightly higher percentage of agricultural area and less forested area than the reference watershed. Both watersheds were dominated by non-carbonate sedimentary bedrock and contained substantial amounts of both well-drained and poorly drained soils. The average slope in both watersheds was approximately the same.

All stream segments within the Cocalamus Creek Subwatershed were designated for trout stocking, whereas stream segments within the South Branch Middle Creek study watershed were designated for cold-water fishes or trout stocking. Also, like the impaired watershed, the Cocalamus Creek Subwatershed only had one NPDES permitted discharge with limits relevant to sediment (Table 5, Figure 4).

Table 5. NPDES Permits in the Cocalamus Creek Subwatershed.

Permit No.	Facility Name	Load, lbs/yr	Load, lbs/d
PA0081817	East Juniata High School[1]	1,462	4
PAR603601	Cocalamus Cr. Disposal Service[2]	NA	NA
PA0246603	Lazy Hog Farm CAFO[3]	NA	NA

[1]Their NPDES permit issued Jan. 29, 2014 includes a 30 mg/l average monthly total suspended solids effluent limitation that was determined using a flow rate of 0.016 MGD.

NA – Not applicable. The NPDES permit issued to the facility did not include numerical effluent limitations relevant to sediment loading.

[2]Permit for industrial stormwater facilities. Note sediment loading associated with development is accounted for in Model My Watershed.

[3] In Pennsylvania, routine, dry-weather discharges from concentrated animal feeding operations (CAFOs) are not allowed. Wet weather discharges are controlled through best management practices, which result in infrequent discharges from production areas and reduced sediment loadings from lands under the control of CAFOs owner or operators, such as croplands where manure is applied. Although not quantified in this table, sediment loadings from CAFOs is accounted for in the modeling of land uses within the watershed, with the assumption of no additional CAFO-related BMPs.

After selecting the potential reference, the two watersheds were visited during winter 2018/2019 to confirm the suitability of the reference as well as to explore whether there were any obvious land use differences that may help to explain why one watershed was impaired for sediment while the other was attaining. While neither watershed was dominated by the extensive croplands typical of Pennsylvania's more fertile regions, such as in central and southern Lancaster County or within the Great Valley Province, both watersheds were clearly influenced by agriculture (Figures 5 and 6). In fact, some of the pasture sites in the reference watershed appeared to be as degraded, if not worse than the pasture land in the impaired watershed.

Based on our observations, we propose three land-use hypotheses that may help explain why the South Branch Middle Creek Watershed is impaired while the Cocalamus Creek Subwatershed is attaining. First, most of the headwater tributaries in the Cocalamus Creek Subwatershed originated in a forested area whereas most of the headwater tributaries in the South Branch Middle Creek Watershed originated in agricultural areas (compare Figures 1 and 6 to well as Figures 3 and 5). By ensuring low pollutant loading upstream, such headwater protection may help prevent pollutant levels reaching the point of impairment in the agricultural valley further downstream. Second, the most common agricultural land uses that we observed proximate to stream channels within the Cocalamus Subwatershed were pasture or hay fields, and they were in relatively flat areas (Figure 5). In contrast, pastureland and even crop fields were observed on steeper slopes near stream channels in the South Branch Middle Creek Watershed (Figure 6). Third, a few sites with apparent significant legacy sediment accumulations were observed within the South Branch Middle Creek Watershed (Figure 6). While potential legacy sediment accumulations were also observed in the reference watershed, the accumulations appeared to be smaller. We suspect however that this is not a major factor explaining the discrepancy between these two watersheds, as the suspected legacy sediment accumulations appeared to be localized rather than ubiquitous.

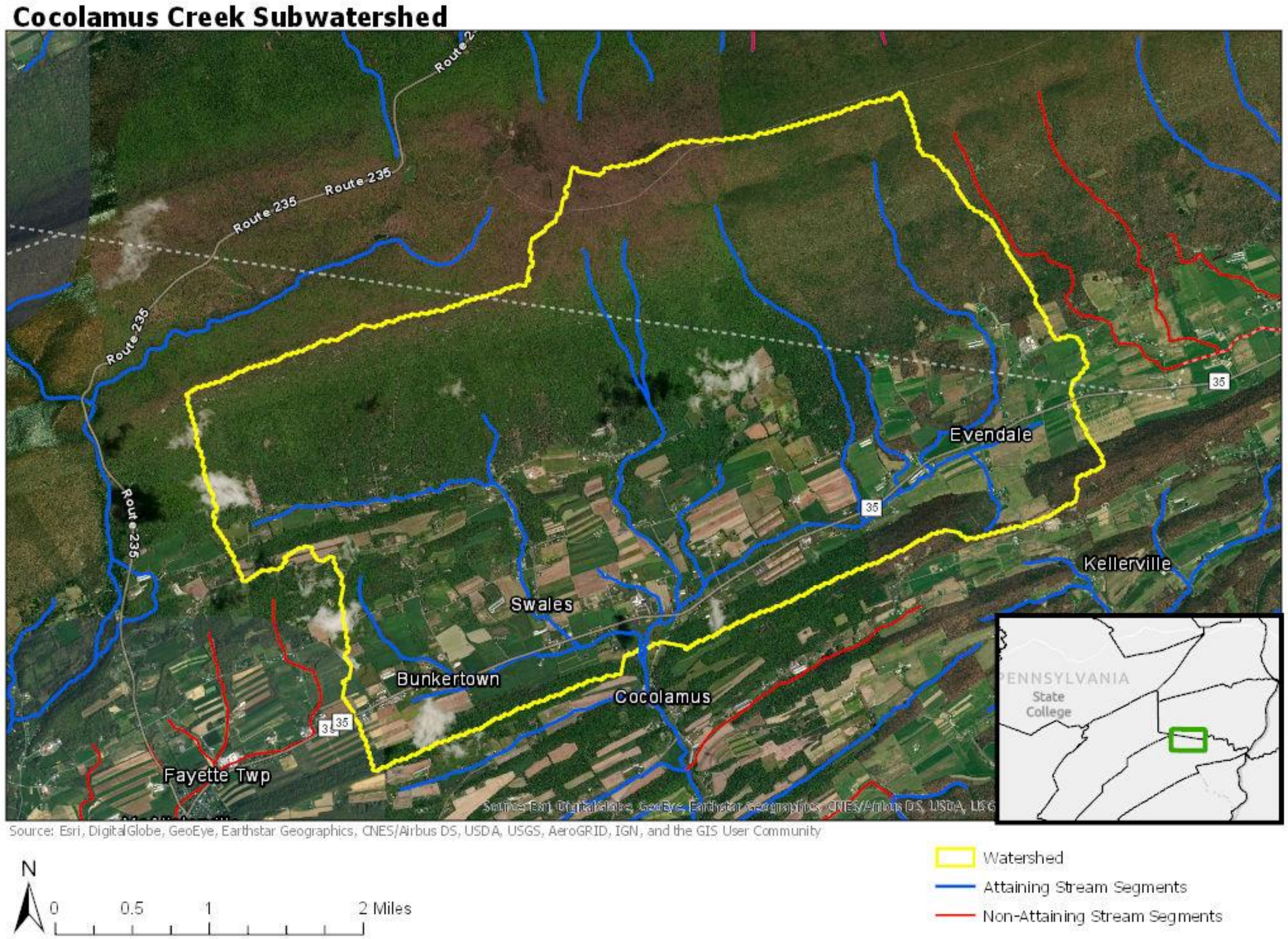


Figure 3. Cocalamus Creek Subwatershed in Juniata and Snyder Counties.

Figure 4. Permitted discharges in the Cocalamus Creek Subwatershed. The discharges are indicated by pink triangles, and the watershed is shown in blue. The easternmost outfall depicted within the watershed is associated with a wastewater treatment plant serving the East Juniata High School. This facility had an effluent limit for total suspended solids. The other outfalls had no numeric permit limits for sediment. This figure was created in EPA's Watershed Resource Registry for Pennsylvania, available at: https://watershedresourcesregistry.org/states/pennsylvania.html

Figure 5. Example stream segments in the unimpaired Cocalamus Creek reference subwatershed. Downstream water quality apparently benefits from headwaters originating in the forested northern half of the watershed, as illustrated in Photographs A and B. See also Figure 2. Many of the stream segments within the agricultural areas along Route 35 appeared to be substantially influenced by agriculture. Fortunately, this appeared to be mostly hay and pasture on relatively flat land (Photographs C and D). Photographs E and F show the beneficial use of riparian buffers along some stream segments within agricultural areas.

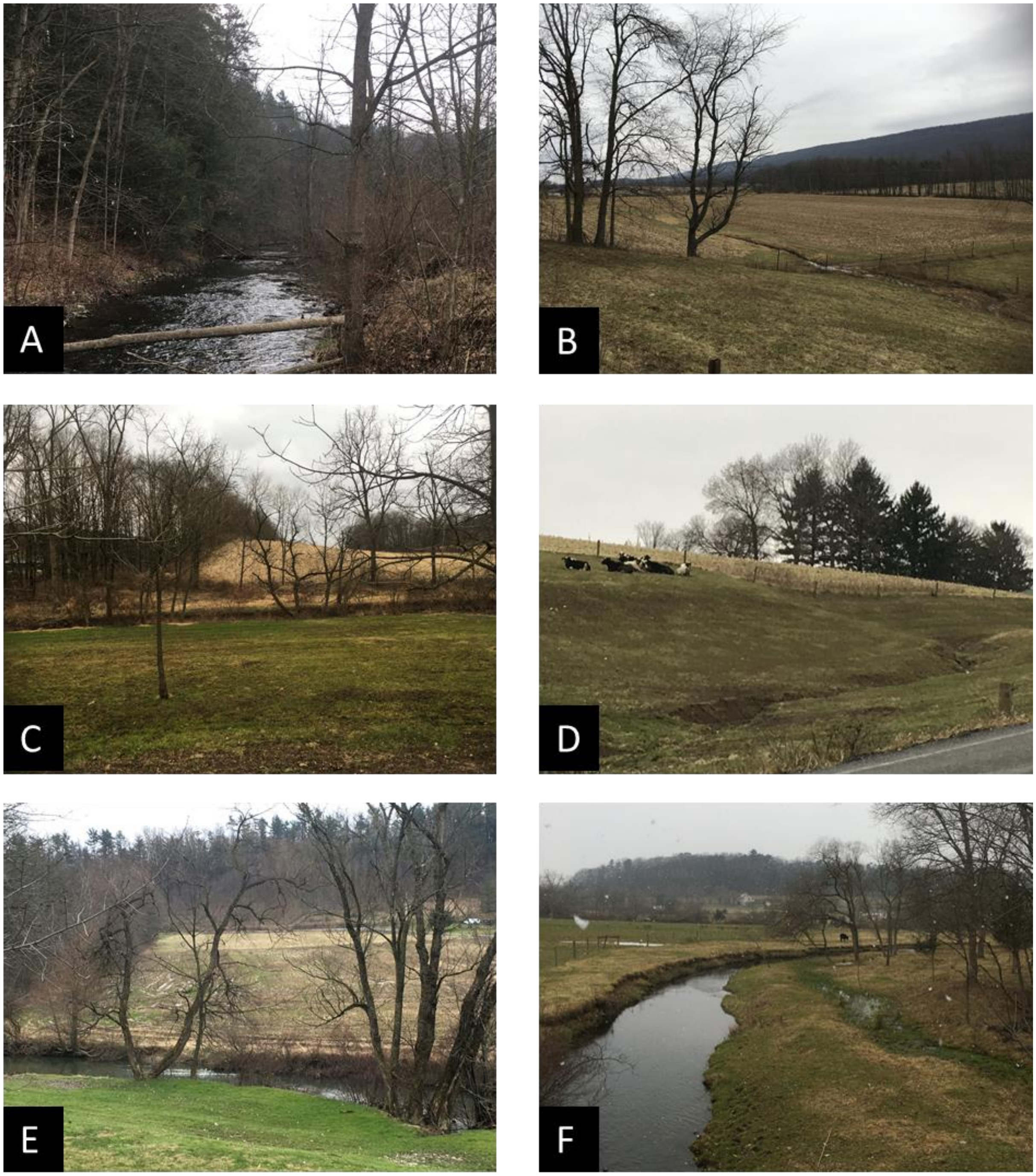


Figure 6. Example stream segments in South Branch Middle Creek Watershed. Some segments had expansive, mature riparian buffers as in photograph A. However, many of the small tributary streams originated in agricultural areas with steep slopes and without adequate buffers (Photographs B, C and D; see also Figure 1). Photograph E depicts cropland sloping towards the mainstem with little to no riparian buffers. Photograph F shows grazing along the mainstem and the erosion of what may be legacy sediments.

Hydrologic / Water Quality Modeling

The TMDL for this watershed was calculated using the "Model My Watershed" application (MMW), which is part of the WikiWatershed web toolkit, developed through an initiative of the Stroud Water Research Center. MMW is a replacement for the Mapshed desktop modelling application that has been used to derive approved sediment TMDLs in Pennsylvania. Both programs calculate sediment and nutrient fluxes using the "Generalized Watershed Loading Function Enhanced" (GWLF-E) model. However, MapShed was built using a MapWindow GIS package that is no longer supported, whereas MMW operates with GeoTrellis, an open-source geographic data processing engine and framework. The MMW application is freely available for use at https://wikiwatershed.org/model/. In addition to the changes to the GIS framework, the MMW application continues to be updated and improved relative to its predecessor.

MMW provides the ability to simulate runoff and sediment load from a watershed given variable-size source areas (i.e., agricultural, forested, and developed land). The model used in MMW, GWLF-E, is a continuous simulation model that uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment loads based on the daily water balance accumulated to monthly values.

GWLF-E is a combined distributed/lumped parameter watershed model that simulates 30-years of daily water, nitrogen, phosphorus and sediment fluxes. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios, but each area is assumed to be homogenous with regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but simply aggregates the loads from each source 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 simply computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

With respect to the major processes simulated, GWLF-E models surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather inputs of temperature and precipitation. 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 (i.e., 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 the conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacity, which is based on average daily runoff, is then applied to the calculated erosion to determine sediment yield for each source sector. 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.

For a detailed discussion of this modelling program, including a description of the data input sources, see https://wikiwatershed.org/documentation/mmw-tech/.

Model My Watershed Version 1.24.0 allows the user to adjust model parameters, such as the area of land coverage types, the use of conservation practices and the efficiencies of those conservation practices, the watershed's sediment delivery ratio, etc. With the exception that flow from the wastewater treatment plants shown in Tables 3 and 5 were entered into Model My Watershed, default values were used for the modelling run. However, a correction for the presence of existing riparian buffers was made in the BMP Spreadsheet Tool provided by Model My Watershed following the model run. The following paragraphs describe the riparian buffer correction methodology.

Riparian buffer coverage was estimated via a GIS analysis. Briefly, landcover per a high resolution landcover dataset (University of Vermont Spatial Analysis Laboratory 2016) was examined within 100 feet of NHD flowlines. To determine riparian buffering within the "agricultural area," a polygon tool was used to clip riparian areas that, based on cursory visible inspection, appeared to be in an agricultural-dominated valley or have significant, obvious agricultural land on at least one side. The selection polygons are shown in Figures 7 and 8. Then the sum of raster pixels that were classified as either "Emergent Wetlands", "Tree Canopy" or "Shrub/Scrub" was divided by the total number of non-water pixels to determine percent riparian buffer. Using this methodology, percent riparian buffer was determined to be 65% in the agricultural area of the impaired watershed versus 49% in the reference watershed.

When accounting for the buffering of croplands using the BMP Spreadsheet Tool, the user enters the length of buffer on both sides of the stream. To estimate this, the length of streams reported by Model My Watershed was multiplied by the proportion of riparian pixels within the watershed that were in the agricultural area selection polygons and then by the proportion of the agricultural lands that were croplands within the watershed, and then by the estimated proportion of riparian buffers in the agricultural lands, and then by two since both sides of the stream are considered. The BMP spreadsheet tool then calculates sediment reduction using a similar methodology as the Chesapeake Bay CAST Model. The length of riparian buffers is converted to acres, assuming that the buffers are 100 feet wide. For sediment loading the model assumes that 2 acres of croplands are treated per acre of buffer. Thus, twice the acreage of buffer is multiplied by the sediment loading rate calculated for croplands and then by a reduction coefficient of 0.54. This calculated reduction was then subtracted from the watershed-wide yearly loading rate for croplands. The BMP spreadsheet tool is designed to account for the area of lost cropland and gained forest when riparian buffers are created. However, this part of the reduction equation was deleted for the present study since we sought to account for historic rather than proposed buffers.

The BMP spreadsheet tool did not calculate sediment reductions for riparian buffers along hay/pasture lands. Thus, it was modified for the present study to estimate these load reductions using the same logic and methodology as was described for croplands.

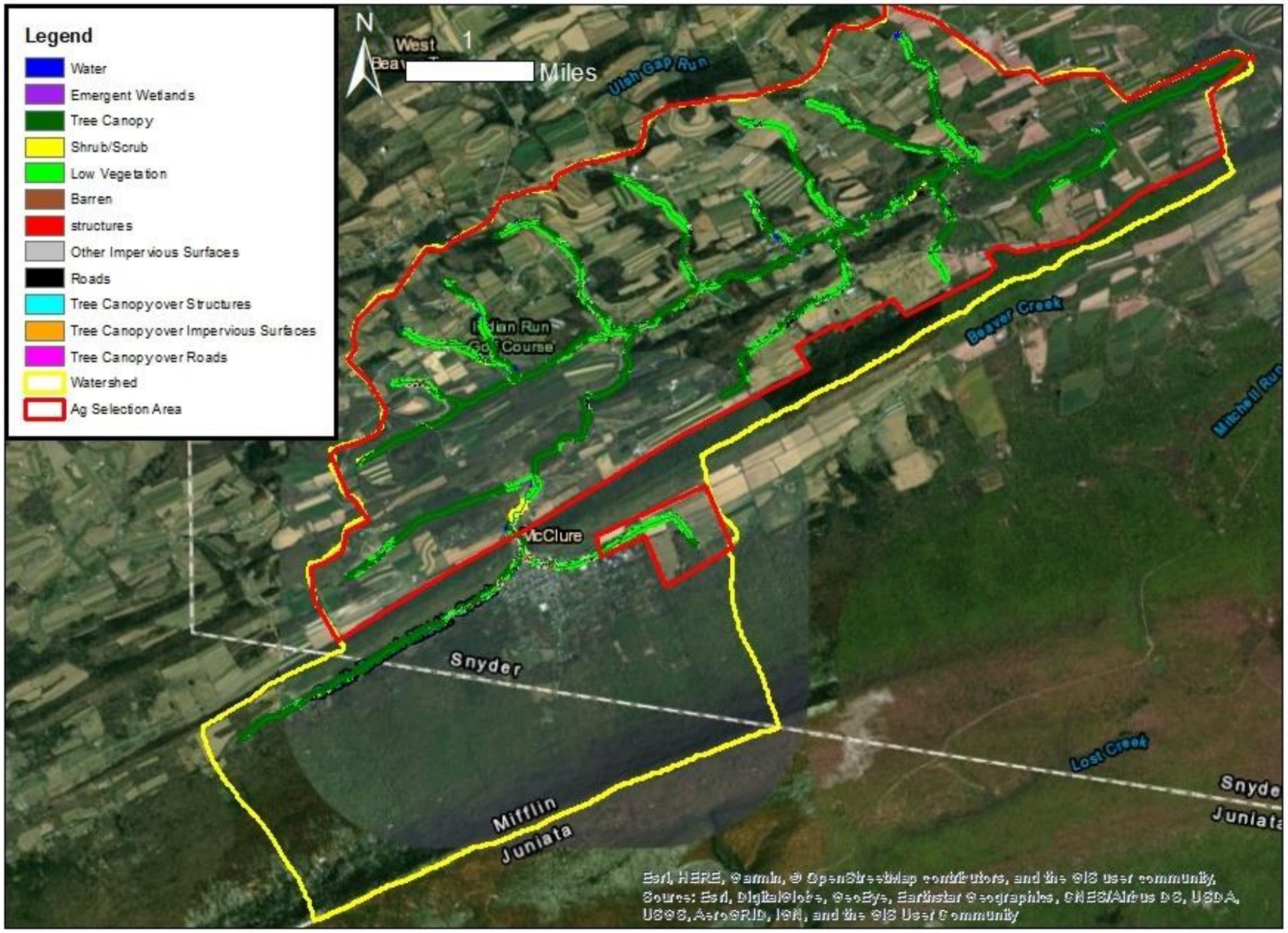


Figure 7. Riparian buffer analysis in the South Branch Middle Creek Subwatershed. A raster dataset of high-resolution land cover is shown within 100 feet (geodisc) of either side of NHD flowlines. The agricultural area selection polygons are shown in red.

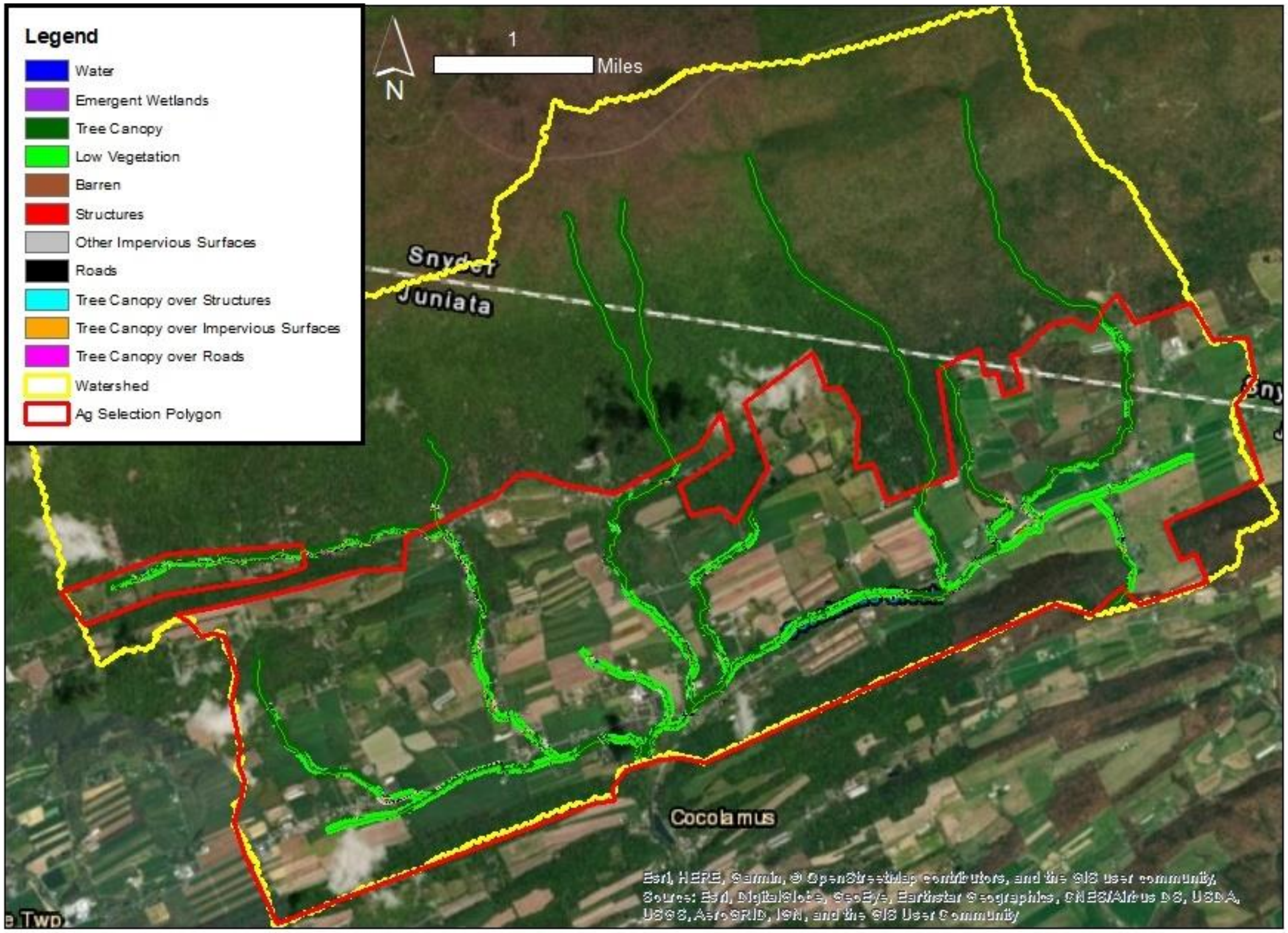


Figure 8. Riparian buffer analysis in the Cocalamus Creek Subwatershed. A raster dataset of high-resolution land cover is shown within 100 feet (geodisc) of either side of NHD flowlines. The agricultural area selection polygons are shown in red.

Calculation of the TMDL

The mean watershed-wide sediment loading rate for the unimpaired reference watershed (Cocalamus Creek Subwatershed) was estimated to be 277 pounds per acre per year (Table 6). This was substantially lower than the estimated loading rate in the impaired South Branch Middle Creek Watershed (337 pounds per acre per year, Table 7). Thus, to achieve the loading rate of the unimpaired watershed, sediment loading in the South Branch Middle Creek Watershed should be reduced to 2,400,681 pounds per year, or 6,577 pounds per day, or less (Table 8).

Table 6. Existing Loading Values for the Cocalamus Creek, reference

Source	Area, ac	Sediment, lbs/yr	Unit Area Load, lb/ac/yr
Hay/Pasture	1,188	549,405	463
Cropland	1,346	1,299,039	965
Forest and Shrub/Scrub	6,133	18,772	3
Wetland	7	32	4
Herbaceous/Grassland	35	3,406	99
Low Intensity Mixed Development	425	4,741	11
Medium Intensity Mixed Development	15	805	54
High Intensity Mixed Development	7	403	54
Streambank		656,596	
Point Sources		1,462	
total	9,156	2,534,660	277

“Streambank” sediment loads were calculated using Model My Watershed’s streambank routine which uses length rather than area.

Table 7. Existing Loading Values for South Branch Middle Creek, impaired

Source	Area ac	Sediment, lbs/yr	Unit Area Load, lbs/ac/yr

Hay/Pasture	1,768	470,030	266
Cropland	1,136	1,642,480	1446
Forest and Shrub/Scrub	5,064	20,119	4
Wetland	7	52	7
Herbaceous/Grassland	22	1,722	78
Low Intensity Mixed Development	632	6,996	11
Medium Intensity Mixed Development	35	2,290	66
High Intensity Mixed Development	7	395	53
Streambank		761,521	
Point Sources		20,440	
total	8,672	2,926,047	337

"Streambank" sediment loads were calculated using Model My Watershed's streambank routine which uses length rather than area.

Table 8. TMDL Values for the South Branch Middle Creek Watershed

Pollutant	Loading Rate in Reference, lbs/ac/yr	Total Area in Impaired Watershed, ac	Target TMDL Value, lbs/yr	Target TMDL Value, lbs/d
Sediment	277	8,672	2,400,681	6,577

Calculation of Load Allocations

In the TMDL equation, the load allocation (LA) is the load derived from nonpoint sources. The LA is further divided into the adjusted loads allocation (ALA), which is comprised of the nonpoint sources causing the impairment and targeted for reduction, as well as the loads not reduced (LNR), which is comprised of the natural and anthropogenic sources that are not considered responsible for the impairment nor targeted for reduction. Thus:

LA =ALA + LNR

Considering that the total maximum daily load (TMDL) is the sum of the margin of safety (MOS), the wasteload allocation (WLA), and the load allocation (LA):

TMDL = MOS + WLA + LA,

then the load allocation is calculated as follows:

LA = TMDL - MOS - WLA

Thus, before calculating the load allocation, the margin of safety and wasteload allocation must be defined.

Margin of Safety

The margin of safety (MOS) is a portion of pollutant loading that is reserved to account for uncertainties. Reserving a portion of the load as a safety factor requires further load reductions from the ALA to achieve the TMDL. For this analysis, the MOS was explicitly designated as ten-percent of the TMDL based on professional judgment. Thus:

2,400,681 lbs/yr TMDL * 0.1 = 240,068 lbs/yr MOS

Wasteload Allocation

The wasteload allocation (WLA) is the pollutant loading assigned to existing permitted point sources as well as future point sources. There were three National Pollutant Discharge Elimination System (NPDES) point source discharges, but only one of them, the McClure Municipal Authority Wastewater Treatment Plant, had significant numeric point source limits for sediment (Table 3, Figure 2). A bulk reserve was also included to allow for insignificant dischargers and minor increases from point sources as a result of future growth of existing or new sources.

Thus, the WLA was comprised of the bulk reserve, which we defined as one percent of the targeted TMDL, plus the permitted sediment loading from the McClure Wastewater Treatment Plant. Therefore:

2,400,681 lbs/yr TMDL * 0.01 = 24,007 lbs/yr bulk reserve + 20,440 lb/yr permitted loads = 44,447 lbs/yr WLA

It should be noted that runoff associated with the concentrated animal feeding operation (CAFO) listed in Table 3 was not provided an individual wasteload allocation. Runnoff from land application areas of CAFOs is typically considered nonpoint source pollution when permittees are operating in compliance with their permits. Furthermore, Pennsylvania does not allow routine point source discharges from CAFO production areas. If however effluent limits are necessary in the future, capacity would be available in the bulk reserve.

Load Allocation

Now that the margin of safety and wasteload allocation have been defined, the load allocation (LA) is calculated as:

2,400,681 lbs/yr TMDL – (240,068 lbs/yr MOS + 44,447 lbs/yr WLA) = 2,116,166 lbs/yr LA

Loads Not Reduced and Adjusted Load Allocation

Since the impairment addressed by this TMDL is for sedimentation due to agriculture, sediment contributions from forests, wetlands, non-agricultural herbaceous/grasslands and developed lands within the South Branch Middle Creek Watershed were considered loads not reduced (LNR). LNR was calculated to be 31,575 lbs/yr (Table 9).

The LNR is subtracted from the LA to determine the ALA:

2,116,166 lbs/yr LA – 31,575 lbs/yr LNR = 2,084,592 lbs/yr ALA

Table 9. Load Allocation, Loads Not Reduced and Adjusted Load Allocation

	Sediment, lbs/yr	Sediment, lbs/d
Load Allocation (LA)	**2,116,166**	**5,798**
Loads Not Reduced (LNR):	**31,575**	**87**
Forest	20,119	55
Wetlands	52	0.1
Non-Agricultural Herbaceous/Grasslands	1,722	5
Low Intensity Mixed Development	6,996	19
Medium Intensity Mixed Development	2,290	6
High Density Mixed Development	395	1
Adjusted Load Allocation (ALA)	**2,084,592**	**5,711**

Calculation of Sediment Load Reductions

To calculate load reductions by source, the ALA was further analyzed using the Equal Marginal Percent Reduction (EMPR) allocation method described in Appendix D. Although the South Branch Middle Creek TMDL was developed to address impairments caused by agricultural activities, streambanks were also significant contributors to the sediment load in the watershed, and streambank erosion rates are influenced by agricultural activities. Thus, streambanks were included in the ALA and targeted for reduction.

In this evaluation, none of the three ALA categories exceeded the allocable load by itself. Thus, all were assigned reduction goals of 27% (Tables 10 and 11).

Table 10. Sediment Load Allocations for Source Sectors in the South Branch Middle Creek Watershed, Annual Values						
		Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/ac/yr	lbs/yr	lbs/ac/yr	lbs/yr	
CROPLAND	1,136	1,049	1,191,323	1,446	1,642,480	27%
HAY/PASTURE	1,768	193	340,922	266	470,030	27%
STREAMBANK			552,346		761,521	27%
AGGREGATE		ALA	2,084,592		2,874,032	27%

Table 11. Sediment Load Allocations for Source Sectors in the South Branch Middle Creek Watershed, Daily Values						
		Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/ac/day	lbs/d	lbs/ac/d	lbs/d	
CROPLAND	1,136	2.9	3,264	4.0	4,500	27%
HAY/PASTURE	1,768	0.5	934	0.7	1,288	27%
STREAMBANK			1,513		2,086	27%
AGGREGATE		ALA	5,711		7,874	27%

Consideration of Critical Conditions and Seasonal Variations

“Model My Watershed” uses a continuous simulation model with daily time steps for weather data and water balance (precipitation, stream flow, surface runoff, subsurface flow, and evapotranspiration) calculations. The source of the weather data (precipitation and temperature) was a dataset compiled by USEPA ranging from 1960-1990 (Stroud Water Research Center 2018). It should be noted however that the dataset is not complete for all years at all locations. The evapotranspiration calculations also take into account the length of the growing season and changing day length. Monthly calculations are made for sediment loads, based on daily water balance accumulated in monthly values. Therefore, variable flow conditions and seasonal changes are inherently accounted for in the loading calculations. Because there is generally a significant lag time between the introduction of sediment to a waterbody and the resulting impact on beneficial uses, establishing this TMDL using average annual conditions is protective for the waterbody.

Recommendations

This document proposes a 18% reduction in sediment loading for the South Branch Middle Creek Watershed. To achieve this goal while maintaining a margin of safety and minor allowance for point sources, sediment loading from croplands, hay/pasture lands and streambanks should be reduced by 27% each. Reductions in stream sediment loading due to agricultural activities can be made through the implementation of required Erosion and Sediment Control Plans (Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Chapter 102.4, see also Appendix E) and through the use of BMPs such as conservation tillage, cover crops, vegetated filter strips, rotational grazing, livestock exclusion fencing, riparian buffers, etc.

Use of riparian buffers is widely recognized as one of the best ways to promote stream health. Riparian buffers protect streams from sedimentation impairments by filtering sediment from runoff and floodwaters and by protecting streambanks from erosion. However, riparian buffers are also beneficial for many other reasons beyond just protecting from sedimentation. For instance, riparian buffers may: filter out other pollutants, such as nutrients; provide habitat and nutrition for aquatic, semi-aquatic and terrestrial organisms; and moderate stream temperature. Use of riparian buffers, or even agricultural land retirement may be particularly beneficial in the areas of the South Branch Middle Creek Watershed where agriculture is occurring along headwater streams and/or on steep slopes (see “Selection of the Reference Watershed” section).

Research over the past decade has led to a growing awareness that the high rates of sediment loading occurring in Pennsylvania during modern times may be in part attributable to the erosion of “legacy sediments” that had accumulated behind historic mill dams. In addition to being a long term source of sediments, these legacy sediments may cut off a stream from its former floodplain and inhibit the growth of some riparian species. In some cases, planting riparian trees directly on legacy sediments with entrenched banks may enhance erosion. Thus, if large accumulations of legacy sediments are found in the impaired watershed, then their removal, or at least bank grading, may be important for preventing sediment loading and establishing riparian buffers.

Development of a more detailed watershed implementation plan is recommended. Further ground truthing should be performed to assess both the extent of existing BMPs and to determine the most cost effective and environmentally protective combination of BMPs required for meeting the prescribed sediment reductions. Key personnel from the regional DEP office, the County Conservation District, Susquehanna River Basin Commission (SRBC) and other state and local agencies and/or watershed groups should be involved in developing a restoration strategy.

Public Participation

Public notice of the draft TMDL was published in the Pennsylvania Bulletin on 6/29/2019 to foster public comment. A 30-day period was provided for the submittal of comments. No Comments were received.

Citations

EPA's Watershed Resource Registry for Pennsylvania, available at: https://watershedresourcesregistry.org/states/pennsylvania.html

Stroud Water Research Center. (2018). Model My Watershed [Software]. Version 1.24.0 Available from https://wikiwatershed.org/

Stroud Water Research Center. (2018). Model My Watershed Technical Documentation. https://wikiwatershed.org/documentation/mmw-tech/

University of Vermont Spatial Analysis Laboratory (2016). High-Resolution Land Cover, Commonwealth of Pennsylvania, Chesapeake Bay Watershed and Delaware River Basin, 2013. Available at: http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3193

Appendix A: Background on Stream Assessment Methodology

Integrated Water Quality Monitoring and Assessment Report, List 5, 303(d), Listing Process

Assessment Methods:

Prior to developing TMDLs for specific waterbodies, there must be sufficient data available to assess which streams are impaired and should be listed in the Integrated Water Quality Monitoring and Assessment Report. Prior to 2004 the impaired waters were found on the 303(d) List; from 2004 to present, the 303(d) List was incorporated into the Integrated Water Quality Monitoring and Assessment Report and found on List 5. Table A1 summarizes the changes to listing documents and assessment methods over time.

With guidance from EPA, the states have developed methods for assessing the waters within their respective jurisdictions. From 1996-2006, the primary method adopted by the Pennsylvania Department of Environmental Protection for evaluating waters found on the 303(d) lists (1998-2002) or in the Integrated Water Quality Monitoring and Assessment Report (2004-2006) was the Statewide Surface Waters Assessment Protocol (SSWAP). SSWAP was a modification of the EPA Rapid Bioassessment Protocol II (RPB-II) and provided a more consistent approach to assessing Pennsylvania's streams.

The assessment method called for selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist was to select as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. The biological surveys were to include kick-screen sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Benthic macroinvertebrates were identified to the family level in the field.

The listings found in the Integrated Water Quality Monitoring and Assessment Reports from 2008 to present were derived based on the Instream Comprehensive Evaluation protocol (ICE). Like the superseded SSWAP protocol, the ICE protocol called for selecting representative segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist was to select as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. The biological surveys were to include D-frame kicknet sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Collected samples were returned to the laboratory where the samples were subsampled for a target benthic macroinvertebrate sample of 200 ± 20% (N = 160-240). The benthic macroinvertebrates in this subsample were then identified to the generic level. The ICE protocol is a modification of the EPA Rapid

Bioassessment Protocol III (RPB-III) and provides a more rigorous and consistent approach to assessing Pennsylvania's streams than the SSWAP.

After these surveys (SSWAP, 1998-2006 lists or ICE, 2008-present lists) were completed, the biologist determined the status of the stream segment. The decision was based on the performance of the segment using a series of biological metrics. If the stream segment was classified as impaired, it was then listed on the state's 303(d) List or presently the Integrated Water Quality Monitoring and Assessment Report with the source and cause documented.

Once a stream segment is listed as impaired, a TMDL typically must be developed for it. A TMDL addresses only one pollutant. If a stream segment is impaired by multiple pollutants, each pollutant receives a separate and specific TMDL within that stream segment. Adjoining stream segments with the same source and cause listings are addressed collectively on a watershed basis.

Table A1. Impairment Documentation and Assessment Chronology

Listing Date:	Listing Document:	Assessment Method:
1998	303(d) List	SSWAP
2002	303(d) List	SSWAP
2004	Integrated List	SSWAP
2006	Integrated List	SSWAP
2008-Present	Integrated List	ICE

Integrated List= Integrated Water Quality Monitoring and Assessment Report
SSWAP= Statewide Surface Waters Assessment Protocol
ICE= Instream Comprehensive Evaluation Protocol

Justification of Mapping Changes to 303(d) Lists 1998 to Present

The following are excerpts from the Pennsylvania DEP Section 303(d) narratives that justify changes in listings between the 1996-2002 303(d) Lists and the 2004 to present Integrated Water Quality Monitoring and Assessment Reports. The Section 303(d) listing process has undergone an evolution in Pennsylvania since the development of the 1996 list.

In the 1996 Section 303(d) narrative, strategies were outlined for changes to the listing process. Suggestions included, but were not limited to, a migration to a Global Information System (GIS), improved monitoring and assessment, and greater public input.

The migration to a GIS was implemented prior to the development of the 1998 Section 303(d) list. Because of additional sampling and the migration to the GIS, some of the information appearing on the 1996 list differed from the 1998 list. Most common changes included:

1. mileage differences due to recalculation of segment length by the GIS;
2. slight changes in source(s)/cause(s) due to new EPA codes;
3. changes to source(s)/cause(s), and/or miles due to revised assessments;
4. corrections of misnamed streams or streams placed in inappropriate SWP subbasins; and
5. unnamed tributaries no longer identified as such and placed under the named watershed listing.

Prior to 1998, segment lengths were computed using a map wheel and calculator. The segment lengths listed on the 1998 Section 303(d) list were calculated automatically by the GIS (ArcInfo) using a constant projection and map units (meters) for each watershed. Segment lengths originally calculated by using a map wheel and those calculated by the GIS did not always match closely. This was the case even when physical identifiers (e.g., tributary confluence and road crossings) matching the original segment descriptions were used to define segments on digital quad maps. This occurred to some extent with all segments, but was most noticeable in segments with the greatest potential for human errors using a map wheel for calculating the original segment lengths (e.g., long stream segments or entire basins).

Migration to National Hydrography Data (NHD)

New to the 2006 report is use of the 1/24,000 National Hydrography Data (NHD) streams GIS layer. Up until 2006 the Department relied upon its own internally developed stream layer. Subsequently, the United States Geologic Survey (USGS) developed 1/24,000 NHD streams layer for the Commonwealth based upon national geodatabase standards. In 2005, DEP contracted with USGS to add missing streams and correct any errors in the NHD. A GIS contractor transferred the old DEP stream assessment information to the improved NHD and the old DEP streams layer was archived. Overall, this marked an improvement in the quality of the streams layer and made the stream assessment data compatible with national standards but it necessitated a change in the Integrated Listing format. The NHD is not attributed with the old DEP five-digit stream codes so segments can no longer be listed by stream code but rather only by stream name or a fixed combination of NHD fields known as reachcode and ComID. The NHD is aggregated by Hydrologic Unit Code (HUC) watersheds so HUCs rather than the old State Water Plan (SWP) watersheds are now used to group streams together. A more basic change was the shift in data management philosophy from one of “dynamic segmentation” to “fixed segments”. The dynamic segmentation records were proving too difficult to manage from an historical tracking perspective. The fixed segment methods will remedy that problem. The stream assessment data management has gone through many changes over the years as system requirements and software changed. It is hoped that with the shift to the NHD and OIT's (Office of Information Technology) fulltime staff to manage and maintain SLIMS the systems and formats will now remain stable over many Integrated Listing cycles.

Appendix B: Model My Watershed Generated Data Tables

Type	NLCD Code	Area (km²)	Coverage (%)
Open Water	11	0.08	0.2
Perennial Ice/Snow	12	0	0
Developed, Open Space	21	1.95	5.5
Developed, Low Intensity	22	0.61	1.7
Developed, Medium Intensity	23	0.14	0.4
Developed, High Intensity	24	0.03	0.1
Barren Land (Rock/Sand/Clay)	31	0	0
Deciduous Forest	41	17.35	49.3
Evergreen Forest	42	1.12	3.2
Mixed Forest	43	1.91	5.4
Shrub/Scrub	52	0.13	0.4
Grassland/Herbaceous	71	0.09	0.3
Pasture/Hay	81	7.16	20.3
Cultivated Crops	82	4.6	13.1
Woody Wetlands	90	0.02	0.1
Emergent Herbaceous Wetlands	95	0.01	0

Table B1. "Model My Watershed" Land Cover Outputs for the S. Branch Middle Creek Watershed

Type	NLCD Code	Area (km²)	Coverage (%)
Open Water	11	0	0
Perennial Ice/Snow	12	0	0
Developed, Open Space	21	1.28	3.5
Developed, Low Intensity	22	0.44	1.2
Developed, Medium Intensity	23	0.06	0.2
Developed, High Intensity	24	0.03	0.1
Barren Land (Rock/Sand/Clay)	31	0	0
Deciduous Forest	41	20.1	54.2
Evergreen Forest	42	2.29	6.2
Mixed Forest	43	2.4	6.5
Shrub/Scrub	52	0.05	0.1
Grassland/Herbaceous	71	0.14	0.4
Pasture/Hay	81	4.81	13
Cultivated Crops	82	5.45	14.7
Woody Wetlands	90	0.03	0.1
Emergent Herbaceous Wetlands	95	0	0

Table B2. "Model My Watershed" Land Cover Outputs for the Cocalamus Creek Subwatershed

Month	Stream Flow (cm)	Surface Runoff (cm)	Subsurface Flow (cm)	Point Src Flow (cm)	ET (cm)	Precip (cm)
Jan	5.64	0.95	4.61	0.07	0.33	7.15
Feb	6.32	1.18	5.08	0.07	0.5	7.31
Mar	7.26	0.59	6.59	0.07	1.82	8.36
Apr	6.23	0.17	5.99	0.07	4.54	8.41
May	4.51	0.14	4.29	0.07	8.75	10.51
Jun	3.65	0.93	2.65	0.07	12.09	10.58
Jul	1.54	0.19	1.28	0.07	11.49	9.86
Aug	0.65	0.14	0.43	0.07	9.26	8.64
Sep	1.06	0.81	0.18	0.07	5.93	9.04
Oct	1.29	0.62	0.6	0.07	3.59	8.06
Nov	2.25	0.47	1.7	0.07	1.74	9.38
Dec	4.88	0.69	4.11	0.07	0.69	8.11
Total	45.28	6.88	37.51	0.84	60.73	105.41

Table B3. "Model My Watershed" Hydrology Outputs for South Branch Middle Creek Watershed

Month	Stream Flow (cm)	Surface Runoff (cm)	Subsurface Flow (cm)	Point Src Flow (cm)	ET (cm)	Precip (cm)
Jan	5.73	0.86	4.87	0.01	0.31	7.15
Feb	6.34	1.07	5.26	0	0.49	7.31
Mar	7.31	0.53	6.78	0.01	1.72	8.36
Apr	6.28	0.15	6.13	0	4.37	8.41
May	4.53	0.13	4.4	0.01	8.51	10.51
Jun	3.64	0.89	2.74	0	11.8	10.58
Jul	1.49	0.17	1.31	0.01	11.29	9.86
Aug	0.55	0.12	0.42	0.01	9.12	8.64
Sep	0.96	0.76	0.19	0	6	9.04
Oct	1.34	0.57	0.77	0.01	3.49	8.06
Nov	2.46	0.42	2.04	0	1.67	9.38
Dec	5.15	0.62	4.52	0.01	0.66	8.11
Total	45.78	6.29	39.43	0.07	59.43	105.41

Table B4. "Model My Watershed" Hydrology Outputs for the Cocalamus Creek Subwatershed

Sources	Sediment (kg)
Hay/Pasture	233,085.50
Cropland	814,496.90
Wooded Areas	9,124.40
Wetlands	23.5
Open Land	781.1
Barren Areas	0
Low-Density Mixed	755.1
Medium-Density Mixed	1,038.70
High-Density Mixed	179.1
Low-Density Open Space	2,417.70
Farm Animals	0
Stream Bank Erosion	345,361.00
Subsurface Flow	0
Point Sources	0
Septic Systems	0

Table B5. Model My Watershed outputs for Sediment in the South Branch Middle Creek Watershed. Note that sediment contributions from point sources were added manually to the BMP Spreadsheet Tool and EMPR spreadsheet. Also, the values for hay/pasture and cropland shown above are prior to correction for existing riparian buffers.

Sources	Sediment (kg)
Hay/Pasture	267,027.00
Cropland	631,370.80
Wooded Areas	8,513.30
Wetlands	14.6
Open Land	1,544.70
Barren Areas	0
Low-Density Mixed	548.1
Medium-Density Mixed	365.1
High-Density Mixed	182.6
Low-Density Open Space	1,601.80
Farm Animals	0
Stream Bank Erosion	297,776.00
Subsurface Flow	0
Point Sources	0
Septic Systems	0

Table B6. Model My Watershed outputs for Sediment in the Cocalamus Creek Watershed. Note that sediment contributions from point sources were added manually to the BMP Spreadsheet Tool and EMPR spreadsheet. Also, the values for hay/pasture and cropland shown above are prior to correction for existing riparian buffers.

Appendix C: Stream Segments in the South Branch Middle Creek Subwatershed with Siltation Impairments

Assessed Use:	Status:	Impairment Source:	Impairment Cause:	Date Listed:	COMID:	Length (mi):
Aquatic Life	Impaired	Agriculture	Siltation	2012	54969991	0.01
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970061	0.25
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970121	1.00
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970251	1.00
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970259	0.71
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970261	0.07
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970277	0.89
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970313	0.27
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970357	0.79
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970481	0.95
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970489	0.05
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970495	0.67
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970499	0.05
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970501	0.04
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970529	0.07
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970577	0.22
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970579	0.46
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970585	0.69
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970745	0.56
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970779	0.15
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970785	0.03
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970787	0.92
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970935	0.51
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970945	0.12
Aquatic Life	Impaired	Agriculture	Siltation	2012	54970947	1.08
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971053	0.01
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971055	1.43
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971087	0.59
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971091	0.60
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971123	0.67
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971125	0.16
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971209	0.37

Aquatic Life	Impaired	Agriculture	Siltation	2012	54971211	0.44
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971371	1.29
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971423	0.71
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971537	0.59
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971551	1.21
Aquatic Life	Impaired	Agriculture	Siltation	2012	54971667	1.27
Aquatic Life	Impaired	Agriculture	Siltation	2012	54972091	2.04

Appendix D: Equal Marginal Percent Reduction Method

Equal Marginal Percent Reduction (EMPR) (An Allocation Strategy)

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute the Adjusted Load Allocation (ALA) between the appropriate contributing nonpoint sources. The load allocation and EMPR procedures were performed using a MS Excel spreadsheet. 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, MOS, WLA and existing loads not reduced.

Step 3: Actual EMPR Process:

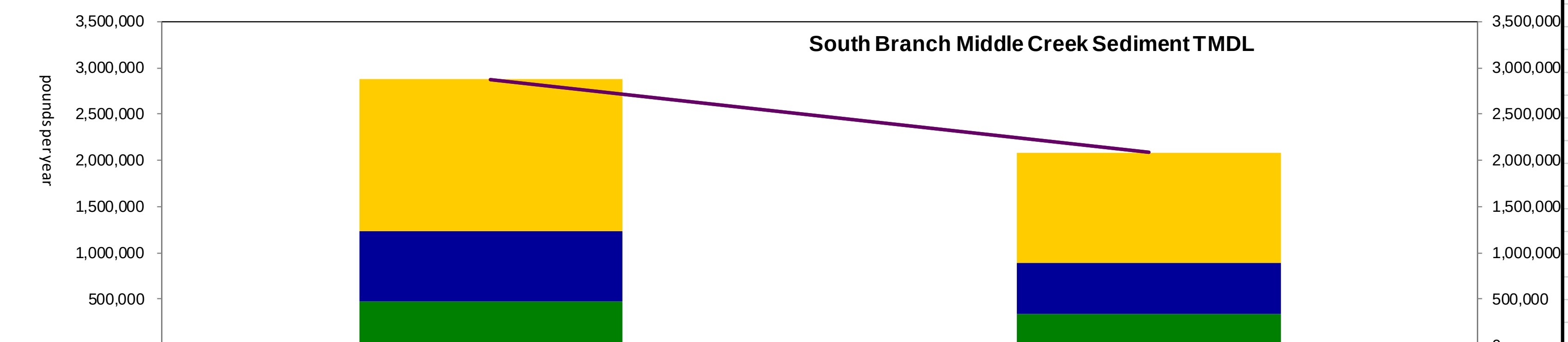
a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving waterbody. If the contributor exceeds the ALA, that contributor would 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 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 percent reduction for each pollutant source

	TMDL				2	ALA = TMDL total load - (MOS + WLA + loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					2084591.6	2084591.6					
	2400681.2											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	1642480.4	2874031.8	good	1642480.4		0.6	451157.2	1191323.2	1135.8	1048.9	27.47%
	HAY/PASTURE	470030.5		good	470030.5	789440.3	0.2	129108.2	340922.3	1767.9	192.8	27.5%
	STREAMBANK	761521.0		good	761521.0		0.3	209174.9	552346.1			27.5%
					2874031.8		1.0		2084591.6			
4	All Ag. Loading Rate	527.69										
			Allowable		Current	Current	**Reduction**					
	Land Use	Acres	loading rate	Final LA	Loading Rate	Load	**Goal**			CURRENT LOAD	FINAL LOAD ALLOCATION	
5	CROPLAND	1,136	1,049	1,191,323	1,446	1,642,480	**27%**		HAY/PASTURE	470,030	340,922	
	HAY/PASTURE	1,768	193	340,922	266	470,030	**27%**		STREAMBANK	761,521	552,346	
	STREAMBANK			552,346		761,521	**27%**		CROPLAND	1,642,480	1,191,323	
	AGGREGATE		ALA	2,084,592		2,874,032	**27%**		AGGREGATE	2,874,032	2,084,592	



	CURRENT LOAD	FINAL LOAD ALLOCATION
CROPLAND	1,642,480	1,191,323
STREAMBANK	761,521	552,346
HAY/PASTURE	470,030	340,922
AGGREGATE	2,874,032	2,084,592

Table D1. Equal Marginal Percent Reduction calculations for the South Branch Middle Creek Watershed

Appendix E: Legal Basis for the TMDL and Water Quality Regulations for Agricultural Operations

Clean Water Act Requirements

Section 303(d) of the 1972 Clean Water Act requires states, territories, and authorized tribes to establish water quality standards. The water quality standards identify the uses for each waterbody and the scientific criteria needed to support that use. Uses can include designations for drinking water supply, contact recreation (swimming), and aquatic life support. Minimum goals set by the Clean Water Act require that all waters be "fishable" and "swimmable."

Additionally, the federal Clean Water Act and the United States Environmental Protection Agency's (EPA) implementing regulations (40 CFR 130) require:

- States to develop lists of impaired waters for which current pollution controls are not stringent enough to meet water quality standards (the list is used to determine which streams need TMDLs);
- States to establish priority rankings for waters on the lists based on severity of pollution and the designated use of the waterbody; states must also identify those waters for which TMDLs will be developed and a schedule for development;
- States to submit the list of waters to EPA every two years (April 1 of the even numbered years);
- States to develop TMDLs, specifying a pollutant budget that meets state water quality standards and allocate pollutant loads among pollution sources in a watershed, e.g., point and nonpoint sources; and
- EPA to approve or disapprove state lists and TMDLs within 30 days of final submission.

Despite these requirements, states, territories, authorized tribes, and EPA have not developed many TMDLs since 1972. Beginning in 1986, organizations in many states filed lawsuits against EPA for failing to meet the TMDL requirements contained in the federal Clean Water Act and its implementing regulations. While EPA has entered into consent agreements with the plaintiffs in several states, many lawsuits still are pending across the country.

In the cases that have been settled to date, the consent agreements require EPA to backstop TMDL development, track TMDL development, review state monitoring programs, and fund studies on issues of concern (e.g., Abandoned Mine Drainage (AMD), implementation of nonpoint source BMPs, etc.).

Pennsylvania Clean Streams Law Requirements, Agricultural Operations

Pennsylvania farms are required by law to operate within regulatory compliance by implementing the applicable requirements outlined in the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Part I Department of Environmental Protection, Subpart C Protection of Natural Resources, Article II Water Resources, Chapters: § 91.36 Pollution control and prevention at agricultural operations, § 92a.29 CAFO and § 102.4 Erosion and sediment control requirements. Water quality regulations can be found at following website: http://www.pacode.com/secure/data/025/025toc.html

Agricultural regulations are designed to reduce the amount of sediment and nutrients reaching the streams and ground water in a watershed.

Appendix F: Comment and Response

No comments were received.