Little Lost Creek TMDL

Juniata County, Pennsylvania

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DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Executive Summary

Total Maximum Daily Loads (TMDLs) for sediment and phosphorus were developed for the Little Lost Creek Subwatershed (Figure 1) to address the siltation and nutrient (phosphorus) 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. Crop-related agriculture has been identified as the cause of these impairments. Because Pennsylvania does not have numeric water quality criteria for sediment or phosphorus, the loading rates from a similar unimpaired watershed were used to calculate the TMDL.

Existing sediment loading in the Little Lost Creek Subwatershed is estimated to be 2,435,189 pounds per year or 6,672 pounds per day. Phosphorus loading was estimated to be 5,866 pounds per year or 16 pounds per day. To meet water quality objectives, sediment loading should be reduced by 19% to 1,977,816 pounds per year or 5,419 pounds per day, and phosphorus loading should be reduced by 20% to 4,685 pounds per year or 13 pounds per day. Allocation among the TMDL variables is summarized in Table 1. To achieve these reductions while maintaining 10% margins of safety and minor allowance for point sources, sediment loading from croplands, hay/pasture lands and streambanks should each be reduced by 28%; and phosphorus loadings from croplands, hay/pasture lands, streambanks and farm animals should be reduced by 38% each.

Table 1. Summary of the Sediment and Total Phosphorus TMDLs for the Little Lost Creek Watershed

lbs/yr:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	1,977,816	197,782	31,458	1,748,576	10,698	1,737,878
Phosphorus	4,685	469	813	3,403	577	2,826
lbs/d:						
Pollutant	TMDL	MOS	WLA	LA	LNR	ALA
Sediment	5,419	542	86	4,791	29	4,761
Phosphorus	12.8	1.3	2.2	9.3	1.6	7.7

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

Little Lost Creek is a tributary of Lost Creek, with the confluence approximately one-half mile southwest of the village of Oakland Mills. This Total Maximum Daily Load (TMDL) document has been prepared to address the siltation and nutrient impairments noted in the 2016 Final Integrated Report (see Appendix A for a description of assessment methodology). All stream segments within the Little Lost Creek Subwatershed were listed as impaired, with the exception of one unnamed tributary system and the last, approximately 0.3 mile, reach of mainstem. The study watershed was delineated to exclude the attaining segments, and will henceforth be referred to as the Little Lost Creek Subwatershed (see Figure 1). The Little Lost Creek Subwatershed is approximately 7.4 square miles and occurs entirely in Juniata County. It contains approximately 12 stream miles, all of which were designated for Trout Stocking (TSF) and Migratory Fishes per PA Code 25 § 93.9n (Table 2).

Agriculture was identified as the source of the siltation and nutrient 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. Soil erosion, along with animal waste and fertilizer use, may lead to excessive phosphorus loading in streams and in turn eutrophication, which may lower dissolved oxygen concentrations, increase pH, change community composition, and degrade aesthetic value.

While Pennsylvania does not have numeric water quality criteria for sediment or phosphorus, 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 crop related agriculture has been identified as the source of the impairments, this TMDL document is applicable to all significant sources of phosphorus that may contribute to eutrophication as well as sediment and solids that may settle to form deposits.

According to the "Model My Watershed" application, land use in this watershed is estimated to be 30% forest/naturally vegetated lands, 60% agriculture, and 10% mixed development. The agricultural lands were approximately equally divided between cultivated crops and pasture/hay (Appendix B, Table B1). There was only one NPDES permitted point source discharge in the watershed that had limits relevant to sedimentation and phosphorus, and its expected contribution to loading was approximately 11,680 lbs/yr total suspended solids and 766.5 lbs/yr total phosphorus (Table 3, Figure 2).

Table 2. Impaired Stream Segments in the Little Lost Creek Subwatershed per the 2016 Final Pennsylvania Integrated Report				
HUC: 02050304 – Lower Juniata				
Source	EPA 305(b) Cause Code	Miles	Designated Use	Use Designation
Crop Related Ag.	Siltation	12	TSF, MF	Aquatic Life
Crop Related Ag.	Nutrients	12	TSF, MF	Aquatic Life

HUC= Hydrologic Unit Code; TSF= Trout Stocking; 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

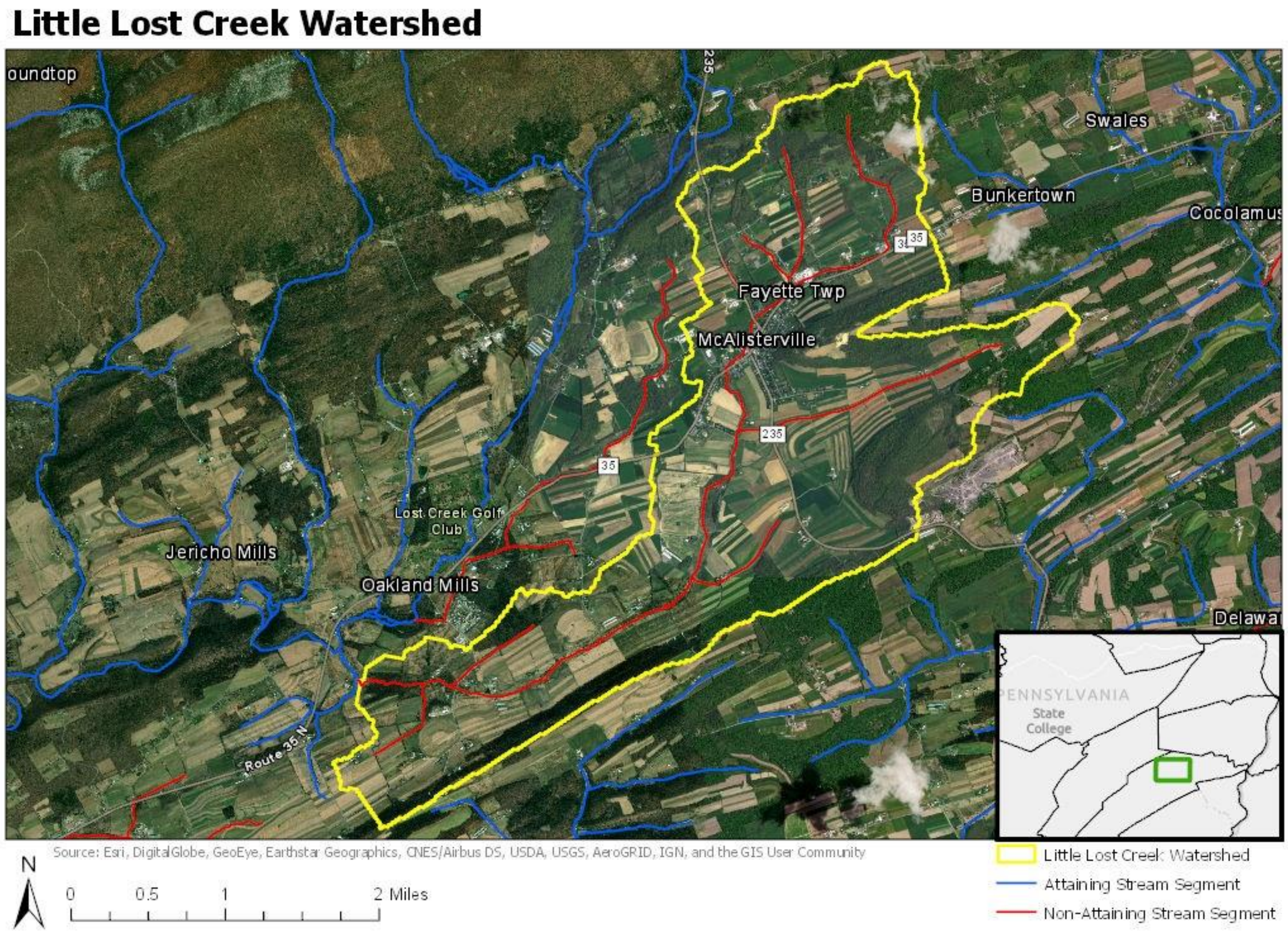

Figure 1. Little Lost Creek Subwatershed, Juniata County. All stream segments within the study watershed were listed as impaired for sediment and nutrients per the 2016 Final Pennsylvania Integrated Report.

Table 3. Existing NPDES Permits in the Little Lost Creek Subwatershed and their Potential Contribution to Sediment and Phosphorus Loading.					
		Sediment Load		Phosphorus Load	
Permit No.	Facility Name	lb/yr	lb/d	lb/yr	lb/d
PA0023604	McAlisterville STP[1]	11,680	32	766.5	2.1
PAG123672	Jay C. Finkbiner[2]	NA	NA	NA	NA

NA – Not applicable. NPDES permit did not include numerical effluent limitations relevant to sediment and/or phosphorus loading.

[1]Based on their NPDES permit issued July 16, 2014. Hydraulic capacity was listed as 0.13 MGD.

[2] Permit for a concentrated animal feeding operation (CAFO). In Pennsylvania, routine, dry-weather discharges from CAFOs are not allowed. Wet weather discharges are controlled through best management practices, which result in infrequent discharges from production areas and reduced sediment/nutrient 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, loadings from CAFOs are accounted for in the modeling of land uses, with the assumption of no additional CAFO-related BMPs.

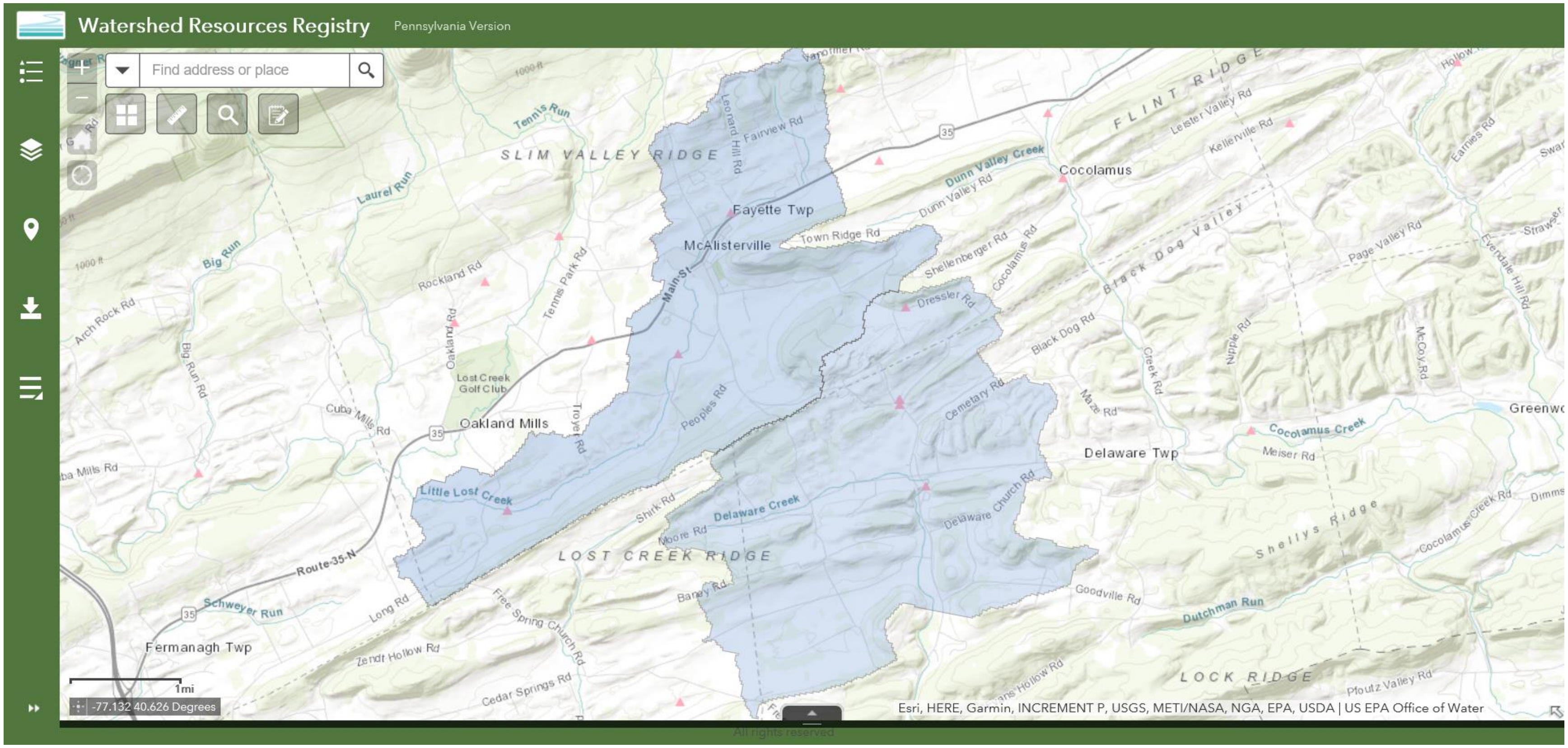

Figure 2. Permitted discharges in the Little Lost Creek Subwatershed (to the north) and the Delaware Creek Subwatershed (to the south). NPDES permitted discharges are indicated by triangles, and the watersheds are shown shaded in blue. This figure was made in EPA's Watershed Resource Registry for Pennsylvania, 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 or phosphorus, the "Reference Watershed Approach" was used. This method estimates loading rates in both the impaired watershed as well as a similar watershed that is not impaired. Then, the loading rates in the unimpaired watershed are 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 and nutrient loading rates. Thus, selection of a reference watershed with similar natural characteristics as the impaired watershed is crucial. Failure to use an appropriate reference watershed could result in problems such as the setting of reduction goals that are unattainable, or nonsensical TMDL calculations that suggest that loadings 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 Little Lost Creek Subwatershed, but lacked stream segments listed as impaired for sediment or nutrients.

Considering that it borders the study watershed and lacked stream segments impaired for sediment or nutrients (Figure 3), the upper Delaware Creek watershed, also located in Juniata County, 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 Delaware 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 Delaware Creek Subwatershed was a suitable reference.

Table 4. Comparison of Little Lost Creek Subwatershed and the Delaware Creek Subwatershed		
	Little Lost Creek Subwatershed	Delaware Creek Subwatershed
Physiographic Province	Ridge and Valley	Ridge and Valley
Area, ac	4,714	4,985
Land Use Distribution	60% Agriculture 30% Forest/Natural Vegetation 10% Other	59% Agriculture 32% Forest/Natural Vegetation 9% Other
Soil Infiltration	16% Group A 34% Group B 5% Group B/D 22% Group C 5% Group C/D 18% Group D	29% Group A 28% Group B 2% Group B/D 20% Group C 4% Group C/D 18% Group D
Bedrock type by dominant lithology	46% Limestone 33% Calcareous Shale 21% Shale	27% Limestone 17% Calcareous Shale 47% Shale 10% Siltstone
Average Annual Precipitation, inches	41.5	41.5
Average Annual Surface Runoff, inches	3.22	2.48
Average Elevation, feet	728	725
Average % Slope	10	11

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 agricultural lands, which comprised nearly twice as much land area as naturally vegetated lands. Also, about a tenth of both watershed lands were developed. Both watersheds had significant quantities of limestone bedrock and both also contained substantial amounts of well-drained and poorly drained soils. The average slope in the two watersheds was nearly equal

As was the case for the impaired study watershed, all stream segments within the Delaware Creek Subwatershed were designated for trout stocking and migratory fishes.

The Delaware Creek Subwatershed only had one substantial NPDES permitted discharge where sediment and phosphorus loading values could be calculated, though loading estimates from a very minor facility serving a single-family residence were included as well (Table 5, Figure 4).

Table 5. Existing NPDES Permits in the Delaware Creek Subwatershed and their Potential Contribution to Sediment and Phosphorus Loading.

		Sediment Load		Phosphorus Load	
Permit No.	Facility Name	lb/yr	lb/d	lb/yr	lb/d
PA0247618	East Salem Sewer Auth.	1,825[A]	5[A]	118[B]	0.3[B]
PA0261157	SFS Kerstetter Velma	12[C]	0.03[C]	2[D]	0.006[D]
PAM414002	McAlisterville Quarry No2[E]	NA	NA	NA	NA
PAR223530	Stella Jones Corp[F]	NA	NA	NA	NA

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

[A]Sediment load based on TSS loading value from their NPDES permit issued June 22, 2018.

[B]NPDES permit lacked P limits. The P values listed above, which were used in modelling existing watershed conditions, were estimated using the nearby McAlisterville STP's permit (see Table 3). The flow listed in East Salem Sewer Authority's permit (0.02 MGD) was approximately 15% of the flow value listed in the McAlisterville STP permit (0.13 MGD), thus it was estimated that the East Salem plant discharged P at 15% of McAlisterville's estimated discharge.

[C]Permit for a small flow wastewater treatment facility. Sediment loading estimated using a 10 mg/l TSS limit and assumed flow of 400 gpd

[D]NPDES permit lacked P limits. The P values listed above, which were used in modelling existing watershed conditions, were estimated using the nearby McAlisterville STP's permit (see Table 3). The estimated flow for Kerstetter permit (0.0004 MGD) was approximately 0.3% of the flow value listed in the McAlisterville STP permit (0.13 MGD), thus it was estimated that the Kerstetter site discharged P at 0.3% of McAlisterville's estimated discharge.

[E]Permit lacked a flow value on which to base loading calculations.

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

After selecting the potential reference, the two watersheds were visited during Spring 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 and nutrients while the other was attaining. It was apparent that streams within both watersheds were highly influenced by agriculture

(Figures 4, 5 and 6). One difference between the two watersheds was that headwater streams in the Little Lost Creek Subwatershed tended to originate in agricultural lands with minimal riparian buffers (Figures 1, 4 and 5) whereas headwater streams in the Delaware Creek Subwatershed more commonly, though not always, originated in forested areas (Figure 3 and 6). Such headwater protection may be especially important given the high connectivity between headwaters and the surrounding landscape. Also, starting with high initial water quality may prevent pollutant inputs occurring downstream from contaminating to the point of impairment.

Substantial efforts have been made to implement agricultural best management practices (BMPs) in the Little Lost Creek Subwatershed. These BMPS included fencing cattle out of streams, incorporating grassy strips between waterways and crop fields, and planting forested riparian buffers (Figure 5). A representative of the Juniata County Conservation District stated that many of the BMPs were established within the past 4 years. Because this work post-dates the Department's most recent assessment data (from 2009), the reductions prescribed for this TMDL were initially calculated without the inclusion of these BMPS. However, the "Implementation" section of this document estimates how these BMPS and other BMPs in progress may be contributing to proposed sediment and phosphorus reductions.

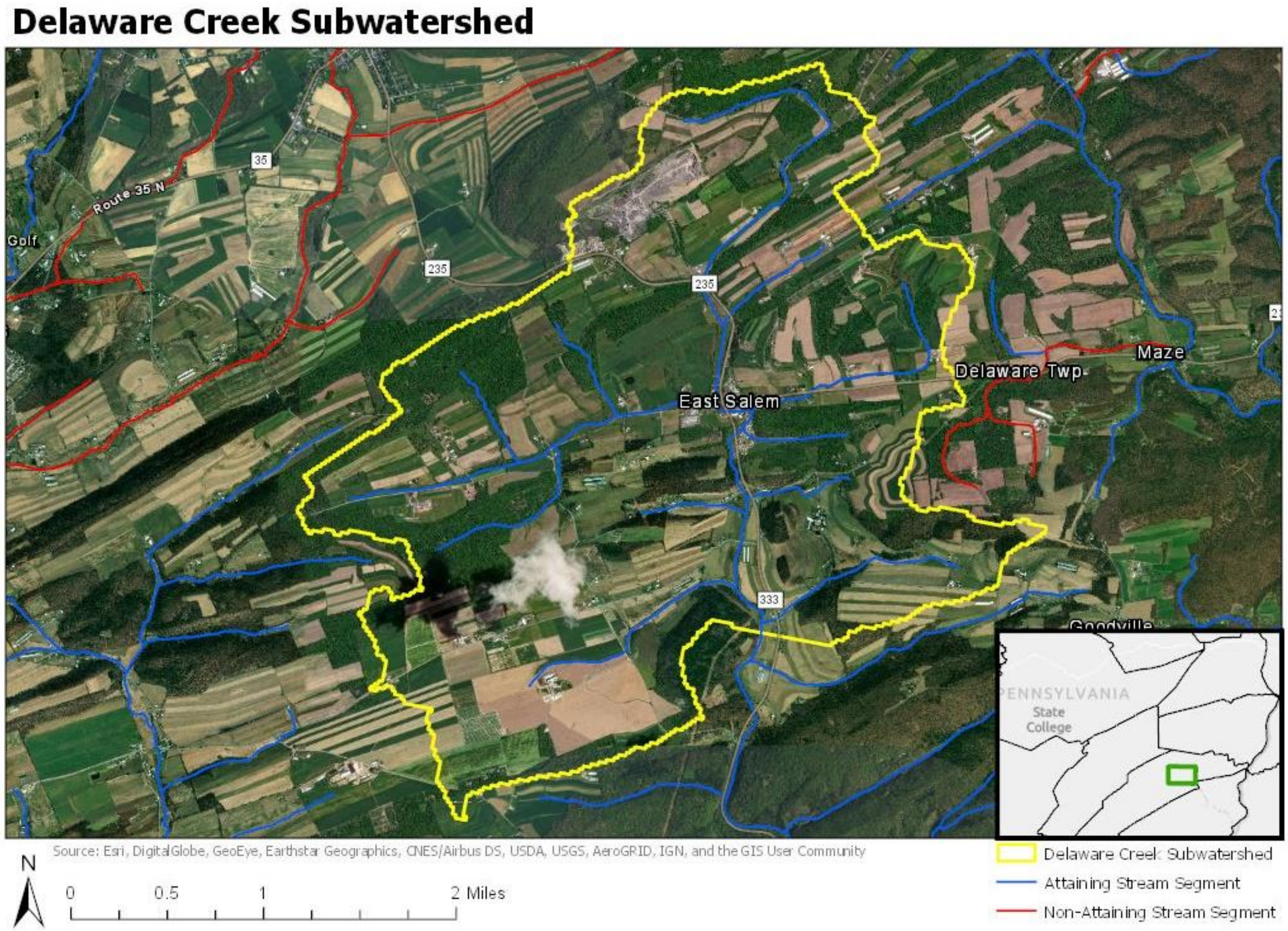

Figure 3. Cocalamus Creek Subwatershed in Juniata County.

Figure 4. Example stream segments among land uses with enhanced sediment and phosphorus loading in the Little Lost Creek Subwatershed. In some cases, streams flowed through agricultural lands with little to no riparian buffering (Photographs A-E). Photograph F shows an unbuffered and channelized stream segment flowing through the village of McAlisterville.

Figure 5. Example BMPs in the Little Lost Creek Subwatershed. Photograph A shows a stream segment with a mature forested buffer, and cattle exclusion fencing was used along the stream segment shown in Photograph B. Grassy buffers separating a stream segments from surrounding croplands are shown in Photographs C and D. Photograph E shows new riparian plantings, still in tree tubes, between a crop field and the stream. Photograph F shows a large floodplain, apparently former pasture land, with new riparian plantings.

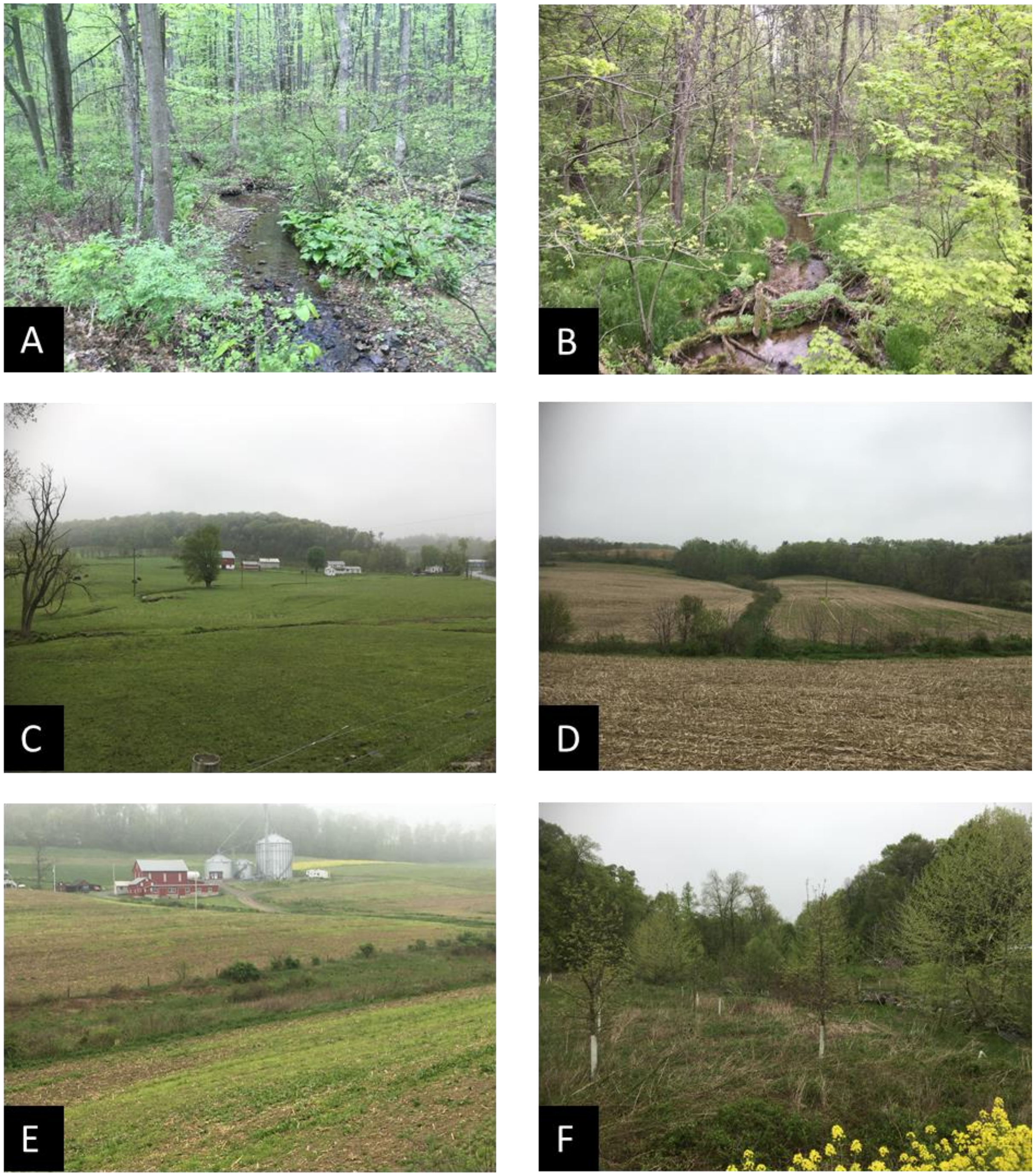

Figure 6. Example stream segments in the unimpaired Delaware Creek reference subwatershed. Headwater tributaries commonly originated in forested areas (Photographs A and B). However, like the impaired watershed, some streams segments flowed through agricultural areas with little or no riparian buffering (Photographs C-E). Note that the vegetated strip along the stream in Photograph E appeared to be used as pasture. Photograph F shows a stream buffer restoration project.

Hydrologic / Water Quality Modeling

The TMDLs for this watershed were 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 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 and nutrient loads 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 and nutrient 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 and efficiency of 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, subsequent to the modelling run, corrections were made for the presence of existing riparian buffers as well as a few minor BMPs observed in the reference watershed (a cattle fencing project, a riparian buffer project and pasture land retirement). These corrections were made using the BMP Spreadsheet Tool provided by Model My Watershed. The following paragraphs describe this 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. 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 29% in the impaired watershed versus 38% 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 the watershed that was croplands, and then by the estimated proportion of riparian buffers, and then by two since both sides of the stream are considered. The BMP spreadsheet tool then calculates sediment and phosphorus 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. 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 and phosphorus loading rates calculated for croplands and then by reduction coefficients of 0.54 for sediment and 0.4 for phosphorus. The calculated reductions were then subtracted from the watershed-wide yearly loading rates 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 equations was deleted for the analysis of historic buffers.

The BMP spreadsheet tool did not calculate reductions for riparian buffers among 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. Likewise, the spreadsheet tool was modified to calculate hay/pastureland retirement using the same logic and methodology as was described for cropland retirement.

Calculation of the TMDL

The mean watershed-wide loading rates for the unimpaired reference subwatershed (Delaware Creek) were estimated to be 420 pounds per acre per year of sediment and 0.99 pounds per acre per year of phosphorus (Table 6). These were substantially lower than the estimated loading rates in the impaired Little Lost Creek Subwatershed (517 pounds per acre per year of sediment and 1.2 pounds per acre per year of phosphorus, Table 7). To achieve the loading rates of the unimpaired watershed, total loadings in the Little Lost Creek Subwatershed should be reduced to 1,977,816 pounds per year of sediment and 4,685 pounds per year of phosphorus, or less (Table 8).

Table 6. Existing Loading Values for Delaware Creek, Reference

Source	Area, ac	Sediment, lbs/yr	Sediment, lb/ac/yr	P lbs/yr	P lbs/ac/yr
Hay/Pasture	1,464	636,934	435	766	0.5
Cropland	1,472	1,132,189	769	1,641	1.1
Forest and Shrub/Scrub	1,590	3,183	2	6	0.004
Wetland	2	2	1	0.0	0.0
Bare Rock	40	97	2	0.9	0.02
Herbaceous/Grassland	2	136	55	0.2	0.09
Low Intensity Mixed Development	395	4,237	11	10.6	0.03
Medium Intensity Mixed Development	15	921	62	2.0	0.1
High Intensity Mixed Development	5	297	60	0.7	0.1
Streambank		311,948		73	
Farm Animals				1,673	
Groundwater				661	
Point Sources		1,837		120	
total	4,985	2,091,781	420	4,955	0.99

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

Table 7. Existing Loading Values for Little Lost Creek, impaired					
Source	Area, ac	Sediment, lbs/yr	Sediment, lb/ac/yr	P lbs/yr	P lbs/ac/yr
Hay/Pasture	1,417	793,671	560	1083	0.8
Cropland	1,425	1,305,391	916	1,777	1.2
Forest and Shrub/Scrub	1,393	3,235	2	7	0.005
Wetland	0	4		0	0.0
Bare Rock	2	4	1	0	0.0
Herbaceous/Grassland	0	12		0	0.0
Low Intensity Mixed Development	440	4,998	11	13	0.03
Medium Intensity Mixed Development	27	1,846	68	4	0.1
High Intensity Mixed Development	10	599	61	1	0.1
Streambank		313,749		75	
Farm Animals				1,587	
Groundwater				551	
Point Sources		11,680		767	
total	4,714	2,435,189	517	5,866	1.2

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

Table 8. TMDL Values for the Little Lost Creek Subwatershed				
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	420	4,714	1,977,816	5,419
Phosphorus	0.99	4,714	4,685	13

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 allocations, the margins of safety and wasteload allocations 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 TMDLs. For this analysis, the MOS for each TMDL was explicitly designated as ten-percent of the TMDLs based on professional judgment. Thus:

Sediment: 1,977,816 lbs/yr TMDL * 0.1 = 197,782 lbs/yr MOS

Phosphorus: 4,685 lbs/yr TMDL * 0.1= 469 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 two National Pollutant Discharge Elimination System (NPDES) point source discharges in the impaired subwatershed, but only one of them, the McAlisterville Sewage Treatment Plant, had significant numeric point source limits for sediment and phosphorus (Table 3, Figure 2). Bulk reserves were 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 WLAs were comprised of the bulk reserves, which we defined as one percent of the targeted TMDLs, plus the permitted sediment and phosphorus loadings from the McAlisterville Wastewater Treatment Plant. Therefore:

Sediment: 1,977,816 lbs/yr TMDL * 0.01 = 19,778 lbs/yr bulk reserve + 11,680 lb/yr permitted loads = 31,458 lbs/yr WLA

Phosphorus: 4,685 lbs/yr TMDL*0.01=47 lbs/yr bulk reserve + 767 lbs/yr permitted loads = 813 lbs/yr WLA

It should be noted that runoff associated with the concentrated animal feeding operation (CAFO) listed in Table 3 was not provided individual wasteload allocations. Runoff 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 reserves.

Load Allocation

Now that the margins of safety and wasteload allocations have been defined, the load allocations (LA) are calculated as:

Sediment: 1,977,816 lbs/yr TMDL – (197,782 lbs/yr MOS + 31,458 lbs/yr WLA) = 1,748,576 lbs/yr LA

Phosphorus: 4,685 lbs/yr TMDL- (469 lbs/yr MOS + 813 lbs/yr WLA) = 3,403 lbs/yr LA

Loads Not Reduced and Adjusted Load Allocation

Since the impairments addressed by this TMDL are due to agriculture, sediment and phosphorus contributions from forests, wetlands, non-agricultural herbaceous/grasslands and developed lands, bare rock, and groundwater (for phosphorus) within the Little Lost Creek Watershed were considered loads not reduced (LNR). LNR were calculated to be 10,698 lbs/yr for sediment and 577 lbs/yr for phosphorus (Table 9).

The LNRs were subtracted from the LAs to determine the ALAs:

Sediment: 1,748,576 lbs/yr LA – 10,698 lbs/yr LNR = 1,737,878 lbs/yr ALA

Phosphorus: 3,403 lbs/yr LA – 577 lbs/yr LNR = 2,826 lbs/yr ALA

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

	Sediment, lbs/yr	Sediment, lbs/d	Phosphorus lbs/yr	Phosphorus lbs/d
Load Allocation (LA)	**1,748,576**	**4,791**	**3,403**	**9**
Loads Not Reduced (LNR):	**10,698**	**29**	**577**	**1.6**
Forest	3,235	9	7.5	0.02
Wetlands	4	0.0	0.0	0.0
Non-Agricultural Herb./Grasslands	12	0.0	0.0	0.0

Low Intensity Mixed Development	4,998	14	13	0.04
Med. Intensity Mixed Dev.	1,846	5.1	4.0	0.01
High Density Mixed Development	599	1.6	1.3	0.004
Bare Rock	4	0.0	0.0	0.0
Groundwater	0.0	0.0	551	1.5
Adjusted Load Allocation (ALA)	**1,737,878**	**4,761**	**2,828**	**7.7**

Calculation of Load Reductions

To calculate load reductions by source, the ALAs were further analyzed using the Equal Marginal Percent Reduction (EMPR) allocation method described in Appendix D. Although the Little Lost Creek TMDLs were developed to address impairments caused by agricultural activities, streambanks were also significant contributors to the sediment and phosphorus loadings 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 ALA categories exceeded the allocable loads of sediment or phosphorus by themselves. Thus, all were assigned reduction goals of 28% for sediment, and 38% for phosphorus (Tables 10 and 11).

Table 10. Sediment Load Allocations for Source Sectors in the Little Lost Creek Subwatershed

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	1,425	660	940,235	916	1,305,391	28%
HAY/PASTURE	1,417	403	571,658	560	793,671	28%
STREAMBANK			225,985		313,749	28%
AGGREGATE			1,737,878		2,412,811	28%

Daily Values						
	Acres	Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/ac/day	lbs/d	lbs/ac/d	lbs/d	
CROPLAND	1,425	1.8	2,576	2.5	3,576	28%
HAY/PASTURE	1,417	1.1	1,566	1.5	2,174	28%
STREAMBANK			619		860	28%
AGGREGATE			4,761		6,610	28%

Table 11. Phosphorus Load Allocations for Source Sectors in the Little Lost Creek Subwatershed						
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	1,425	0.78	1,111	1.25	1,777	38%
HAY/PASTURE	1,417	0.48	677	0.76	1,083	38%
STREAMBANK			47		75	38%
FARM ANIMALS			992		1,587	38%
AGGREGATE			2,826		4,522	38%
Daily Values						
	Acres	Allowable Loading	Load Allocation	Current Loading	Current Load	Reduction Goal
Land Use	Acres	lbs/ac/day	lbs/d	lbs/ac/d	lbs/d	
CROPLAND	1,425	0.0021	3.0	0.0034	4.9	38%
HAY/PASTURE	1,417	0.0013	1.9	0.0021	3.0	38%
STREAMBANK			0.1		0.2	38%
FARM ANIMALS			2.7		4.3	
AGGREGATE			7.7		12.4	38%

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 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 and phosphorus to a waterbody and the resulting impact on beneficial uses, establishing this TMDL using average annual conditions is protective for the waterbody.

Implementation

It was apparent during site visits that progress has already been made in implementing agricultural BMPs within the Little Lost Creek Watershed (Figure 5). According to correspondence with the Juniata County Conservation District, there has been interest in restoring Little Lost Creek because it is recognized as a pollutant source to Lost Creek. Lost Creek is designated for High-Quality Cold-Water Fishes and is classified as a Class-A Wild Trout Stream a short distance upstream of the confluence with Little Lost Creek. Downstream of the confluence with Little Lost Creek however, it is simply designated for Trout Stocking. It is hoped that by implementing watershed restoration efforts along lower Lost Creek, Little Lost Creek, and other tributaries in the area, the wild trout population may be expanded.

The author attempted to document and model the obvious recent BMPs that were visible from the road. Estimates of BMP locations were drawn on printouts of imagery in the field, and then dimensions were estimated using GIS measuring tools back at the office. Where it appeared that significant hay/pasture land or cropland may have been retired when establishing riparian buffers or fencing cattle from streams, this land retirement was included as a separate BMP, with the assumption that it was converted to forested area. By comparing the locations of riparian buffers to surrounding land use per the NLCD 2011 landcover raster layer, buffering reductions were assigned to either cropland or hay and pasture lands. Calculations of BMP reductions were made using a customized version of the BMP Spreadsheet Tool provided by the Model My Watershed Program.

Recent BMPs or BMPs in Progress	Sediment lbs/yr removed	Phosphorus lbs/yr removed
33.79 acres riparian crop buffers	33,897	34.1
11.27 acres riparian hay/pasture buffers	6,910	7
6.09 acres cropland retired	5,643	7.6
2,401 ft streambanks fenced from cattle	6,123	8.4
36.93 acres pasture retired	20,877	28.3
90% ag. erosion and sedimentation plan implementation	190,559	161.6
90% nutrient management plan implementation	n/a	760.4
subtotal	*264,009*	*1007.4*
Hypothetical Proposed BMPS		
additional 5% ag. erosion and sedimentation plan implementation	10,587	9.0
additional 5% nutrient management plan implementation		42.2
additonal 68 acres riparian crop buffers (2X recent amount)	68,215	68.5
68 acres croplands removed in establishing previous	63,004	85.3
3,000 feet streambank stabilization	345,000	522.0
subtotal	*486,806*	*727.0*
all reductions total	***750,815***	***1,734***
	lbs/yr	*lbs/yr*
current loading for targeted sectors [1]	2,412,811	4,522
current loading targeted sectors - all reductions	1,661,996	2,788
adjusted loads allocation	1,739,075	2,828

[1] *Targeted sectors include croplands, hay/pasture, and streambanks for sediment, and these three plus farm animals for phosphorus*

Table 12. Recent, in-progress and hypothetical BMPs in the Little Lost Creek Subwatershed

It was also sought to account for management practice BMPs. Considering that BMPs such as conservation tillage, use of cover crops, grazing practices, nutrient management practices etc. would be called for by required Erosion and Sedimentation and Nutrient Management Plans (see Appendix E), the implementation of these plans were modelled as BMPs rather than each practice individually. Compliance inspections for these plans have begun, and a 90% implementation rate is assumed for the near future. The total estimated reductions for these recent and in-progress BMPs is 264,009 lbs/yr of sediment and 1,007 lbs/yr phosphorus (Table 12).

In order to demonstrate how the adjusted loads allocations could ultimately be achieved, hypothetical BMPs were also proposed in Table 12. It may be feasible to bring the rate of compliance with agricultural plans to 95% over the long term and double the amount of recently-established cropland buffers. Where buffers are established on former croplands, credit could be claimed for the cropland retirement in addition to the buffering effect. Streambank stabilization results in very large estimated sediment and phosphorus reductions, and three parcels were identified as potential candidates for such projects. One of the parcels, with approximately 2,000 feet of mainstem flowing through it, was confirmed to have significant bank erosion problems. The other two parcels also have approximately 2,000 feet each of mainstem flowing through them and are suspected of having bank erosion problems based on their appearance in satellite imagery and their view from a distance. For the sake of modelling reductions, it was conservatively assumed that 3,000 feet of streambank stabilization could take place among these sites. Taken together, these hypothetical BMPs would be estimated to reduce sediment and phosphorus loading by 486,806 lbs/yr and 727 lbs/yr respectively. The total estimated reductions associated with the recent/in-progress BMPs and proposed BMPs, 750,815 lbs/yr sediment and 1,734 lbs/yr phosphorus, would be more than sufficient to achieve the adjusted loads allocations (Table 12). It should be noted that there are other potential BMPs for consideration as well, such as use of cover crops, conservation tillage, floodplain restoration, grazing land management, animal waste management systems, etc. However, to avoid double counting, these BMPs should only be counted separately if implemented beyond what is necessary to satisfy the required erosion and sedimentation and nutrient management plans.

Even though the establishment of riparian buffers is estimated to result in relatively modest sediment and phosphorus reductions (Table 12), use of riparian buffers is widely recognized as one of the best ways to promote stream health. Not only do riparian buffers protect streambanks and filter out pollutants, they also provide habitat and nutrition for aquatic, semi-aquatic and terrestrial organisms, and moderate stream temperature. Thus, their use is encouraged wherever feasible.

Summary

This document proposes a 19% reduction in sediment loading and 20% reduction in phosphorus loading for the Little Lost Creek Subwatershed. To achieve these goals while maintaining margins of safety and minor allowances for point sources, it is proposed to reduce sediment loading from croplands, hay/pasture lands and streambanks by 28% each, and reduce phosphorus loading from croplands, hay/pasture, streambanks and farm animals by 38% each.

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 and phosphorus reductions. The hypothetical BMPs mentioned previously in the "Implementation" section are merely suggestions for how the TMDL may be achieved. 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 July 13, 2019 to foster public comment. A 30-day period was provided for the submittal of comments. No public comments were received.

Citations

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

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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 sought to select 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 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 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 (km^2)	Coverage (%)
Open Water	11	0.01	0.1
Perennial Ice/Snow	12	0	0
Developed, Open Space	21	1.27	6.6
Developed, Low Intensity	22	0.51	2.7
Developed, Medium Intensity	23	0.11	0.6
Developed, High Intensity	24	0.04	0.2
Barren Land (Rock/Sand/Clay)	31	0.01	0.1
Deciduous Forest	41	5.26	27.5
Evergreen Forest	42	0.1	0.5
Mixed Forest	43	0.13	0.7
Shrub/Scrub	52	0.15	0.8
Grassland/Herbaceous	71	0	0
Pasture/Hay	81	5.74	30.1
Cultivated Crops	82	5.77	30.2
Woody Wetlands	90	0	0
Emergent Herbaceous Wetlands	95	0	0

Table B1. “Model My Watershed” Land Cover Outputs for the Little Lost Creek Subwatershed

Type	NLCD Code	Area (km^2)	Coverage (%)
Open Water	11	0	0
Perennial Ice/Snow	12	0	0
Developed, Open Space	21	1.3	6.4
Developed, Low Intensity	22	0.3	1.5
Developed, Medium Intensity	23	0.06	0.3
Developed, High Intensity	24	0.02	0.1
Barren Land (Rock/Sand/Clay)	31	0.16	0.8
Deciduous Forest	41	5.81	28.8
Evergreen Forest	42	0.25	1.2
Mixed Forest	43	0.27	1.3
Shrub/Scrub	52	0.11	0.6
Grassland/Herbaceous	71	0.01	0.1
Pasture/Hay	81	5.93	29.4
Cultivated Crops	82	5.96	29.5
Woody Wetlands	90	0.01	0
Emergent Herbaceous Wetlands	95	0	0

Table B2. “Model My Watershed” Land Cover Outputs for the Delaware Creek Subwatershed

Month	Stream Flow (cm)	Surface Runoff (cm)	Subsurface Flow (cm)	Point Src Flow (cm)	ET (cm)	Precip (cm)
Jan	5.75	1.12	4.55	0.08	0.33	7.15
Feb	6.42	1.39	4.95	0.07	0.51	7.31
Mar	7.27	0.75	6.44	0.08	1.82	8.36
Apr	6.14	0.22	5.85	0.08	4.61	8.41
May	4.39	0.21	4.1	0.08	8.98	10.51
Jun	3.51	0.99	2.44	0.08	12.15	10.58
Jul	1.44	0.24	1.12	0.08	11.31	9.86
Aug	0.63	0.19	0.36	0.08	9	8.64
Sep	1.13	0.9	0.15	0.08	5.85	9.04
Oct	1.38	0.72	0.58	0.08	3.66	8.06
Nov	2.34	0.61	1.66	0.08	1.76	9.38
Dec	5.02	0.83	4.11	0.08	0.7	8.11
Total	45.42	8.17	36.31	0.95	60.68	105.41

Table B3. “Model My Watershed” Hydrology Outputs for the Little Lost Creek Subwatershed

Month	Stream Flow (cm)	Surface Runoff (cm)	Subsurface Flow (cm)	Point Src Flow (cm)	ET (cm)	Precip (cm)
Jan	5.44	0.84	4.59	0.01	0.33	7.15
Feb	6.25	1.05	5.19	0.01	0.51	7.31
Mar	7.27	0.55	6.71	0.01	1.79	8.36
Apr	6.21	0.17	6.03	0.01	4.57	8.41
May	4.39	0.16	4.22	0.01	8.9	10.51
Jun	3.43	0.86	2.56	0.01	12.44	10.58
Jul	1.4	0.18	1.21	0.01	11.81	9.86
Aug	0.54	0.14	0.39	0.01	9.34	8.64
Sep	0.89	0.73	0.15	0.01	6.01	9.04
Oct	1.09	0.56	0.52	0.01	3.63	8.06
Nov	1.99	0.45	1.53	0.01	1.75	9.38
Dec	4.6	0.62	3.97	0.01	0.69	8.11
Total	43.5	6.31	37.07	0.12	61.77	105.41

Table B4. “Model My Watershed” Hydrology Outputs for the Delaware Creek Subwatershed

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus
Hay/Pasture	364,887.10	1,535.60	496.1
Cropland	600,148.80	3,842.10	814.1
Wooded Areas	1,467.30	42.6	3.4
Wetlands	1.7	0.2	0
Open Land	5.5	0.1	0
Barren Areas	1.6	0.7	0
Low-Density Mixed	653	15.9	1.7
Medium-Density Mixed	837.3	17.3	1.8
High-Density Mixed	271.8	5.6	0.6
Low-Density Open Space	1,613.60	39.3	4.2
Farm Animals	0	2,613.40	719.9
Stream Bank Erosion	142,290.00	108	34
Subsurface Flow	0	25,775.50	249.9
Point Sources	0	0	0
Septic Systems	0	39.8	0

Table B5. Model My Watershed outputs for sediment and phosphorus (kg) in the Little Lost Creek Subwatershed. Note that sediment and phosphorus 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)	Total Nitrogen (kg)	Total Phosphorus
Hay/Pasture	296,525.60	1,141.90	354.4
Cropland	524,148.30	3,752.20	755.8
Wooded Areas	1,443.60	29	2.7
Wetlands	1	0.1	0
Open Land	61.7	1.5	0.1
Barren Areas	44.2	10.3	0.4
Low-Density Mixed	357.2	8.2	0.9
Medium-Density Mixed	417.6	8.6	0.9
High-Density Mixed	134.5	2.8	0.3
Low-Density Open Space	1,564.50	36	3.9
Farm Animals	0	2,754.60	758.6
Stream Bank Erosion	142,005.00	113	34
Subsurface Flow	0	32,731.40	299.8
Point Sources	0	0	0
Septic Systems	0	20.7	0

Table B6. Model My Watershed outputs for sediment and phosphorus (kg) in the Delaware Creek Subwatershed. Note that sediment and phosphorus 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, as well as a pasture retirement project.

Appendix C: Stream Segments in the Little Lost Creek Subwatershed with Siltation and Nutrient Impairments

STR_ASSESS	STR_ATTAIN	SOURCE_CAU	STR_HUC	COMID	INT_LENGTH	DTE_CREATE
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66203845	0.886228	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66203847	0.423548	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66203865	1.729908	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66203867	0.080871	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66203873	0.189122	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204007	1.823024	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204009	1.188974	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204139	1.108329	7/7/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204145	0.769636	10/19/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204397	0.670393	10/19/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204401	0.211727	10/19/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204403	1.995458	10/19/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204433	0.537885	10/19/2000
Aquatic Life	Impaired	Crop Related Agric - Nutrients ; Crop Related Agric - Siltation	2050304	66204499	0.630633	10/19/2000

Table C1. Listing of stream segments with aquatic life impairements in the Little Lost Creek Subwatershed. Note that “SOURCE_CAU” in the above table stands for source and cause.

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					1737877.8	1737877.8					
	1977815.7											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	1305391.1	2412811.2	good	1305391.1		0.5	365155.8	940235.3	1424.7	660.0	28.0%
	HAY/PASTURE	793670.7		good	793670.7	674933.5	0.3	222012.8	571657.9	1417.3	403.3	28.0%
	STREAMBANK	313749.5		good	313749.5		0.1	87764.8	225984.6			28.0%
					2412811.2		1.0		1737877.8			
4	All Ag. Loading Rate	531.99										
			Allowable		Current	Current	**Reduction**					
	Land Use	Acres	loading rate	Final LA	Loading Rate	Load	**Goal**			CURRENT LOAD	FINAL LOAD ALLOCATION	
5	CROPLAND	1,425	660	940,235	916	1,305,391	**28%**		HAY/PASTURE	793,671	571,658	
	HAY/PASTURE	1,417	403	571,658	560	793,671	**28%**		STREAMBANK	313,749	225,985	
	STREAMBANK			225,985		313,749	**28%**		CROPLAND	1,305,391	940,235	
	AGGREGATE		ALA	1,737,878		2,412,811	**28%**		AGGREGATE	2,412,811	1,737,878	

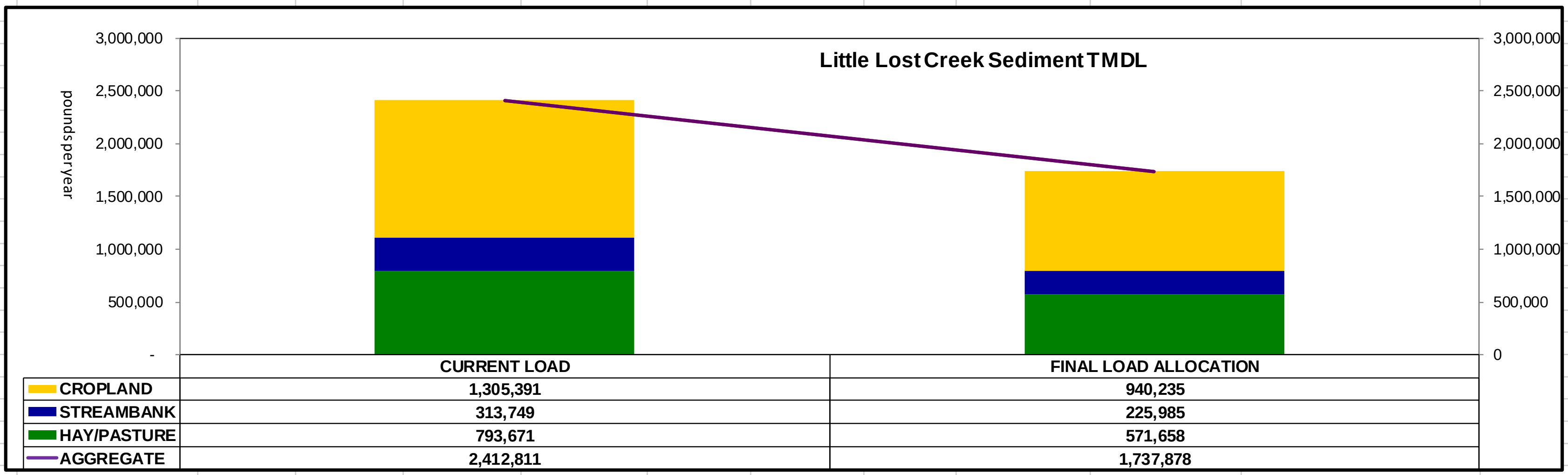

Table D1. Sediment Equal Marginal Percent Reduction calculations for the Little Lost Creek Subwatershed

1	TMDL				2	ALA = TMDL total load - (MOS + WLA + loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					2826.4	2826.4					
	4685.1											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	1777.1	4522.3	good	1777.1		0.4	666.4	1110.6	1424.7	0.78	37.50%
	HAY/PASTURE	1082.9		good	1082.9	1696.0	0.2	406.1	676.8	1417.3	0.48	37.5%
	STREAMBANK	75.0		good	75.0		0.0	28.1	46.9			37.5%
	Farm Animals	1587.4		good	1587.4		0.4	595.3	992.1			37.5%
					4522.3		1.0		2826.4			
4	All Ag. Loading Rate	0.63										
			Allowable		Current	Current	**Reduction**					
	Land Use	Acres	loading rate	Final LA	Loading Rate	Load	**Goal**			CURRENT LOAD	AL LOAD ALLOCATION	
5	CROPLAND	1,424.7	0.78	1,110.6	1.247	1,777	**37.50%**		HAY/PASTURE	1,083	677	
	HAY/PASTURE	1,417.3	0.48	676.8	0.76	1,083	**37.5%**		Farm Animals	1,587	992	
	STREAMBANK	-		46.9		75	**37.5%**		CROPLAND	1,777	1,111	
	Farm Animals			992.08		1,587	**37.5%**		STREAMBANK	75	47	
	AGGREGATE		ALA	2,826.38		4,522	**37.50%**		AGGREGATE	4,522	2,826	

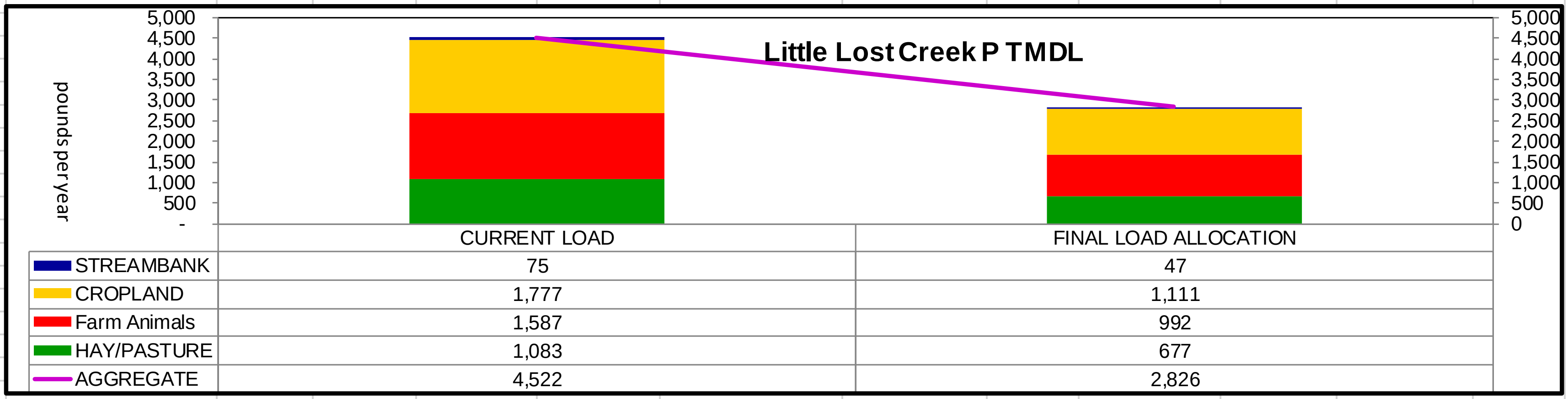

Table D2. Phosphorus Equal Marginal Percent Reduction calculations for the Little Lost Creek Watershed

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 public comments were received.