Crooked Creek Suspended Solids TMDL
Allegheny River

Armstrong and Indiana Counties
Pennsylvania

Prepared by:

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DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Summary of the Crooked Creek TMDLs

1. These TMDLs were developed for Crooked Creek, SWP 17E, located in Armstrong and Indiana Counties, Pennsylvania. The watershed is 195.3 square miles. It is a tributary of the Allegheny River. Access to the watershed is available by traveling Route 422 west from Indiana. Protected stream uses in the watershed include aquatic life, water supply, and recreation. The lower section of the basin is currently designated as Warm Water Fishes (WWF) under §93.9t in Title 25 of the Pa. Code. Other portions of the watershed are designated as cold Water Fishes (CWF) and the headwaters, of South Branch Plum Creek is designated as a special protection High Quality (HQ) Watershed.

2. TMDLs for the Crooked Creek Watershed were developed to address use impairments caused by suspended solids. Crooked Creek first appeared on Pennsylvania's 303(d) list in 1996, when the mainstem were listed as impaired by suspended solids emanating from upstream mining activities. Suspended solids TMDLs were developed to address suspended solids impairments identified in the Department's current Integrated Water Quality Report. This suspended solids TMDL report supersedes and replaces the TMDLs established in the report, Total Maximum Daily Loads (TMDLs) Crooked Creek Watershed, dated March 5, 2009 and approved by the U.S. Environmental Protection Agency, Region 3 on April 8, 2009. In order to ensure attainment and maintenance of water quality standards in the Crooked Creek Watershed, mean annual loading of suspended solids will need to be limited to 75,880,797 lbs./yr.

   The major components of the Crooked Creek Watershed TMDLs are summarized below:

Component	Suspended solids (lbs./yr.)
TMDL (Total Maximum Daily Load)	75,880,797
WLA (Wasteload Allocation)	12,278,280
MOS (Margin of Safety)	7,588,080
LA (Load Allocation)	56,014,437

3. The current mean annual suspended solids loading to Crooked Creek is estimated to be 109,963,026 lbs./yr., requiring a 31% reduction to meet the TMDL.

4. There are 13 mining related NPDES permits and 33 NPDES permits (storm water, public and private STPs, and industrial discharges) point sources of suspended solids located in the Crooked Creek Watershed; and were adjusted in the Waste Load Allocation (WLA). An additional allocation of 1% of the suspended solids TMDL (75,880,797 lbs./yr.) was incorporated as a bulk reserve (758,807.97 lbs./yr.) for the dynamic nature of future permit activity.

5. The suspended solids TMDL includes a nonpoint source load allocation (LA) of 56,014,437 lbs./yr. Adjusted Load Allocations to sources receiving reductions (ALA) total 51,191,977 lbs./yr. Suspended solids loadings from nonpoint sources not reduced (LNR) were maintained at 4,822,460 lbs./yr. Allocations of suspended solids to all nonpoint sources in the Crooked Creek Watershed are summarized below:

Load Allocations for Sources of Suspended solids			
Source	**Current Loading (lbs./yr.)**	**Load Allocation (lbs./yr.)**	**% Reduction**
Coal_Mines	1,677,900	1,053,439	37%
Transition	2,925,060	1,836,445	37%
Cropland	25,742,800	16,162,146	37%
Stream Bank	63,275,314	32,139,947	49%

Adjusted Loads Allocation to NPS Reduced (ALA)	**93,621,074**	**51,191,977**	**45%**
NPS Loads Not Reduced (LNR)	4,822,460	4,822,460	0%
Total Load Allocations (LA)	**98,443,534**	**56,014,437**	**45%**

6. Ten percent of the Crooked Creek suspended solids TMDLs were set-aside as a margin of safety (MOS). The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. The MOS for the suspended solids TMDL was set at 7,588,080 lbs./yr.

7. The continuous simulation model used for developing the Crooked Creek TMDLs considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The combination of these actions accounts for seasonal variability.

I. Introduction

Watershed Description

Crooked Creek is part of State Water Plan subbasin 17E, HUC 05010006-Allegheny-Redbank, and is located Northwest of Indiana in Armstrong and Indiana Counties, Pennsylvania (Figure 1). Access to the watershed is available by traveling west from Indiana on Route 422. Protected stream uses in the watershed include aquatic life, water supply, and recreation. The entire basin is currently designated as Cold Water Fishes (CWF) under §93.9t in Title 25 of the Pa. Code. 1. Crooked Creek drains portions of the Appalachian Plateau physiographic province. Land use in the Crooked Creek basin is dominated by forest (58%) and agriculture (37%). Other land uses include coal mines (0.3%), development (3%), and transitional land (0.5%). Agricultural activities, primarily row and cover crops, are randomly distributed throughout the Crooked Creek Watershed.

Surface Water Quality

The *2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, Streams, Category 5, Waterbodies, Pollutants Requiring A TMDL* identified 34.62 miles of the Crooked Creek watershed as impaired by suspended solids (listed as “Cause: Siltation”). Sources include: removal of vegetation, bank modification small residential runoff, abandoned mines, agriculture, grazing related agriculture, construction, highway road bridge construction, and road runoff (listed as “Cause: Cause Unknown”). The 305b database entry for the station on Crooked Creek includes the following comment: “Crooked Creek is impaired due to severe runoff problems from the abandoned mine site at Ernest, the watershed also has numerous problems with field crops and livestock.” (Table 1)(Figure 1).

Table 1 - Impaired Waters Listings for Crooked Creek Watershed

2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a and 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Hydrologic Unit Code: 05010006-Middle Allegheny-Redbank			
Anthony Run HUC: 05010006			
Aquatic Life (15946) - 1.9 miles			
Removal of Vegetation	Siltation	2012	2025
Cheese Run HUC: 05010006			
Aquatic Life (15943) - 1.34 miles			
Removal of Vegetation	Siltation	2012	2025
Aquatic Life (15944) - 0.95 miles			
Bank Modifications	Siltation	2012	2025
Removal of Vegetation		2012	2025
Small Residential Runoff		2012	2025
Crooked Creek HUC: 05010006			
Aquatic Life (15914) - 0.41 miles			
Abandoned Mine Drainage	Siltation	2012	2025
Agriculture		2012	2025
Removal of Vegetation		2012	2025
Curry Run HUC: 05010006			
Aquatic Life (15944) - 1.69 miles			
Bank Modifications	Siltation	2012	2025
Removal of Vegetation		2012	2025
Small Residential Runoff		2012	2025
Dark Hollow Run HUC: 05010006			
Aquatic Life (4886) - 1.14 miles			
Grazing Related Agric	Siltation	2004	2017
Dutch Run HUC: 05010006			
Aquatic Life (16211) - 2.76 miles			
Bank Modifications	Siltation	2012	2025
Removal of Vegetation		2012	2025
Small Residential Runoff		2012	2025
Goose Run HUC: 05010006			
Aquatic Life (4857) - 1 miles			
Grazing Related Agric	Siltation	2004	2017

2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a and 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
McKee Run Unnamed To (ID:123858663) HUC: 05010006			
Aquatic Life (4383) - 0.54 miles			
Road Runoff	Cause Unknown	2004	2017
Pine Run HUC: 05010006			
Aquatic Life (15901) - 1.15 miles			
Bank Modifications	Siltation	2012	2025
Small Residential Runoff		2012	2025
Pine Run Unnamed To (ID:123861172) HUC: 05010006			
Aquatic Life (15901) - 0.42 miles			
Bank Modifications	Siltation	2012	2025
Small Residential Runoff		2012	2025
Pine Run Unnamed To (ID:123861180) HUC: 05010006			
Aquatic Life (15901) - 0.94 miles			
Bank Modifications	Siltation	2012	2025
Small Residential Runoff		2012	2025
Plum Creek HUC: 05010006			
Aquatic Life (15900) - 2.14 miles			
Habitat Modification	Siltation	2012	2025
Upstream Impoundment		2012	2025
Reddings Run HUC: 05010006			
Aquatic Life (16214) - 4.03 miles			
Agriculture	Siltation	2012	2025
Bank Modifications		2012	2025
Removal of Vegetation		2012	2025
Road Runoff		2012	2025
Small Residential Runoff		2012	2025
Reddings Run Unnamed To (ID:123851626) HUC: 05010006			
Aquatic Life (16214) - 0.8 miles			
Agriculture	Siltation	2012	2025
Bank Modifications		2012	2025
Removal of Vegetation		2012	2025
Road Runoff		2012	2025
Small Residential Runoff		2012	2025

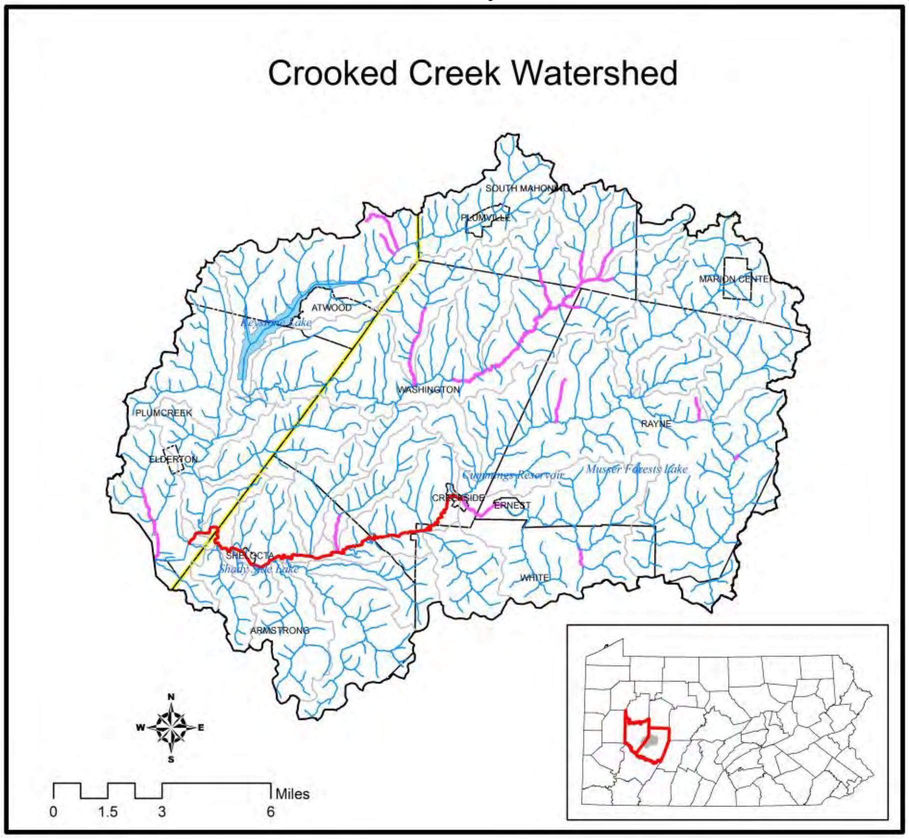
2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a and 5 Waterbodies, Pollutants Requiring a TMDL

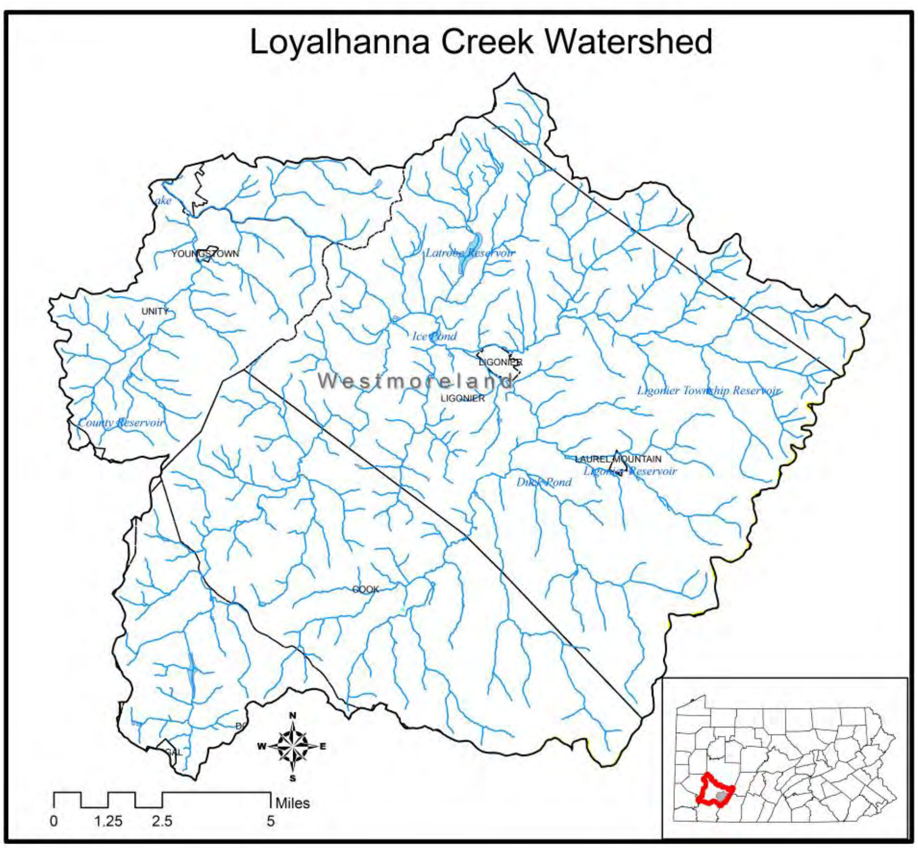
Stream Name HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Reddings Run Unnamed To (ID:123851647) HUC: 05010006			
Aquatic Life (16214) - 0.78 miles			
Agriculture	Siltation	2012	2025
Bank Modifications		2012	2025
Removal of Vegetation		2012	2025
Road Runoff		2012	2025
Small Residential Runoff		2012	2025
Reddings Run Unnamed To (ID:123851656) HUC: 05010006			
Aquatic Life (16214) - 0.46 miles			
Agriculture	Siltation	2012	2025
Bank Modifications		2012	2025
Removal of Vegetation		2012	2025
Road Runoff		2012	2025
Small Residential Runoff		2012	2025
South Branch Plum Creek HUC: 05010006			
Aquatic Life (4307) - 3.4 miles			
Grazing Related Agric	Siltation	2004	2017
Aquatic Life (4312) - 1.04 miles			
Grazing Related Agric	Siltation	2004	2017
Aquatic Life (4318) - 2.77 miles			
Grazing Related Agric	Siltation	2004	2017
Removal of Vegetation		2004	2017
Aquatic Life (15942) - 1.54 miles			
Bank Modifications	Siltation	2012	2025
South Branch Plum Creek Unnamed To (ID:123851608) HUC: 05010006			
Aquatic Life (4294) - 0.49 miles			
Removal of Vegetation	Siltation	2004	2017
South Branch Plum Creek Unnamed To (ID:123851617) HUC: 05010006			
Aquatic Life (4300) - 0.49 miles			
Construction	Siltation	2004	2017
Sugarcamp Run HUC: 05010006			
Aquatic Life (4203) - 1.02 miles			
Abandoned Mine Drainage	Siltation	2004	2017
Twomile Run HUC: 05010006			
Aquatic Life (16213) - 0.47 miles			
Bank Modifications	Siltation	2012	2025
Small Residential Runoff		2012	2025

2014 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a and 5 Waterbodies, Pollutants Requiring a TMDL

Stream Name HUC Use Assessed (Assessment ID) - Miles Source	Cause	Date Listed	TMDL Date
Walker Run HUC: 05010006			
Aquatic Life (15947) - 0.94 miles			
Agriculture	Siltation	2012	2025
Highway, Road, Bridge Const.		2012	2025
Removal of Vegetation		2012	2025

Figure 1 - Crooked Creek Watershed & Loyalhanna Creek Watershed (Reference)





II. Approach to TMDL Development

Pollutants & Sources

Suspended solids have been identified as the pollutants causing designated use impairments in the Crooked Creek Watershed. Based on information contained in the Department's 305(b) report database, siltation from stream banks and cropland appear to be the primary source of pollutants.

TMDL Endpoints

Pennsylvania does not currently have specific numeric criteria for sediment. Therefore, to establish endpoints such that the designated uses of the Crooked Creek watershed are attained and maintained, for all waterbodies, Pennsylvania utilizes its narrative water quality criteria, which state that:

> *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)).*

In an effort to address suspended solids impairments found in the Crooked Creek Watershed, Total Maximum Daily Loads (TMDLs) were developed for suspended solids. Based on a reference watershed approach, a total load capacity (or endpoint) of 75,880,797 lbs./yr. was determined to be an amount of suspended solids that is protective of all designated uses will address the suspended solids impairments.

Reference Watershed Approach

The TMDLs developed for the Crooked Creek Watershed address suspended solids. Because neither Pennsylvania nor EPA has instream numerical water quality criteria for suspended solids, a method was developed to implement the applicable narrative criteria. The method employed for these TMDLs is termed the "Reference Watershed Approach." Meeting the water quality objectives specified by these TMDLs will result in the impaired stream segments attaining their designated uses.

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. Other features such as base geologic formation should be matched to the extent possible; however, most variations can be adjusted in the model. The objective of the process is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to, or slightly lower than, the loading rate in the non-impaired, reference segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

Selection of the Reference Watershed

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that the Department has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology. Finally, the size of the reference watershed should be within 20-30% of the impaired watershed area.

The search for a reference watershed for Crooked Creek that would satisfy the above characteristics was done by means of a desktop screening using several GIS coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land cover/use grid, the Pennsylvania's 305(b) assessed streams database, and geologic rock types.

The headwaters of Loyalhanna Creek Watershed located upstream of Crooked Creek was selected as the reference watershed for developing the Crooked Creek TMDLs (Figure 4). The watershed is located in State Water Plan subbasin 17E and protected uses include aquatic life, water supply, and recreation. Based on the Department's 305(b) report database, the headwaters of Loyalhanna Creek is currently attaining its designated uses. The attainment of designated uses is based on sampling done by the Department in 2002, using the Statewide Surface Water Assessment Program (SSWAP) protocol.

Drainage area, location, and other physical characteristics of the Crooked Creek Watershed were compared to the headwaters of Loyalhanna Creek Watershed (Table 3). An analysis of value counts for each pixel of the MRLC grid revealed that while land cover/use distributions are not an exact match, both watersheds are similar. Forest and agriculture are the dominant land use categories in both watersheds. Surficial geology was also compared. Rock types in the Crooked Creek Watershed include interbedded sedimentary (100%). The headwaters, of Loyalhanna Creek Watershed also contains interbedded sedimentary (82%), and sandstone (18%) rocks. Bedrock geology primarily affects surface runoff and background nutrient loads through its influences on soils, landscape, fracture density, and directional permeability. Crooked Creek and the headwaters of Loyalhanna Creek Watershed are very similar in terms of soil types, soil K factor, precipitation, and average runoff, (Table 2).

Table 2. Comparison Between Crooked Creek and Reference Watershed

ATTRIBUTE	WATERSHED	
	Crooked Creek	**Headwaters of Loyalhanna Creek**
Physiographic Province	Appalachian Plateau (100%)	Appalachian Plateau (100%)
Area (mi^2)	195.3	186.1
Land Use	Agriculture (37%) Forested (59%) Development (3%) Mined Land\Transitional (1%)	Agriculture (20%) Forested (74%) Development (4%) Mined Land\Transitional (1%)
Geology	Interbedded Sedimentary (100%)	Interbedded Sedimentary (82%) Sandstone(18%)
Soils	Hazleton-Dekalb-Buchanon (1%) Gilpin-Weikert-Ernest (76%) Monongahela-Philo-Atkins (16%) Gilpin-Wharton-Ernest (4%) Gilpin-Wharton-Weikert (2%)	Hazleton-Dekalb-Buchanon (31%) Leck Kill-Calvin-Klinesville (8%) Gilpin-Weikert-Ernest (1%) Monongahela-Philo-Atkins (16%) Gilpin-Wharton-Ernest (41%) Gilpin-Wharton-Weikert (3%)
Dominant HSG	C (100%)	C (100%)
K Factor	0.31	0.32
15-Year Average Rainfall (in)	45.6	48.0
15-Year Average Runoff (in)	3.5	2.8

III. Watershed Assessment and Modeling

TMDLs for the Crooked Creek Watershed were developed using the ArcView Generalized Watershed Loading Function (AVGWLF) model as described in Appendix A. The AVGWLF model was used to establish existing loading conditions for the Crooked Creek Watershed and the headwaters of Loyalhanna Creek Watershed. All modeling outputs have been attached to this TMDL as Appendices B and C.

The AVGWLF model produced information on watershed size, land use, and suspended solids loading (Tables 2 and 3). The suspended solids loads represent an annual average over the 15 years simulated by the model. This information was used to calculate existing unit area loading rates for the Crooked Creek and the headwaters of Loyalhanna Creek Watersheds.

Unit area loading rates for suspended solids were estimated for each watershed by dividing the mean annual loadings (lbs./yr.) by the total area (acres). Unit area load estimates for suspended solids in the Crooked Creek Watershed are 790.12 lbs./acre/yr. (Table 3). Unit area load estimates for suspended solids in the headwaters of Loyalhanna Creek Watershed are 609.03 lbs./acre/yr. (Table 4).

Table 3. Existing Loading Values for Crooked Creek (impaired)

Source	Area (ac)	Sediment (lbs)	Unit Area Load (lbs/ac/yr)
Hay/Past	22,282	3,281,380	147.27
Cropland	23,611	25,742,800	1,090.29
Forest	73,548	994,520	13.52
Wetland	457	660	1.44
Coal_Mines	393	1,677,900	4,270.55
Turf_Grass	3	20	8.00
Transition	605	2,925,060	4,831.62
Lo_Int_Dev	3,684	545,220	147.98
Hi_Int_Dev	10	680	68.69
Stream Bank		63,275,314	
Coal Mine Point Sources		109,363.0	
Non-coal Point Sources		11,410,109.0	
total	124,593	109,963,026	882.58

Table 4. Existing Loading Values for Loyalhanna Creek (reference)

Source	Area (ac)	Sediment (lbs.)	Unit Area Load (lb/ac/yr)
Hay/Past	12,691	2,378,720	187.43
Cropland	11,906	13,625,500	1,144.47
Forest	93,030	1,648,660	17.72
Wetland	292	660	2.26
Coal_Mines	87	332,400	3,842.77
Turf_Grass	677	65,660	96.97
Transition	593	1,890,320	3,187.19
Lo_Int_Dev	4,967	460,900	92.80
Hi_Int_Dev	452	36,680	81.11
Stream Bank		55,503,052	
total	124,694	75,942,552	609.03

IV. TMDLs

Targeted TMDL values for the Crooked Creek Watershed were established based on current loading rates for suspended solids in the headwaters of Loyalhanna Creek Watershed. The entire length of the headwaters of Loyalhanna Creek is currently designated as Cold Water Fishes (CWF) and recent Unassessed Waters program assessments have determined that the portion of the basin used as a reference is attaining its designated uses. Reducing the loading rates of suspended solids in the Crooked Creek basin to levels equal to, or less than, the headwaters of Loyalhanna Creek Watershed will provide conditions favorable for the reversal of current use impairments.

Background Pollutant Conditions

There are two separate considerations of background pollutants within the context of these TMDLs. First, there is the inherent assumption of the reference watershed approach that because of the similarities between the reference and impaired watershed, the background pollutant contributions will be similar. Therefore, the background pollutant contributions will be considered when determining the loads for the impaired watershed that are consistent with the loads from the reference watershed. Second, the AVGWLF model implicitly considers background pollutant contributions through the soil and the groundwater component of the model process.

Targeted TMDL

The TMDL target suspended solids load for Crooked Creek is the product of the unit area suspended solids-loading rate in the reference watershed (Loyalhanna Creek) and the total area of the impaired watershed (Crooked Creek). These numbers and the resulting TMDL target load are shown in Table 5.

Table 5. TMDL Total Load Computation

Pollutant	Unit Area Loading Rate in Loyalhanna Creek Watershed (lbs/acre/yr)	Total Watershed Area in Crooked Creek (acres)	TMDL Total Load (lbs/year)
Suspended solids	609.03	124,593	75,880,797

Targeted TMDL values were used as the basis for load allocations and reductions in the Crooked Creek Watershed, using the following equation

1. TMDL = LA+WLA+MOS
2. LA = ALA-LNR

Where:

TMDL = Total Maximum Daily Load
LA = Load Allocation
ALA = Adjusted Load Allocation
LNR = Loads Not Reduced
WLA = Waste Load Allocation
MOS = Margin of Safety

Wasteload Allocation

The waste load allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. Reviewing the Department's permitting files identified 13 mining related NPDES permits and 33 NPDES permits (storm water, public and private Sewage Treatment Plants (STP), and industrial discharges) point sources of suspended solids located in the Crooked Creek Watershed; and were adjusted in the Waste Load Allocation (WLA). An additional allocation of 1% of the suspended solids TMDL (75,880,797 lbs./yr.) was incorporated as a bulk reserve (758,807.97 lbs./yr.) for the dynamic nature of future permit activity. Load Allocations (LA) for suspended solids was made to the following nonpoint sources: croplands, transition land, quarries and associated stream banks. Waste Load Allocations totaled: 12,278,280 lbs.\yr. Permits in the Crooked Creek Watershed are listed in Table 6a and 6b (next page).

Table 6a. Mining Permits Crooked Creek

Mining Company	Permit Number
A &T Coal Company	32803053
TLH Coal Company	32060103
Cloe Mining Company	32813007
Tanoma Coal Company	32840701
Bedrock Mines	32110103
Bedrock Mines	32130104
Bedrock Mines	32130105
Cambria Reclamation Company	32950201
Indiana Investments, Incorporated	32841312
Rosebud Mining Company	32971302
Tipple Four J., Incorporated	32901603
Consol Coal Company	32841321
Consol Coal Company	32141301

Table 6b. Non-Mining Permits Crooked Creek

Non-Mining Company	Permit Number
Keystone Generating Station	PA0026981
FRS Creekside	
Keystone Cleaning	PA0095443
PLT	PA0002275
Northview Estates MHP\STP	PA0033871
Elderdon STP	
Sylvan Acres	PA0093033
MHP\STP	PA0096989
Sharp Paving STP	
Sagamore WTP	PA0097489
Rayne Twp. Elementary	PA0097497
Crystal Waters	PA0204498

Personal Care FAC	
STP	PA0205559
Plumville STP	PA0217123
Shelocta STP	PA0217140
Creekside	PA0217247
Washington Element.	PA0217565
Maple Valley PCH	PA0217921
STP	
Urling Mine 3	
Portal/Bathouse STP	PA0218162
Creekside STP	PA0218642
Marion Center STP	
Marion Center	PA0218669
(Supply Shelocta	
Plant)	
Marion Center Plant	PA0219070
Jesse Patterson SR	
SFTF	PA0254631
Clawson SR STP	PAG046164
Semone SR STP	PAG046258
Immekus SR STP	PAG046264
Coffman SR STP	PAG046281
Christ Our Savior	
Orthodox Church	PAG046289
STP	
Paul Price SR STP	PAG046337
Keystone Generating	
STA	PAG106112
West Salisbury	
Foundry & Mach CO	PAR206162
INC	
Marion Centre	
Supply INC Shelocta	PAR216159
PLT	
Rankin Auto	
Wrecking Inc.	PAR606133
Kay Area	
Einfalt Recycling	PAS316101
and Salvage, Inc	PAS602203
White Twp.	PA0272060
Municipal Authority	

1. TMDLs and NPDES Permitting Coordination

NPDES permitting is inherently linked to TMDLs through waste load allocations and their translation, through the permitting program, to effluent limits. Primary responsibility for NPDES permitting rests with the District Mining Offices (for mining NPDES permits) and the Regional Offices (for industrial NPDES permits). Therefore, the DMOs and Regions will maintain tracking mechanisms of available waste load allocations, etc. in their respective offices. The TMDL program will assist in this effort. However, the primary role of the TMDL program is TMDL development and revision/amendment (the necessity for which is as defined in the Future Modifications section) at the request of the respective office. All efforts will be made to coordinate public notice periods for TMDL revisions and permit renewals/reissuances.

a) Load Tracking Mechanisms

The Department has developed tracking mechanisms that will allow for accounting of pollution loads in TMDL watersheds. This will allow permit writers to have information on how allocations have been distributed throughout the watershed in the watershed of interest while making permitting decisions. These tracking mechanisms will allow the Department to make minor changes in WLAs without the need for EPA to review and approve a revised TMDL. Tracking will also allow for the evaluation of loads at downstream points throughout a watershed to ensure no downstream impairments will result from the addition, modification or movement of a permit.

2. Options for New and Expanding Permittees in TMDL Watersheds

This TMDL does not prohibit the permitting of new or expanding dischargers in this watershed. The Department has various options for issuing permits to new or expanding dischargers in watersheds with approved TMDLs. Any option resulting in a change of the TMDL allocation may occur so long as the sum of the WLAs is unchanged, there is no change to the total TMDL or loading capacity, there is no localized exceedance of water quality standards and the re-allocation of WLA is public noticed as part of the NPDES permits process. Options applicable (although not limited) to this TMDL to support future growth are discussed below.

1. Allocate WLA based on the remaining bulk reserve included in a TMDL for anticipated future growth.
2. Use WLA made available when another permit in the watershed has been terminated because a discharge has ceased. If no permits have been recently terminated, it may be necessary to delay permit issuance until additional WLA becomes available.

3. Re-allocate the WLA(s) of existing permits to "free-up" WLA for future growth. Permits may be reissued with effluent limitations to reflect a reduced WLA than provided in the TMDL. For example, the reduced WLA could be based on actual flows (as opposed to design flows). Reductions of WLA could also reflect actual load reductions made by the existing permittee. This option requires amending of the permits involved in the reallocation prior to issuing proposed new or expanding permit.

4. In the event that there is no available WLA for the pollutant(s) addressed in this TMDL, the applicant of the proposed new or expanding discharge may still pursue non-discharge alternatives.

5. An applicant may apply for an offset via the permitting program. An offset is when the applicant agrees to treat an existing source (point or non-point) where there is no responsible party and receive a WLA based on a proportion of the load reduction to be achieved, as decided by the permitting authority. The result of using these types of offsets in permitting is a net improvement in long-term water quality through the reduction of the total pollutant load delivered to the waterbody. Offsets should not be confused with trading, in which credits are generated for market sale. Trading necessitates meeting the TMDL goals fully before marketing credits, while offsets allow for an alternate approach to meeting the WLA portion of the TMDL while making net progress toward meeting the TDML goals.

Margin of Safety

The margin of safety (MOS) is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDLs for suspended solids were reserved as the MOS. Using 10% of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of Crooked Creek. The MOS for the suspended solids TMDL is 7,588,080 lbs./yr.

MOS (Suspended solids) = 75,880,797 lbs./yr. (TMDL) x 0.1 = 7,588,080 lbs./yr.

Waste Load Allocation

The waste load allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. A search of the Pennsylvania Department of Environmental Protection's (Department) efacts permit database identified 13 mining related NPDES permits and 33 NPDES permits (storm water, public and private STPs, and industrial discharges) point sources of suspended solids located in the Crooked Creek Watershed (see Appendix E, Table E1 and Table E2 for individual WLAs); and were adjusted in the Waste Load Allocation (WLA). An additional allocation of 1% of the suspended solids TMDL (75,880,797 lbs./yr.) was incorporated as a bulk reserve (758,807.97 lbs./yr.) for the dynamic nature of future permit activity. In March 2019, 384 lb/yr was moved from the bulk reserved to the non-mining WLA to account for the issuance of PA0272060 to White Township Municipal Authority. The update WLAs (NPDES permits and bulk reserve) are presented below.

WLA= MGD Flow * monthly average concentration* 8.34* 365= WLA lbs./yr. for NPDES Permits

WLA= 11,410,493 lbs./yr. (Total WLA for Non-Mining NPDES permits) +
109,363.0 lbs./yr. (Total WLA for Mining NPDES permits)

WLA= 11,519,856 lbs./yr. (Total WLA for NPDES permits) + 758,424 lbs./yr. (1% Bulk Reserve)

WLA= 12,278,280 lbs./yr.

Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. LA for sediment was computed by subtracting the MOS value and the WLA from the TMDL value. LAs for sediment were 56,014,437 lbs/yr, respectively.

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. LA for sediment was computed by subtracting the MOS value and the WLA from the TMDL value. LAs for sediment were 56,014,437 lbs./yr.

LA (Sediment) =
75,880,797 lbs./yr (TMDL) – 7,588,080 lbs./yr. lbs./yr. (MOS) – 12,278,280 lbs./yr. lbs./yr. (WLA) = 56,014,437 lbs/yr

Adjusted Load Allocation

The adjusted load allocation (ALA) is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those non-point source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Since the Crooked Creek Watershed TMDLs were developed to address impairments resulting from mining activities, mining related sources were considered for reductions before other sources of suspended solids. Reductions were applied to CROPLAND, TRANSITIONAL, COAL MINES, and STREAMBANK sources for both suspended solids. Those land uses/sources for which existing loads were not reduced (HAY/PAST, FOREST, WETLAND, LO_INT_DEV, HI_INT_DEV) were carried through at their existing loading values (Table 7). The ALA for suspended solids is 51,191,977 lbs./yr.

Table 7. Load Allocation, Loads Not Reduced and Adjusted Load Allocations

	Sediment (lbs./yr)
Load Allocation	56,014,437
Loads Not Reduced	4,822,460
Hay/past	3,281,380
Forest	994,520
Wetland	660
lo_int_dev	545,220
hi_int_dev	680
Adjusted load allocation	51,191,977

TMDLs

The suspended solids TMDLs established for the Crooked Creek Watershed consists of a Load Allocation (LA) and a Margin of Safety (MOS). The individual components of the TMDLs are summarized in Table 8.

Table 7. TMDL, WLA, MOS, LA, LNR and ALA for Crooked Creek	
Component	Sediment (lbs/yr)
TMDL (Total Maximum Daily Load)	75,880,797
WLA (Waste Load Allocation)	12,278,280
MOS (Margin of Safety)	7,588,080
LA (Load Allocation)	56,014,437
LNR (Loads Not Reduced)	4,822,460
ALA (Adjusted Load Allocation)	51,191,977

V. Calculation of Suspended Solids Load Reductions

Adjusted load allocations established in the previous section represent the suspended solids loads that are available for allocation between contributing sources in the Crooked Creek Watershed. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method (Appendix E) was used to distribute the ALA between the appropriate contributing land uses.

The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix E. Table 8 contains the results of the EMPR for suspended solids for the appropriate contributing land uses in Crooked Creek Watershed. The load allocation for each land use is shown, along with the percent reduction of current loads necessary to reach the targeted LA.

Table 8. Suspended solids Load Allocations & Reductions

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)		Percent Reduction
		Current	Allowable	Current	Allowable	
Coal_Mines	393	4270.55	2681.19	1,677,900	1,053,439	37%
Transition	605	4831.62	3033.44	2,925,060	1,836,445	37%
Cropland	23611	1090.29	684.52	25,742,800	16,162,146	37%
Stream Bank				63,275,314	32,139,947	49%
	TOTAL			**93,621,074**	**51,191,977**	**45%**

VI. Consideration of Critical Conditions

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

VII. Consideration of Seasonal Variations

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

VIII. Recommendations for Implementation

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Crooked Creek Suspended Solids TMDL identifies the overall load reductions for siltation currently causing use impairments and distributes allowable loads among all reduced non-point sources.

Various methods to eliminate or treat pollutant sources and to provide a reasonable assurance that the proposed TMDLs can be met exist in Pennsylvania. These methods include PADEP's primary efforts to improve water quality through reclamation of abandoned mine lands (for abandoned mining) and through the National Pollution Discharge Elimination System (NPDES) permit program (for active mining). Funding sources available that are currently being used for projects designed to achieve TMDL reductions include the Environmental Protection Agency (EPA) 319 grant program and Pennsylvania's Growing Greener Program. Federal funding is through the Department the Interior, Office of Surface Mining (OSM), for reclamation and mine drainage treatment through the Appalachian Clean Streams Initiative and through Watershed Cooperative Agreements.

OSM reports that nationally, of the $8.5 billion of high priority (defined as priority 1&2 features or those that threaten public health and safety) coal related AML problems in the AML inventory, $6.6 billion (78%) have yet to be reclaimed; $3.6 billion of this total is attributable to Pennsylvania watershed costs. Almost 83 percent of the $2.3 billion of coal related environmental problems (priority 3) in the AML inventory are not reclaimed.

The Bureau of Abandoned Mine Reclamation, Pennsylvania's primary bureau in dealing with abandoned mine reclamation (AMR) issues, has established a comprehensive plan for abandoned mine reclamation throughout the Commonwealth to prioritize and guide reclamation efforts for throughout the state to make the best use of valuable funds (www.dep.state.pa.us/dep/deputate/minres/bamr/complan1.htm). In developing and implementing a comprehensive plan for abandoned mine reclamation, the resources (both human and financial) of the participants must be coordinated to insure cost-effective results. The following set of principles is intended to guide this decision making process:

- Partnerships between the DEP, watershed associations, local governments, environmental groups, other state agencies, federal agencies and other groups organized to reclaim abandoned mine lands are essential to achieving reclamation and abating acid mine drainage in an efficient and effective manner.

- Partnerships between AML interests and active mine operators are important and essential in reclaiming abandoned mine lands.

- Preferential consideration for the development of AML reclamation or AMD abatement projects will be given to watersheds or areas for which there is an approved rehabilitation plan. (guidance is given in Appendix B to the Comprehensive Plan).

- Preferential consideration for the use of designated reclamation moneys will be given to projects that have obtained other sources or means to partially fund the project or to projects that need the funds to match other sources of funds.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects where there are institutional arrangements for any necessary long-term operation and maintenance costs.

- Preferential consideration for the use of available moneys from federal and other sources will be given to projects that have the greatest worth.

- Preferential consideration for the development of AML projects will be given to AML problems that impact people over those that impact property.

- No plan is an absolute; occasional deviations are to be expected.

A detailed decision framework is included in the plan that outlines the basis for judging projects for funding, giving high priority to those projects whose cost/benefit ratios are most favorable and those in which stakeholder and landowner involvement is high and secure.

In addition to the abandoned mine reclamation program, regulatory programs also are assisting in the reclamation and restoration of Pennsylvania's land and water. PADEP has been effective in implementing the NPDES program for mining operations throughout the Commonwealth. This reclamation was done through the use of remining permits that have the potential for reclaiming abandoned mine lands, at no cost to the Commonwealth or the federal government. Long-term treatment agreements were initialized for facilities/operators that need to assure treatment of post-mining discharges or discharges they degraded which will provide for long-term treatment of discharges. According to OSM, "PADEP is conducting a program where active mining sites are, with very few exceptions, in compliance with the approved regulatory program".

The Commonwealth is exploring all options to address its abandoned mine problem. During 2000-2006, many new approaches to mine reclamation and mine drainage remediation have been explored and projects funded to address problems in innovative ways. These include:

- Project XL - The Pennsylvania Department of Environmental Protection ("PADEP"), has proposed this XL Project to explore a new approach to encourage the remining and reclamation of abandoned coal mine sites. The approach would be based on compliance with in-stream pollutant concentration limits and implementation of best management practices ("BMPs"), instead of National Pollutant Discharge Elimination System ("NPDES") numeric effluent limitations measured at individual discharge points. This XL project would provide for a test of this approach in up to eight watersheds with significant acid mine drainage ("AMD") pollution. The project will collect data to compare in-stream pollutant concentrations versus the loading from individual discharge points and provide for the evaluation of the performance of BMPs and this alternate strategy in PADEP's efforts to address AMD.
- Awards of grants for 1) proposals with economic development or industrial application as their primary goal and which rely on recycled mine water and/or a site that has been made suitable for the location of a facility through the elimination of existing Priority 1 or 2 hazards, and 2) new and innovative mine drainage treatment technologies that will provide waters of higher purity that may be needed by a particular industry at costs below conventional treatment costs as in common use today or reduce the costs of water treatment below those of conventional lime treatment plants. Eight contracts totaling $4.075 M were awarded in 2006 under this program.
- Projects using water from mine pools in an innovative fashion, such as the Shannopin Deep Mine Pool (in southwestern Pennsylvania), the Barnes & Tucker Deep Mine Pool (the Susquehanna River Basin Commission into the Upper West Branch Susquehanna River), and the Wadesville Deep Mine Pool (Excelon Generation in Schuylkill County).

There currently isn't a watershed organization interested in the Crooked Creek Watershed. It is recommended that agencies work with local interests to form a watershed group that will be dedicated to the remediation and preservation of these watersheds through public education, monitoring and assessment, and improvement projects. Information on formation of a watershed group is available through websites for the PADEP (www.dep.state.pa.us), the AMR Clearinghouse (www.amrclearinghouse.com), the EPA (www.epa.gov), the Susquehanna River Basin Commission (www.srbc.net) and others. In addition, each DEP Regional Office (6) and each District Mining Office (5) have watershed managers to assist stakeholder groups interested in restoration in their watershed. Most Pennsylvania county conservation districts have a watershed specialist who can also provide assistance to stakeholders (www.pacd.org). Potential funding sources for AMR projects can be found at www.dep.state.pa.us/dep/subject/pubs/water/wc/FS2205.pdf.

Additionally, the Crooked Creek Suspended Solids TMDL represent an attempt to quantify this loading that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. This specifically identifies the necessary overall load reductions for sediment currently causing use impairments and distributes those reduction goals to the appropriate nonpoint sources. Reaching the reduction goals established by this TMDL will only occur through Best Management Practices (BMPs). BMPs that would be helpful in lowering the amounts of sediment and nutrients reaching Crooked Creek include the following: streambank stabilization and fencing; riparian buffer strips; strip cropping; conservation tillage; stormwater retention wetlands; and heavy use area protection, Some of the work needed is actively being pursued through efforts targeting the abandoned mine lands.

The Natural Resources Conservation Service maintains a National Handbook of Conservation Practices (NHCP), which provides information on a variety of BMPs. The NHCP is available online at http://www.ncg.nrcs.usda.gov/nhcp_2.html. Many of the practices described in the handbook could be used in the Crooked Creek Watershed to help limit siltation impairments. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of restoration plans. Development of any restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. This type of assessment has been ongoing in the Crooked Creek Watershed, and it is strongly encouraged to continue.

The Federal Nonpoint Source Management Program (§ 319 of the Clean Water Act) is one funding source for nonpoint source pollution reduction BMPs, such as those described above. This grant program provides funding to assist in implementing Pennsylvania's Nonpoint Source Management Program. This includes funding for abandoned mine drainage, agricultural and urban run-off, and natural channel design/streambank stabilization projects. Information on Pennsylvania's Nonpoint Source Management Program can be found at:
http://www.portal.state.pa.us/portal/server.pt/community/nonpoint_source_management/10615

As mentioned before, a second funding source is Pennsylvania's Growing Greener Watershed Grants, which provides nearly $547 million in funding to clean up non-point sources of pollution throughout Pennsylvania. The grants were established by the Environmental Stewardship and Watershed Protection Act. Information on Pennsylvania's Growing Greener Watershed Grants can be found at:
http://www.depweb.state.pa.us/portal/server.pt/community/growing_greener/13958

Information on these and other programs and additional funding sources can be found at:
http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Grants/GrantLoans

By developing the sediment TMDLs for the Crooked Creek Watershed, PADEP continues to support design and implementation of restoration plans to correct current use impairments. PADEP welcomes local efforts to support watershed restoration plans. For more information about this TMDL, interested parties should contact the appropriate watershed manager in PADEP's South West Regional Office (412-442-4000).

IX. Public Participation

Public notice of the TMDL was published in the Pennsylvania Bulletin on January 31, 2015 to foster public comment on the allowable loads calculated. A 30-day period was provided for the submittal of comments and notice. No comments were received during this time.

X. Future TMDL Modifications

In the future, the Department may adjust the load and/or wasteload allocations in this TMDL to account for new information or circumstances that are developed or discovered during the implementation of the TMDL when a review of the new information or circumstances indicate that such adjustments are appropriate. Adjustment between the load and wasteload allocation will only be made following an opportunity for public participation. A wasteload allocation adjustment will be made consistent and simultaneous with associated permit(s) revision(s)/reissuances (i.e., permits for revision/reissuance in association with a TMDL revision will be made available for public comment concurrent with the related TMDLs availability for public comment). New information generated during TMDL implementation may include, among other things, monitoring data, BMP effectiveness information, and land use information. All changes in the TMDL will be tallied and once the total changes exceed 1% of the total original TMDL allowable load, the TMDL will be revised. The adjusted TMDL, including its LAs and WLAs, will be set at a level necessary to implement the applicable WQS and any adjustment increasing a WLA will be supported by reasonable assurance demonstration that load allocations will be met. The Department will notify EPA of any adjustments to the TMDL within 30 days of its adoption and will maintain current tracking mechanisms that contain accurate loading information for TMDL waters.

Changes in TMDLs Requiring EPA Approval

- Increase in total load capacity.
- Transfer of load between point (WLA) and nonpoint (LA) sources.
- Modification of the margin of safety (MOS).
- Change in water quality standards (WQS).
- Non-attainment of WQS with implementation of the TMDL.

- Allocations in trading programs.

Changes in TMDLs Not Requiring EPA Approval

- Changes among individual WLAs but not the total sum of the WLA with no other changes in the TMDL; TMDL public notice concurrent with permit public notice.
- Removal of a pollutant source that will not be reallocated.
- Reallocation between LAs.
- Changes in land use.

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

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

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

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

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

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

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

GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
Gwnback	A grid of background concentrations of N in groundwater derived from water well sampling.
Landuse5	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
Majored	Coverage of major roads. Used for reconnaissance of a Watershed.
MCD	Minor civil divisions (boroughs, townships and cities).
Npdespts	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
Padem	100-meter digital elevation model. This used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes *rain_cool* and *rain_warm* are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference Watersheds for which nutrient and suspended solids loads have been calculated.
Soilphos	A grid of soil phosphorous loads, which has been generated from soil sample data. Used to help set phosphorus and suspended solids values.
Smallsheds	A coverage of Watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level Watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute *mu_k* sets the k factor in the USLE. The attribute *mu_awc* is the unsaturated available capacity., and the *muhsg_dom* is used with landuse cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare Watersheds of similar qualities.
T9sheds	Data derived from a DEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute *aeu_acre* helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
Weather Files	Historical weather files for stations around Pennsylvania to simulate flow.

Appendix B - AVGWLF Model Outputs for the Crooked Creek Watershed

Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	9017	75	0.294	2.262	0.03	0.45
Cropland	9555	82	0.296	2.495	0.3	0.3
Forest	29764	73	0.294	2.696	0.002	0.52
Wetland	185	87	0.363	0.245	0.01	0.1
Coal_Mines	159	87	0.311	1.308	0.8	0.8
Turf_Grass	1	71	0.29	0.06	0.08	0.2
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
Transition	245	87	0.306	1.504	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	1491	83	0.311	1.813	0.08	0.2
Hi_Int_Dev	4	93	0.333	0.78	0.08	0.2

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.62	9.4	0	0.08	0	0
Feb	0.67	10.4	0	0.08	0	0
Mar	0.7	11.8	0	0.08	0	0
Apr	0.71	13.2	0	0.26	0	0
May	0.89	14.4	1	0.26	0	0
Jun	0.99	14.9	1	0.26	0	0
Jul	1.04	14.6	1	0.26	0	0
Aug	1.08	13.6	1	0.26	0	0
Sep	1.1	12.2	1	0.08	0	0
Oct	0.94	10.8	0	0.08	0	0
Nov	0.86	9.6	0	0.08	0	0
Dec	0.81	9.1	0	0.08	0	0

Init Unsat Stor (cm)	10	**Initial Snow (cm)**	0	**Recess Coefficient**	0.1
Init Sat Stor (cm)	0	**Sed Delivery Ratio**	0.07	**Seepage Coefficient**	0
Unsat Avail Wat (cm)	11.4445	**Tile Drain Ratio**	0.5	**Sediment A Factor**	3.6077E-04
		Tile Drain Density	0		

Load File | **Save File** | **Export to JPEG** | **Close**

GWLF Total Loads for file: crooked_9_18-0

Period of analysis: 19 years from 1975 to 1993

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dis N	Total N	Dis P	Total P
Hay/Past	22281.5	3.1	23438.4	1640.7	41995.7	51839.8	4002.2	5203.2
Cropland	23610.9	5.7	183877.0	12871.4	80501.7	157730.1	7565.7	16987.6
Forest	73548.3	2.6	7103.7	497.3	8385.8	11369.4	264.8	628.8
Wetland	457.1	8.8	4.8	0.3	173.1	175.1	5.5	5.7
Coal_Mines	392.9	8.8	11985.0	838.9	9.4	5043.1	1.5	615.6
Turf_Grass	2.5	2.2	0.1	0.0	3.1	3.2	0.2	0.2
Transition	605.4	8.8	20893.3	1462.5	3498.2	12273.5	241.3	1311.8
Lo_Int_Dev	3684.3	6.2	3894.5	272.6	0.0	2157.5	0.0	287.7
Hi_Int_Dev	9.9	16.0	4.8	0.3	0.0	77.4	0.0	8.6
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				31637.7		3163.8		1392.1
Groundwater					640765.0	640765.0	12078.2	12078.2
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					2806.0	2806.0	400.1	400.1
Totals	124592.8	3.50	251201.5	49221.8	778138.1	887403.8	24559.4	38919.6

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Appendix C - AVGWLF Model Outputs for the Reference Watershed

Rural LU	Area (ha)	CN	K	LS	C	P
Hay/Past	5136	75	0.321	2.868	0.03	0.45
Cropland	4818	82	0.329	2.563	0.3	0.3
Forest	37648	73	0.27	4.185	0.002	0.52
Wetland	118	87	0.353	0.428	0.01	0.1
Coal_Mines	35	87	0.261	3.611	0.52	0.52
Turf_Grass	274	71	0.348	1.155	0.08	0.2
	0	0	0	0	0	0
	0	0	0	0	0	0
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
	0	0	0	0	0	0
Transition	240	87	0.348	0.949	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
Lo_Int_Dev	2010	83	0.335	1.148	0.08	0.2
Hi_Int_Dev	183	93	0.352	0.955	0.08	0.2

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
Jan	0.61	9.4	0	0.08	0	0
Feb	0.66	10.4	0	0.08	0	0
Mar	0.69	11.8	0	0.08	0	0
Apr	0.7	13.2	0	0.26	0	0
May	0.86	14.3	1	0.26	0	0
Jun	0.96	14.9	1	0.26	0	0
Jul	1.01	14.6	1	0.26	0	0
Aug	1.04	13.6	1	0.26	0	0
Sep	1.06	12.2	1	0.08	0	0
Oct	0.92	10.8	0	0.08	0	0
Nov	0.84	9.7	0	0.08	0	0
Dec	0.79	9.1	0	0.08	0	0

Init Unsat Stor (cm)	10	Initial Snow (cm)	0	Recess Coefficient	0.1
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.07	Seepage Coefficient	0
Unsat Avail Wat (cm)	15.4093	Tile Drain Ratio	0.5	Sediment A Factor	4.1244E-04
		Tile Drain Density	0		

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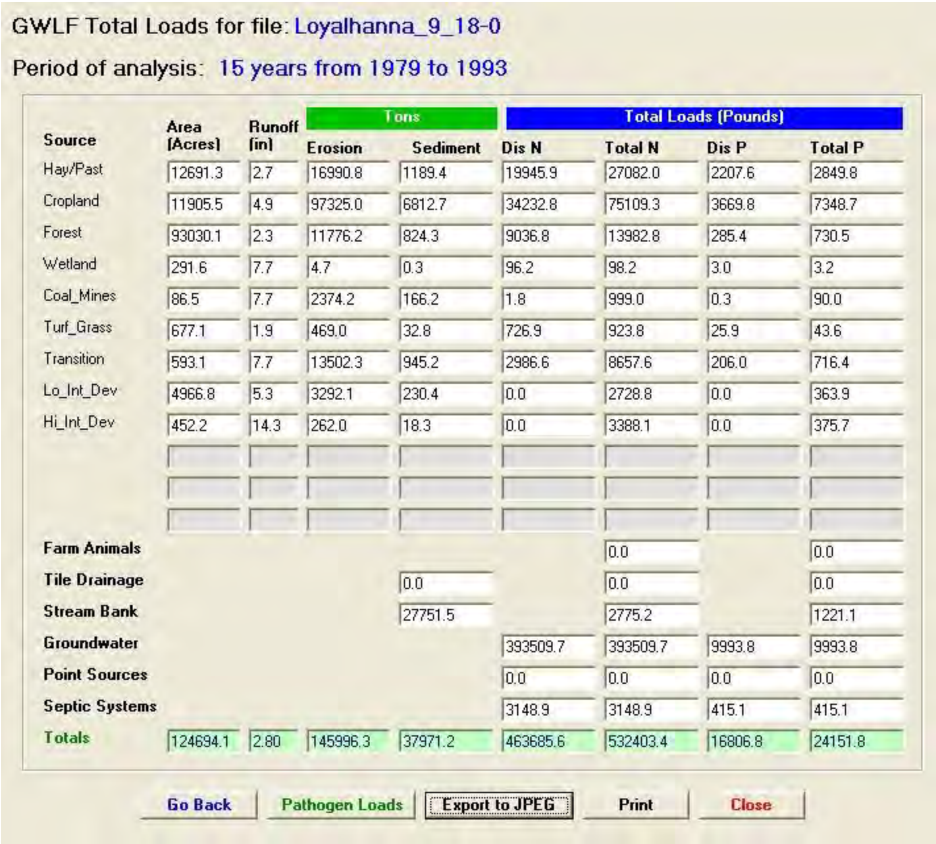

GWLF Total Loads for file: Loyalhanna_9_18-0

Period of analysis: 15 years from 1979 to 1993

Source	Area (Acres)	Runoff (in)	Tons Erosion	Tons Sediment	Total Loads (Pounds) Dis N	Total N	Dis P	Total P
Hay/Past	12691.3	2.7	16990.8	1189.4	19945.9	27082.0	2207.6	2849.8
Cropland	11905.5	4.9	97325.0	6812.7	34232.8	75109.3	3669.8	7348.7
Forest	93030.1	2.3	11776.2	824.3	9036.8	13982.8	285.4	730.5
Wetland	291.6	7.7	4.7	0.3	96.2	98.2	3.0	3.2
Coal_Mines	86.5	7.7	2374.2	166.2	1.8	999.0	0.3	90.0
Turf_Grass	677.1	1.9	469.0	32.8	726.9	923.8	25.9	43.6
Transition	593.1	7.7	13502.3	945.2	2986.6	8657.6	206.0	716.4
Lo_Int_Dev	4966.8	5.3	3292.1	230.4	0.0	2728.8	0.0	363.9
Hi_Int_Dev	452.2	14.3	262.0	18.3	0.0	3388.1	0.0	375.7
Farm Animals						0.0		0.0
Tile Drainage				0.0		0.0		0.0
Stream Bank				27751.5		2775.2		1221.1
Groundwater					393509.7	393509.7	9993.8	9993.8
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					3148.9	3148.9	415.1	415.1
Totals	124694.1	2.80	145996.3	37971.2	463685.6	532403.4	16806.8	24151.8

Go Back | Pathogen Loads | Export to JPEG | Print | Close

Appendix D - Equal Marginal Percent Reduction Method

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

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

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

Step 3: Actual EMPR Process:

a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving 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 of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

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

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

Appendix E - Equal Marginal Percent Reduction Calculations

Step 1: TMDL Total Load
Load = Sediment loading rate in ref. * Acres in Impaired
75880797

Step 2: Adjusted LA = (MDL total load - ((MOS) - loads not reduced)
51191977 51191977

Step 3:

	Annual Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
Coal_Mines	1677900.0	93621073.6	good	1677900	ADJUST	2%	624461	1053439	393	2681.19	37.2%
					30345760						
Transition	2925060.0		good	2925060		4%	1088615	1836445	605	3033.44	37.2%
Cropland	25742800.0		good	25742800		32%	9580654	16162146	23611	684.52	37.2%
Stream Bank	63275313.6		bad	51191977		63%	19052030	32139947			49.2%
				81537737		100%		51191977			

All Ag. Loading 35089.48

Step 4:

Step 5:

	Acres	Allowable (Target) loading rate	Final LA	Current Loading Rates	Current Load	% Red.
Coal_Mines	393	2681.19	1053439	4270.55	1677900	37%
Transition	605	3033.44	1836445	4831.62	2925060	37%
Cropland	23611	684.52	16162146	1090.29	25742800	37%
Stream Bank			32139947		63275314	49%
			51191977		93621074	45%

Non-Mining Waste Load Allocations:

Site	Permit #	Municipality	County	Outfall	Type	WLA (lbs/year)
KEYSTONE GENERATING STATION	PA0026981	Plumcreek	Armstrong	020	Stormwater- Industrial	31,415
				003	Industrial Waste	1,461,168
				005	Stormwater- Industrial	327,241
				007	Stormwater- Industrial and Industrial Waste	39,726
				011	Industrial Waste	1,196,331
				012	Industrial Waste	1,196,331
				013	Industrial Waste- Underdrains	59,817
				015	Stormwater- Industrial	26,788
				016	Stormwater- Industrial	21,430
				018	Stormwater- Industrial	9,985
				019	Stormwater- Industrial	18,021
				010	Stormwater- Industrial	1,196,331
				014	Industrial Waste- Underdrains	59,817
				017	Stormwater- Industrial	502,277
				008	Stormwater- Industrial	180,820
				009	Stormwater- Industrial	146,421
				006	Stormwater- Industrial	12,785
				002	Industrial Waste- Backwash	7,610
				107	Industrial Waste	3,409
				021	Stormwater-Industrial	13,546
				022	Stormwater-Industrial	270,925
				004	Stormwater- Industrial	27,397
FRS CREEKSIDE	PA0095443	Washington	Indiana	003	Industrial Waste	6,488
				001	Stormwater-Industrial	21,918
				002	Stormwater-Industrial	21,918
KEYSTONE CLEANING PLT	PA0002275	Plumcreek	Armstrong	001	Sewage Non-Publicly Owned (Non-Muni)	274
NORTHVIEW ESTATES MHP STP	PA0033871	White	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	10,502
ELDERTON STP	PA0093033	Elderton	Armstrong	001	Sewage Publicly Owned (Muni)	8,828
SYLVAN ACRES MHP STP	PA0096989	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	1,790
SHARP PAVING STP	PA0097489	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	9
SAGAMORE WTP	PA0097497	Cowanshannock	Armstrong	001	Industrial Waste	913
RAYNE TWP ELEM SCH	PA0204498	Rayne	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	1,279
CRYSTAL WATERS PERSONAL CARE FAC STP	PA0205559	Rayne	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	530
PLUMVILLE STP	PA0217123	South Mahoning	Indiana	001	Sewage Publicly Owned (Muni)	8,219
SHELOCTA STP	PA0217140	Armstrong	Indiana	001	Sewage Publicly Owned (Muni)	10,192
CREEKSIDE WASHINGTON ELEM SCH STP	PA0217247	Washington	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	365
MAPLE VALLEY PCH STP	PA0217565	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	731
URLING MINE 3 PORTAL/BATHHOUSE STP	PA0217921	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	457
CREEKSIDE STP	PA0218162	Washington	Indiana	001	Sewage Publicly Owned (Muni)	82,191
MARION CENTER STP	PA0218642	East Mahoning	Indiana	001	Sewage Publicly Owned (Muni)	9,680
MARION CTR SUPPLY SHELOCTA PLT	PA0218669	Armstrong	Indiana	001	Industrial Waste	547,938
				002	Industrial Waste	15,221
MARION CENTER PLANT	PA0219070	Marion Center	Indiana	001	Industrial Waste	15,221
Jesse Patterson SR SFTF	PA0254631	Plumcreek	Armstrong	001	Sewage Non-Publicly Owned (Non-Muni)	24
CLAWSON SR STP	PAG046164	White	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	91
SEMONE SR STP	PAG046258	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	30
IMMEKUS SR STP	PAG046264	Rayne	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	24
COFFMAN SR STP	PAG046281	Rayne	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	24
CHRIST OUR SAVIOR ORTHODOX CHURCH STP	PAG046289	Rayne	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	61
PAUL PRICE SR STP	PAG046337	Armstrong	Indiana	001	Sewage Non-Publicly Owned (Non-Muni)	37
KEYSTONE GENERATING STA	PAG106112	Plumcreek	Armstrong	603	Hydrostatic Testing Discharges (Occasional)	182,646
WEST SALISBURY FOUNDRY & MACH CO INC	PAR206162	Elk Lick	Somerset	001	Stormwater-Industrial	304,410
MARION CENTER SUPPLY INC SHELOCTA PLT	PAR216159	Armstrong	Indiana	001	Stormwater-Industrial	304,410
MARION CENTER SUPPLY INC SHELOCTA PLT	PAR216159	Armstrong	Indiana	001	Stormwater-Industrial	304,410
RANKIN AUTO WRECKING INC	PAR606133	Rural Valley	Armstrong	001	Stormwater-Industrial	304,410
				002	Stormwater-Industrial	304,410
				003	Stormwater-Industrial	304,410
				004	Stormwater-Industrial	304,410
				005	Stormwater-Industrial	304,410
KAY ARENA	PAS316101	Rayne	Indiana	001	Stormwater-Industrial	304,410
				003	Stormwater-Industrial	304,410
				002	Stormwater-Industrial	304,410
EINFALT RECYCLING & SALVAGE INC.	PAS602203	Stockertown	Northampton	001	Stormwater-Industrial	304,410
						11,410,109

Mining Waste Load Allocations:

Operator	Permit #	Municipality	Outfall	WLA (lbs/year)
Indiana Investments	32841312	Armstrong	001 (MDT)	7,671
Tipple Four J, Inc.	32901603	Armstrong	001 (sed pond)	0
A & T coal Co.	32803053	Armstrong	MP-S2	7,671
TLH Coal Co.	32060103	East Mahoning	001 (SED)	0
			002 (SED)	0
			003 (SED)	0
			004(MDT)	0
			005 (MDT)	0
			006 (MDT)	0
Cloe Mining Co., Inc.	32813007	Rayne	001 (MDT)	5,370
Tanoma Coal Co., Inc.	32840701	Rayne	001 (MDT)	7,671
Consol Mining Co., LLC	32841321	Washington	001 (MDT)	4,603
Rosebud Mining Company	32971302	Washington	001 (MDT)	21,309
			004 (MDT)	31,963
Bedrock Mines	32110103	Washington	001 (MDT)	15,342
Bedrock Mines	32130104	Washington	001 (MDT)	171
			002 (SED)	1,888
			003 (SED)	484
Bedrock Mines	32130105	Washington	001 (SED)	2,664
			002 (MDT)	256
Consol Mining Co., LLC	32141301	Washington	001 (MDT)	1,534
Cambria Reclamation Corp.	32950201	White	001 (MDT)	0
			005 (MDT)	767
				109,363

Appendix F - Comment and Response Document

Crooked Creek Watershed TMDL

(No comments were received during the 30 days window after the January 31, 2015 posting.)