Ross Run Sediment TMDL
Little Mahoning Creek
Indiana County

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

August 2018

-

Ross Run Sediment TMDL
Indiana County, Pennsylvania

Executive Summary

A Total Maximum Daily Load (TMDL) was developed to address impairments in Ross Run as noted in the ***2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report*** (Integrated List), initially listed in 2006 (see Table 5.). Ross Run is a tributary of the Little Mahoning Creek and the larger Allegheny River Basin (Figure 1.). The watershed is located in East-, North-, and South Mahoning Townships, Indiana County. The impairments were noted during bioassessments in the watershed (2005 & 2010) and excessive siltation due to grazing-related agriculture was identified as causing impairment to the designated aquatic life use of a High Quality - Cold Water Fish(ery), HQ-CWF, in Ross Run.

Because PA does not currently have water quality criteria for sediment, a TMDL endpoint was identified using a reference watershed approach. Based on a comparison to the similar, non-impaired watershed, the Mudlick Run, another HQ-CWF, was chosen for comparison and is a tributary to Little Mahoning Creek and the larger Mahoning Creek and Allegheny River basin, Indiana County (Figure 2.), the maximum sediment loading that should still allow water quality objectives to be met in the impaired segments of Ross Run. Allocations from the calculated TMDLs are summarized below:

Table 1. Summary of TMDL for Ross Run in lbs./yr.

Pollutant	TMDL	WLA	MOS	LA	LNR	ALA
Sediment (lbs./yr.)	**720,359.3**	**7,203.6**	**72,035.9**	**641,119.8**	**12,400.0**	**628,719.8**
Sediment (lbs./day)	**1,973.6**	**19.7**	**197.4**	**1,756.5**	**34.0**	**1,722.5**

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

Load allocations were distributed to nonpoint sources, with 10% of the TMDL reserved explicitly as a margin of safety (MOS). The waste load allocation (WLA) is that portion of the total load assigned to National Pollutant Discharge Elimination System (NPDES) permitted point source discharges. A search of the Pennsylvania Department of Environmental Protection's (Department) efacts permit database identified no point source discharges within Ross Run. Yet, to take in account future permit activity, 1% of the TMDL was incorporated into the WLA as a bulk reserve.

The load allocation (LA) is that portion of the total load assigned to nonpoint sources, specifically all land use sources other than NPDES permitted point sources. Loads not reduced (LNR) are the portion of the LA associated with nonpoint sources other than agricultural (croplands, hay/pasture), and associated stream bank. It is equal to the sum of modeled loading on forested land use, low, medium, and high development. The adjusted load allocation (ALA) represents the remaining portion of the LA distributed among agricultural land and associated stream banks. The TMDL developed for the impaired Ross Run established an overall reduction in the current sediment loading to 24.6%.

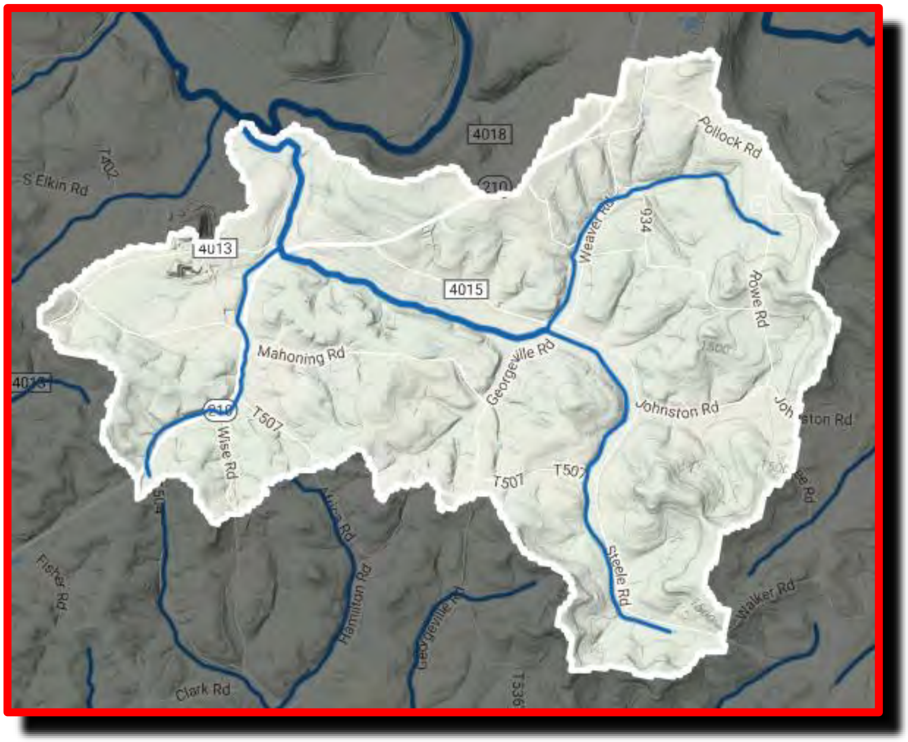


Figure 1. – Ross Run, Indiana County (Impaired)
Figure 2. - Mudlick Run, Indiana County (Non-impaired reference)

Introduction

Ross Run is currently designated as a High Quality - Cold Water Fish(ery) (HQ-CWF), (PA Code 25 § 93.9). A HQ-CWF, provides for the maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold-water habitat.   This watershed is located in northwest Indiana County (Figure 1.), between Plumville and Marion Center. Its watershed boundaries lie within East-, North-, and South Mahoning townships (USGS quadrangles – Plumville and Marion Center). and flow northwest of US 119, approximately 5 miles (along the majority of Johnston Road) before joining with Little Mahoning Creek (northwest of SR210). It has a total drainage area of 4,920.0 acres. The current land use estimated for Ross Run watershed is as follows: Agriculture - 39%, Forest – 53%, Development – 8% (Table 2., Figure 3.)

Type	Area (km²)	Coverage (%)
Open Water	0.00	0.0
Perennial Ice/Snow	0.00	0.0
Developed, Open Space	1.16	5.9
Developed, Low Intensity	0.31	1.5
Developed, Medium Intensity	0.01	0.1
Developed, High Intensity	0.00	0.0
Barren Land (Rock/Sand/Clay)	0.06	0.3
Deciduous Forest	10.26	51.7
Evergreen Forest	0.08	0.4
Mixed Forest	0.11	0.5
Shrub/Scrub	0.00	0.0
Grassland/Herbaceous	0.09	0.5
Pasture/Hay	4.79	24.1
Cultivated Crops	2.97	15.0
Woody Wetlands	0.00	0.0
Emergent Herbaceous Wetlands	0.00	0.0

Table 2., Percent land use, and Figure 3. Map of land use distribution in Ross Run

The soils are classified primarily as Hydrologic Soils Group (HSG) C and D (Table 3., Figure 4.). These soil groups are characterized as having slow to very slow infiltration rates when thoroughly wetted and consist chiefly of soils of moderately fine to fine structure. These types of soils have a high runoff potential and must be managed as such to minimize impairments to receiving waters. The generally, low gradient drainage amongst sloping hills, with minimally vegetated agricultural areas, creates excess runoff during precipitation events. Unsuccessful sediment transport consecutively downstream causes inundation of benthic habitat to the point of impairment.

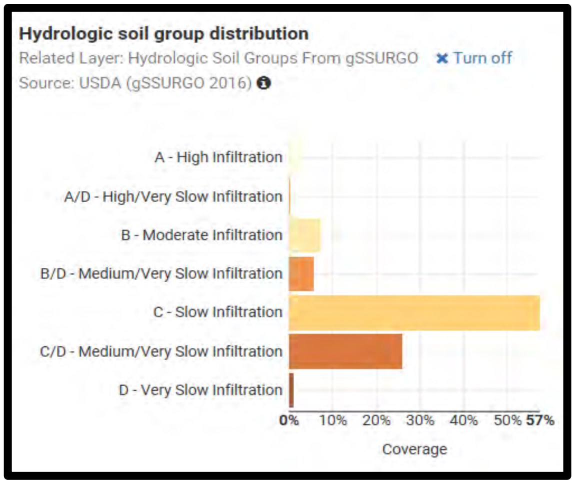
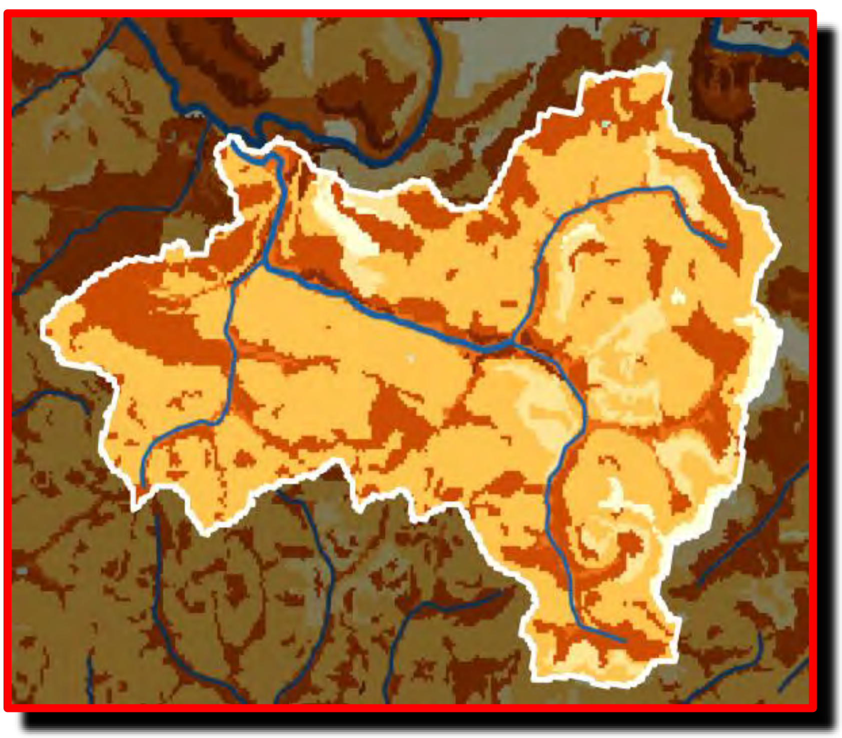


Table 3. Percentage of hydric soil types, and Figure 4. Map of hydric soil distribution in Ross Run



The watershed of Ross Run lies within the Pittsburgh Low Plateau Section of the Appalachian Plateau Province. This section consists of a smooth undulating upland surface cut by numerous, narrow, relatively shallow valleys. Rocks within the watershed are generally interbedded sedimentary, and specifically, the underlying bedrock group is the Glenshaw Formation (tan, Figure 5.). This geology is found at the higher elevations of the watershed. The Glenshaw's main rock type is also shale. It consists of repeated sequences of sandstone, siltstone, shale, claystone (red beds), limestone, and coal.

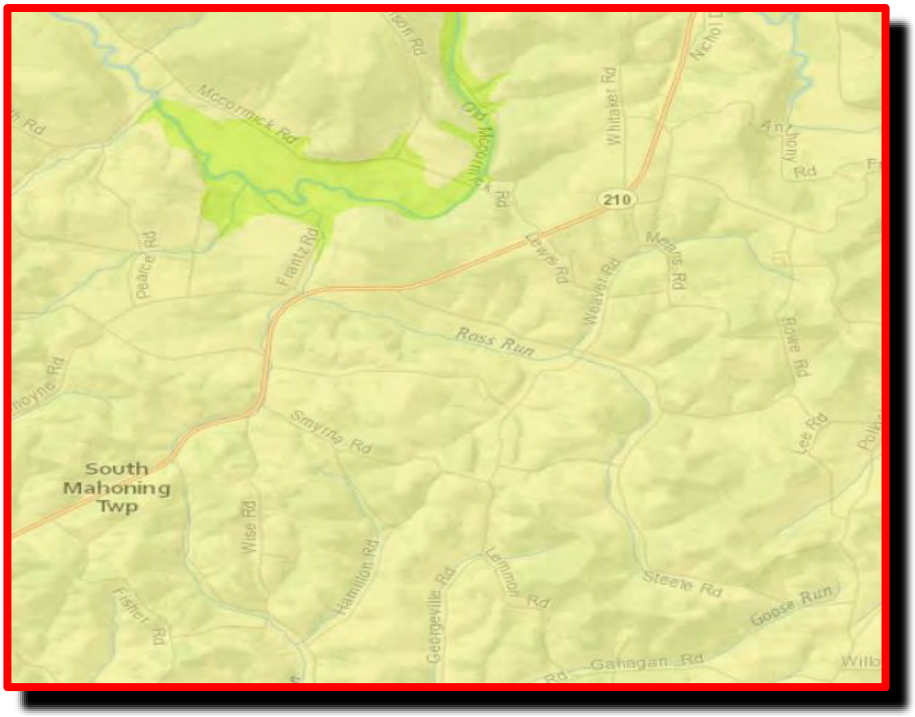
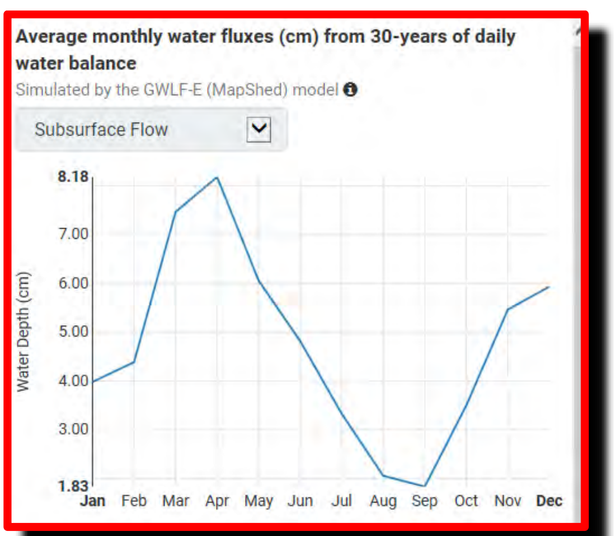


Figure 5. General geology of Ross Run

Table 4. Monthly subsurface hydrology of Ross Run



The TMDL was completed to address the impairments noted on the ***2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, Streams, Category 5, Waterbodies, Pollutants Requiring A TMDL*** required under the Clean Water Act, and cover the listed segments shown (Figure 6., Table 5.) (purple-impaired, green-not impaired). Excessive siltation, from grazing related agriculture has been listed as causing the majority of impairment. The TMDL addresses these impairments from croplands, hay/pasture land uses, and associated stream banks.

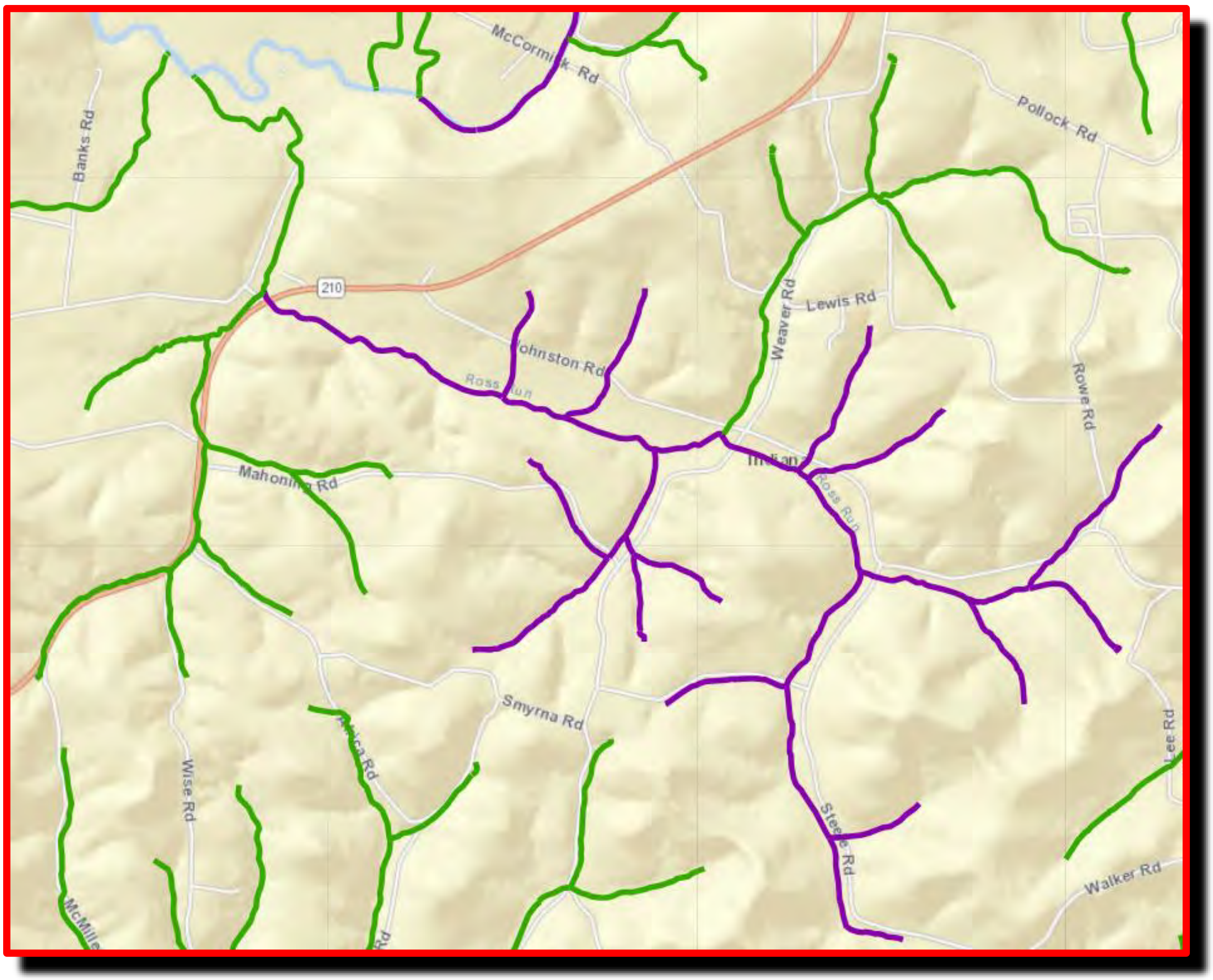


Figure 6. Biologically impaired and non-impaired segments of Ross Run

Table 5. 2016 Integrated WQ Monitoring & Assessment Report - Impaired Streams List

2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a, 4c, and 5 Waterbodies

Stream Nam / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Hydrologic Unit Code: 05010006-Middle Allegheny-Redbank			
Ross Run HUC: 05010006			
Aquatic Life (12815) - 3.68 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed Of (ID:123861270) HUC: 05010006			
Aquatic Life (12815) - 0.39 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed Of (ID:123861276) HUC: 05010006			
Aquatic Life (12815) - 0.4 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed Of (ID:123861280) HUC: 05010006			
Aquatic Life (12815) - 0.28 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed Of (ID:123861291) HUC: 05010006			
Aquatic Life (12815) - 0.41 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed Of (ID:123861294) HUC: 05010006			
Aquatic Life (12815) - 0.39 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861258) HUC: 05010006			
Aquatic Life (12815) - 0.31 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861269) HUC: 05010006			
Aquatic Life (12815) - 0.41 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861284) HUC: 05010006			
Aquatic Life (12815) - 1.23 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861299) HUC: 05010006			
Aquatic Life (12815) - 0.92 miles			
Grazing Related Agric	Siltation	2006	2019

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2016 Pennsylvania Integrated Water Quality Monitoring and Assessment Report - Streams, Category 4a, 4c, and 5 Waterbodies

Stream Nam HUC Use Assessed (Assessment ID) - Miles Source	Cause	Date Listed	TMDL Date
Ross Run Unnamed To (ID:123861301) HUC: 05010006			
Aquatic Life (12815) - 0.5 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861306) HUC: 05010006			
Aquatic Life (12815) - 0.52 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861315) HUC: 05010006			
Aquatic Life (12815) - 0.51 miles			
Grazing Related Agric	Siltation	2006	2019
Ross Run Unnamed To (ID:123861319) HUC: 05010006			
Aquatic Life (12815) - 0.36 miles			
Grazing Related Agric	Siltation	2006	2019

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 Best Management Practices (BMPs), etc.).

Pennsylvania Clean Streams Law Requirements and Agricultural Operations

All Pennsylvania farmers are subject to the water quality regulations authorized under the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, and found within Chapters 91-93, 96, 102 and 105. These regulations include topics such as manure management, Concentrated Animal Operations (CAOs), Concentrated Animal Feeding Operations (CAFOs), Pollution Control and Prevention at Agricultural Operations, Water Quality Standards, Water Quality Standards Implementation, Erosion and Sediment Control Requirements, and Dam Safety and Waterway Management. To review these regulations, please refer to http://pacode.com/ or the Pennsylvania Water Quality Action Packet for Agriculture which is supplied by the County Conservation Districts. To find your County Conservation

District's contact information, please refer to http://pacd.org/ or call any DEP office or the Pennsylvania Conservation Districts Headquarters at 717-238-7223.

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

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. Please see Table 3 below for a breakdown of the changes to listing documents and assessment methods through 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 required selecting representative stream segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selected as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. All the biological surveys included 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 SSWAP protocol that preceded the ICE protocol, the method requires selecting representative segments based on factors such as surrounding land uses, stream characteristics, surface geology, and point source discharge locations. The biologist selects as many sites as necessary to establish an accurate assessment for a stream segment; the length of the stream segment could vary between sites. All the biological surveys include D-frame kick net sampling of benthic macroinvertebrates, habitat surveys, and measurements of pH, temperature, conductivity, dissolved oxygen, and alkalinity. Collected samples are returned to the laboratory where the samples are then subsampled to obtain a benthic macroinvertebrate sample of 200 + or – 20% (160 to 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, all of those pollutants receive separate and specific TMDLs within that stream segment. In order for the TMDL process to be most effective, adjoining stream segments with the same source and cause listing are addressed collectively on a watershed basis.

Table 6. 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

Basic Steps for Determining a TMDL

Although all watersheds must be handled on a case-by-case basis when developing TMDLs, there are basic processes or steps 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. Calculate TMDL for the waterbody using EPA approved methods and computer models;
3. Allocate pollutant loads to various sources;
4. Determine critical and seasonal conditions;
5. Submit draft report for public review and comments; and
6. EPA approval of the TMDL.

TMDL Elements (WLA, LA, MOS)

A TMDL equation consists of a waste load allocation, load allocation and a margin of safety. The waste load allocation (WLA) is the portion of the load assigned to point sources (National Pollutant Discharge Elimination System (NPDES) permitted discharges). The load allocation (LA) is the portion of the load assigned to nonpoint sources (non-permitted). The margin of safety (MOS) is applied to account for uncertainties in the computational process. The MOS may be expressed implicitly (documenting conservative processes in the computations) or explicitly (setting aside a portion of the allowable load).

Future TMDL Modifications

In the future, the Department may adjust the load and/or waste load 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 waste load allocation will only be made following an opportunity for public participation. A waste load 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 water quality standards (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 That May Require 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.
- Allocation transfers in trading programs.

Changes in TMDLs That May Not Require 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.

TMDL Endpoints

Pennsylvania does not currently have specific numeric criteria for sediment or nutrient loading requirements. Therefore, to establish endpoints such that the designated uses of the Ross Run 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)"; 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 excess siltation in the Ross Run watershed, a Total Maximum Daily Loads (TMDLs) were developed. Based on a reference watershed approach, a total load capacity (or endpoint) of **720,359.3** lbs./yr. of sediment loading was determined sufficient in order to be protective of all High Quality - Cold Water Fishery, aquatic life uses, as it is maintained in the reference watershed, the Mudlick Run, Indiana County.

TMDL Approach

Sedimentation is an essential component of aquatic ecosystems, as it often contains minerals used by many aquatic organisms, and provides habitat. Sedimentation is a natural process that is caused by the weathering of landscape, whereby wind and water erode the surfaces of rocks and soils creating small particles. When these particles enter streams, they may flow with the current (suspended solids), or be deposited on the streambed. Typically, natural inputs of sediment to streams do not cause problems; however, when landscape is modified, excessive amounts of sediment can enter streams or erode from streams and cause undesirable effects (Bryan and Rutherford 1995). Agricultural practices such as row cropping involve the tilling of landscapes to make the soil porous and fertile, which consequently loosens soil directly, as well as indirectly by removing plants whose roots once held soil in place. During rain events, loosened soil is directed toward nearby streams via overland runoff, and depending upon the density of vegetation along the shoreline, sediment enters into the water.

The soil of pasture land is often more stable than that of cropland, yet in-stream sedimentation issues arise from the surface runoff associated with this land use. If the pasture land is grazed, the soil becomes compacted from the constant trampling by livestock, and therefore precipitation leaves the area via surface runoff and enters streams instead of infiltrating into the soil. In addition, because vegetation within pasture land typically has shallow roots and little water retention ability, precipitation that does infiltrate the soil saturates the soil quickly, which consequently reduces absorbance and increases surface runoff. The sudden increase in water volume in a stream raises the velocity of the flow to a point where soil from the streambanks begins to erode into the channel. Runoff volume from this land use is further increased in areas with steep topography, and areas in which cattle have overgrazed the vegetation. In addition to facilitating hydrology-related sedimentation issues, the overgrazing and trampling of vegetation in riparian zones leads to loosened soil that directly enters streams.

Eroded sediment can cause numerous problems for aquatic organisms. Suspended sediment causes turbidity, which can interfere with predation efficiency; cause respiration problems by clogging gills of aquatic organisms (Horne and Goldman 1994); and also reduces sunlight penetration, which affects plant photosynthesis (Waters 1995). Causing a higher magnitude of problems, deposited sediment can 1) suffocate eggs of fish and other organisms, 2) suffocate small organisms, 3) severely reduce habitat and habitat diversity, and 4) alter flow patterns (USEPA 1999).

Selection of the Reference Watershed

The reference watershed approach was used to estimate the appropriate sediment loading reduction necessary to restore healthy aquatic communities to the Ross Run watershed. This approach is based on selecting a non-impaired, or reference, watershed and estimating its current loading rates for the pollutants of interest. The objective of the process is to reduce loading rates of those pollutants identified as causing impairment to a level equivalent to or lower than the loading rates in the reference watershed. Achieving the appropriate load reductions should allow the return of a healthy biological community to affected stream segments. First, there are three factors that should be considered when selecting a suitable reference watershed: impairment status, similarity of physical properties, and size of the watershed. A watershed that the Department has assessed and determined to be attaining water quality standards should be used as the reference. Second, a watershed that closely resembles the impaired watershed in physical properties such as land use/land cover, physiographic province, elevation, slope and geology should be chosen. Finally, the size of the reference watershed should be within 20-30% of the impaired watershed.

The search for a reference watershed that would satisfy the above characteristics was done by means of a desktop screening using several GIS shapefiles, including a watershed layer, geologic formations layer, physiographic province layer, soils layer, Landsat-derived land cover/use grid, and the stream assessment information found on the Department's Instream Comprehensive Evaluation Protocol (ICE) GIS-based website. As a result, the Mudlick Run were selected as the reference for developing the Ross Run Sediment TMDL. It is designated as a High Quality - Cold Water Fish(ery) like Ross Run and is identified as attaining this aquatic life use. (Figure 7. non-impaired-green, impaired-purple).

Figure 7. Non-impaired segments in the Mudlick Run

Mudlick Run is located in North Mahoning Township, Indiana County). Its headwaters are west of I-119 (near the town of Merchand) and flows generally southwest to approximately SR210 to its confluence tributary to Little Mahoning Creek. Its watershed has an area approximately 3,807.0 acres. Land use in this watershed is composed of agriculture (23%) including croplands and hay/pasture, forestland (70%), and (7%) in low intensity development, open space, and barren land (Table 7., Figure 8.).

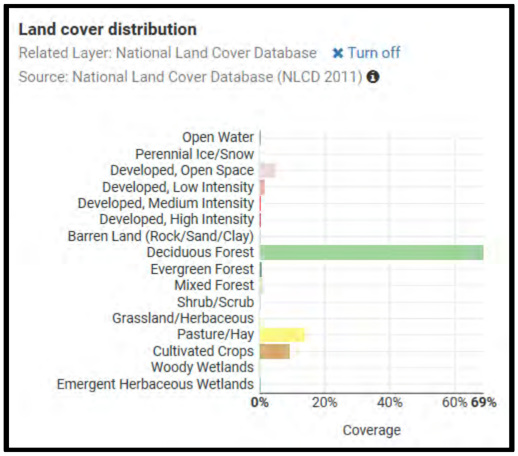
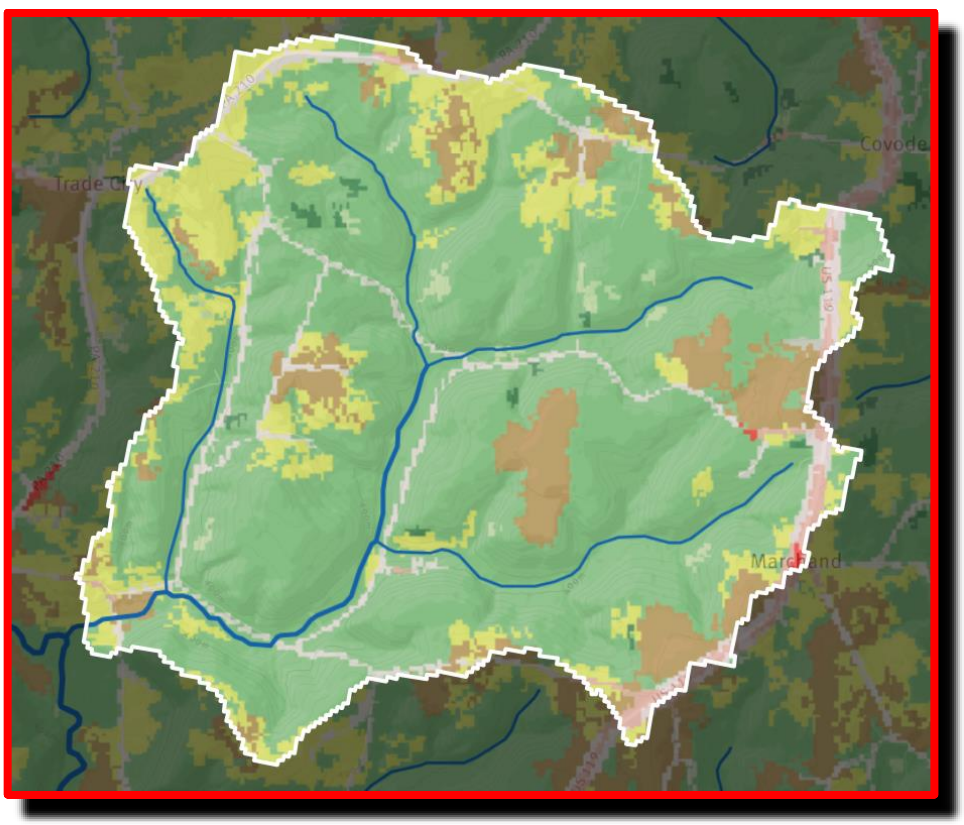


Table 7. Percentage of land use, and Figure 8. Map of land use distribution in the Mudlick Run



Like Ross Run, the soils are classified primarily as Hydrologic Soils Group (HSG) C and D (Table 8. and Figure 9.). These soil groups are characterized as having slow to very slow infiltration rates when thoroughly wetted and consist chiefly of soils of moderately fine to fine structure. These types of soils have a high runoff potential and must be managed as such to minimize impairments to receiving waters. The generally, low gradient drainage amongst sloping hills, with minimally vegetated agricultural areas, creates excess runoff during precipitation events. Unsuccessful sediment transport consecutively downstream causes inundation of benthic habitat to the point of biological impairment

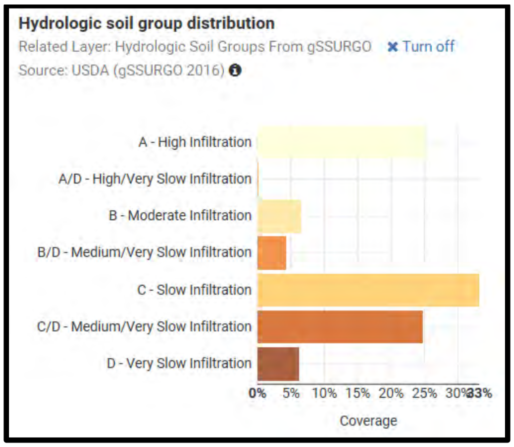
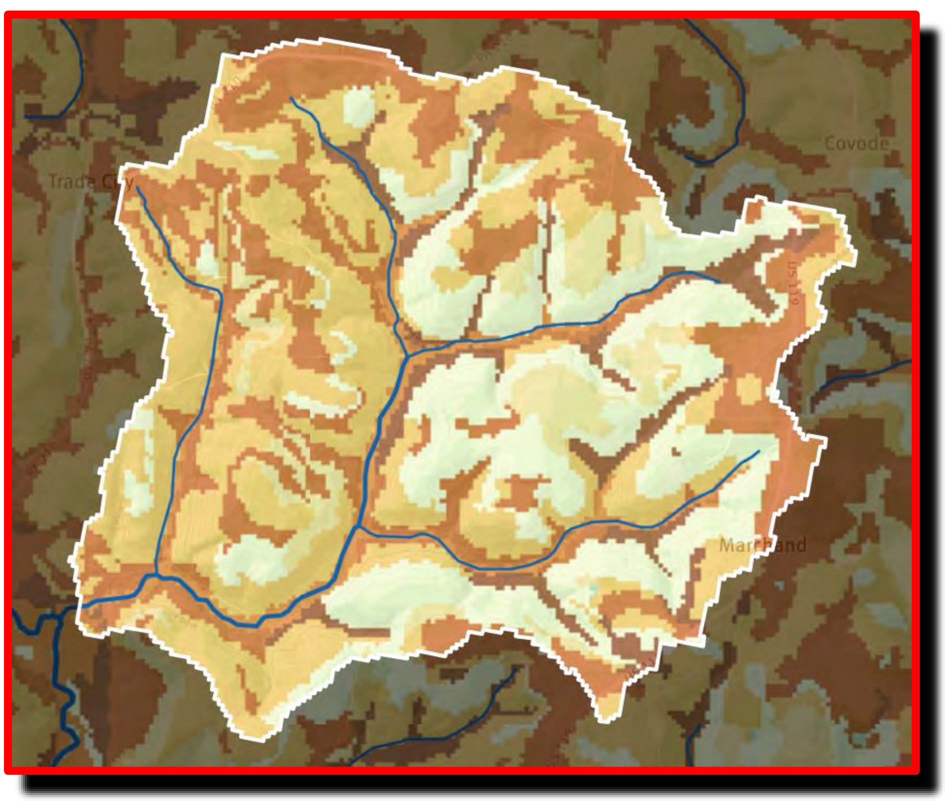


Table 8. Percentage of hydric soils, and Fig. 9. Map of hydric soil distribution in Mudlick Run



The watershed of Mudlick Run lies within Indiana County portion of the Pittsburgh Low Plateau Section of the Appalachian Plateau Province. This section consists of a smooth undulating upland surface cut by numerous, narrow, relatively shallow valleys. Rocks within the watershed are generally interbedded sedimentary, and specifically, the underlying bedrock group is the Glenshaw Formation (tan, Figure 10.). This geology is found at the higher elevations of the watershed. The Glenshaw's main rock type is also shale. It consists of repeated sequences of sandstone, siltstone, shale, claystone (red beds), limestone, and coal.

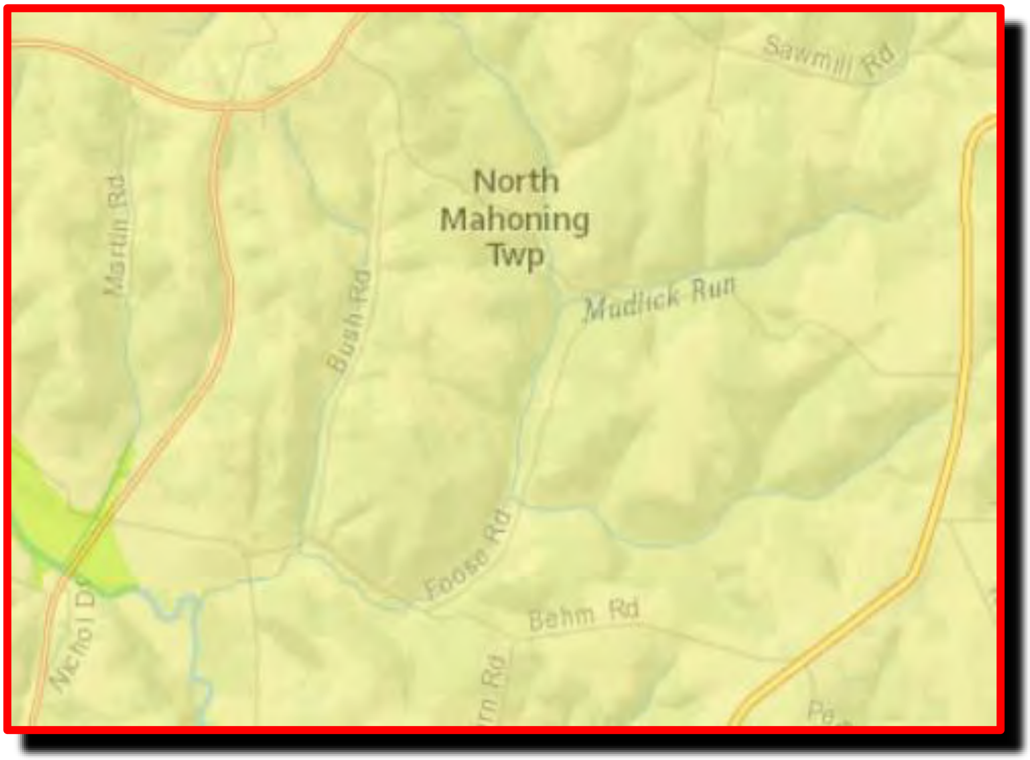
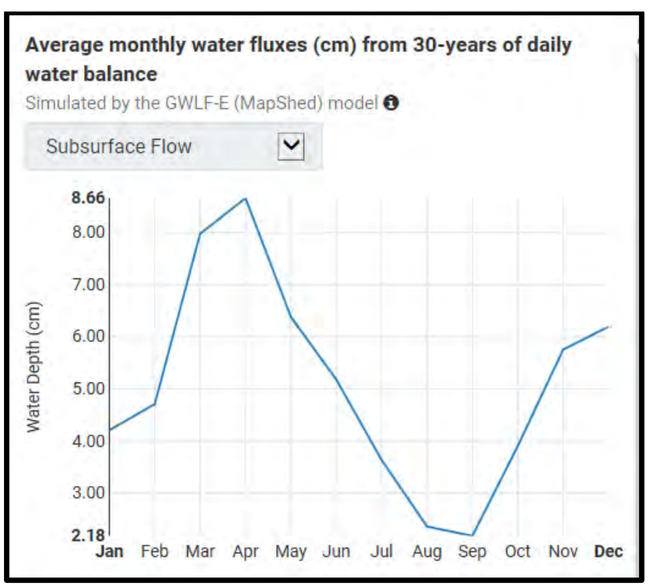


Figure 10. General geology of the Mudlick Run, and Table 9. Subsurface flow in the watershed



<table>
<tr><th colspan="3">Table 10. Comparison of Ross Run (impaired) and Mudlick Run (reference)</th></tr>
<tr><th></th><th>Ross Run</th><th>Mudlick Run</th></tr>
<tr><td>Physiographic Province</td><td>Appalachian Plateau Province (Pittsburgh Low Plateau Section)</td><td>Appalachian Plateau Province (Pittsburgh Low Plateau Section)</td></tr>
<tr><td>Area (acres)</td><td>4,851</td><td>3,807</td></tr>
<tr><td>Land Use Distribution
% Agriculture
% Forest
% Development</td><td>39
53
8</td><td>23
70
7</td></tr>
<tr><td>Surface Geology:
% Interbedded Sedimentary</td><td>100
Glenshaw Formation</td><td>100
Glenshaw Formation</td></tr>
<tr><td>Dominant Soils:</td><td>
<table>
<tr><th>Type</th><th>Area (km²)</th><th>Coverage (%)</th></tr>
<tr><td>A - High Infiltration</td><td>0.59</td><td>3.0</td></tr>
<tr><td>A/D - High/Very Slow Infiltration</td><td>0.00</td><td>0.0</td></tr>
<tr><td>B - Moderate Infiltration</td><td>1.40</td><td>7.1</td></tr>
<tr><td>B/D - Medium/Very Slow Infiltration</td><td>1.10</td><td>5.6</td></tr>
<tr><td>C - Slow Infiltration</td><td>11.40</td><td>57.5</td></tr>
<tr><td>C/D - Medium/Very Slow Infiltration</td><td>5.14</td><td>25.9</td></tr>
<tr><td>D - Very Slow Infiltration</td><td>0.21</td><td>1.0</td></tr>
</table>
</td><td>
<table>
<tr><th>Type</th><th>Area (km²)</th><th>Coverage (%)</th></tr>
<tr><td>A - High Infiltration</td><td>3.85</td><td>25.0</td></tr>
<tr><td>A/D - High/Very Slow Infiltration</td><td>0.00</td><td>0.0</td></tr>
<tr><td>B - Moderate Infiltration</td><td>1.01</td><td>6.6</td></tr>
<tr><td>B/D - Medium/Very Slow Infiltration</td><td>0.65</td><td>4.2</td></tr>
<tr><td>C - Slow Infiltration</td><td>5.10</td><td>33.2</td></tr>
<tr><td>C/D - Medium/Very Slow Infiltration</td><td>3.81</td><td>24.8</td></tr>
<tr><td>D - Very Slow Infiltration</td><td>0.95</td><td>6.2</td></tr>
</table>
</td></tr>
<tr><td>Average Rainfall (in.)</td><td>37.82 24 years</td><td>44.52, 30 years</td></tr>
<tr><td>Average Runoff (in.)</td><td>3.79, 24 years</td><td>2.79, 30 years</td></tr>
</table>

Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The TMDL for this watershed was calculated using the Mapshed - Generalized Watershed Loading Function Interface. The remaining paragraphs in this section are excerpts from the GWLF User's Manual (Haith et al., 1992).

The core watershed simulation model for the MAPSHED software application is the GWLF (Generalized Watershed Loading Function) model developed by Haith and Shoemaker. The original

DOS version of the model was re-written in Visual Basic by Evans et al. (2002) to facilitate integration with Mapshed, and tested extensively in the U.S. and elsewhere.

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

GWLF is considered to be a combined distributed/lumped parameter watershed model. 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 regarding 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 models surface runoff using the Soil Conservation Service Curve Number, or SCS-CN, approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation USLE algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (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 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.

For execution, the model requires two separate input files containing transport and weather-related data. The transport (transport.dat) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The weather (weather.dat) file contains daily average temperature and total precipitation values for each year simulated.

Since its initial incorporation into MAPSHED, the GWLF model has been revised to include a number of routines and functions not found in the original model. For example, a significant revision in one of the earlier versions of MAPSHED was the inclusion of a streambank erosion routine. This routine is based on an approach often used in the field of geomorphology in which monthly streambank erosion is estimated by first calculating a watershed-specific lateral erosion rate (LER). After a value for LER has been computed, the total sediment load generated via streambank erosion is then calculated by multiplying the above erosion rate by the total length of streams in the watershed (in meters), the average streambank height (in meters), and the average soil bulk density (in kg/m3).

The inclusion of the various model enhancements mentioned above has necessitated the need for several more input files than required by the original GWLF model, including a "scenario" (*.scn) file, an animal data (animal.dat) file. Also, given all of the new and recent revisions to the model, it has been renamed "GWLF-E" to differentiate it from the original model.

As alluded to previously, the use of GIS software for deriving input data for watershed simulation models such as GWLF is becoming fairly standard practice due to the inherent advantages of using GIS for manipulating spatial data. In this case, a customized interface developed by Penn State University for Mapshed GIS software (versions 3.2 or 3.3) is used to parameterize input data for the GWLF-E model. In utilizing this interface, the user is prompted to load required GIS files and to provide other information related to various "non-spatial" model parameters (e.g., beginning and end of the growing season; the months during which manure is spread on agricultural land, etc.). This information is subsequently used to automatically derive values for required model input parameters which are then written to the appropriate input files needed to execute the GWLF-E model. Also accessed through the interface are Excel-formatted weather files containing daily temperature and precipitation information. (In the version of MAPSHED used in Pennsylvania, a statewide weather database was developed that contains about twenty-five (25) years of temperature and precipitation data for seventy-eight (78) weather stations around the state). This information is used to create the necessary weather.dat input file for a given watershed simulation.

Part 2. GIS Based Derivation of Input Data

The primary sources of data for this analysis were geographic information system (GIS) formatted databases and shapefiles. In using the MAPSHED 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 growing season, manure spreading period, etc.). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, MAPSHED 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 cropping practices. Complete GWLF-formatted weather files are also included for the seventy-eight weather stations around the state.

Table 11. lists GIS datasets and shapefiles used for the Ross Run TMDL calculations via MAPSHED and provides explanations of how they were used for development of the input files for the GWLF model.

Table 11. GIS Datasets

DATASET	DESCRIPTION
county.shp	The county boundaries coverage lists data on conservation practices which provides C and P values in the Universal Soil Loss Equation (USLE).
padem	100-meter digital elevation model; this is used to calculate land slope and slope length.
palumrlc	A satellite image derived land cover grid which is classified into 15 different landcover categories. This dataset provides landcover loading rates for the different categories in the model.
physprov.shp	A shapefile of physiographic provinces. This is used in rainfall erosivity calculations.
smallsheds.shp	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
streams.shp	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
PAgeo	A shapefile of the surface geology used to compare watersheds of similar qualities.
weathersta.shp	Historical weather files for stations around Pennsylvania to simulate flow.
soils.shp	A shapefile providing soil characteristics data. This is used in multiple calculations.
zipcodes.shp	This shapefile provides animal density numbers used in the LER calculation.

In the GWLF model, the nonpoint source load calculated is affected by terrain conditions such as amount of agricultural land, land slope, and inherent soil erodibility. It is also affected by farming practices utilized in the area. Various parameters are included in the model to account for these conditions and practices. Some of the more important parameters are summarized below:

Areal extent of different land use/cover categories: This is calculated directly from a GIS layer of land use/cover.

Curve number: This determines the amount of precipitation that infiltrates into the ground or enters surface water as runoff. It is based on specified combinations of land use/cover and hydrologic soil type, and is calculated directly using digital land use/cover and soils layers.

K factor: This factor relates to inherent soil erodibility, and affects the amount of soil erosion taking place on a given unit of land.

LS factor: This factor signifies the steepness and length of slopes in an area and directly affects the amount of soil erosion.

C factor: This factor is related to the amount of vegetative cover in an area. In agricultural areas, the crops grown and the cultivation practices utilized largely control this factor. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

P factor: This factor is directly related to the conservation practices utilized in agricultural areas. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.

Sediment delivery ratio: This parameter specifies the percentage of eroded sediment that is delivered to surface water and is empirically based on watershed size.

Unsaturated available water-holding capacity: This relates to the amount of water that can be stored in the soil and affects runoff and infiltration. It is calculated using a digital soils layer.

Other less important factors that can affect sediment loads in a watershed are also included in the model.

The above parameter descriptions were taken from the *MAPSHED Version 7.1 Users Guide* (Evans et al., 2007).

Watershed Assessment and Modeling

The MAPSHED model was used to establish existing loading conditions for the impaired (siltation) Ross Run and the corresponding non-impaired, reference of Mudlick Run. All MAPSHED data and outputs have been attached to this TMDL as Attachment A. Department staff visited the listed watersheds to get a better understanding of existing conditions that might influence the MAPSHED model. The following are general observations (as detailed with photos and descriptions) of the individual watersheds of Mudlick Run (reference-Figures 11. and 12.) and Ross Run (impaired-Figures 20. and 21.).

Figure 11. Percent land use, and Figure 12. Map of land use distribution in Mudlick Run (reference)

Figure 13. Mid-stream predominantly forest buffer with fields and ag.
Figure 14. Extensive vegetation helps with maintaining cold water fishery characteristics

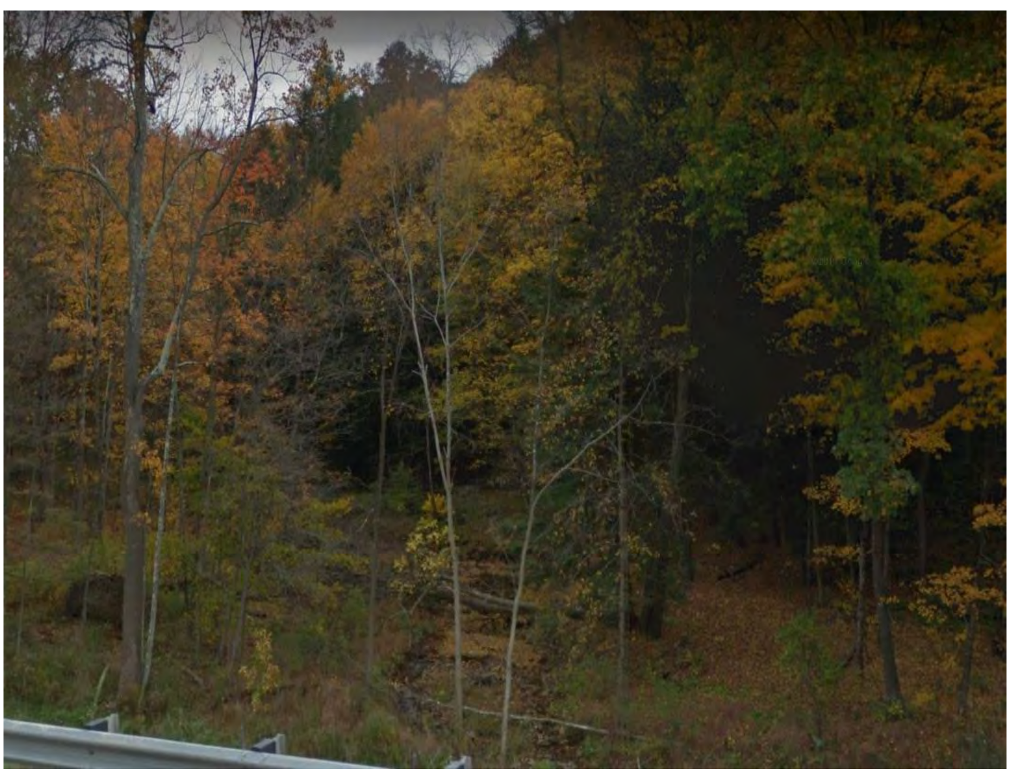


Figure 15. Rooted slopes and buffering between farm and stream
Figure 16. Pasture for cows is rotated and fenced away from Ross Run

Figure 17. In addition to cattle, horse pasture appears renewable
Figure 18. Areas open to fields show banks with a minimum of pressure from erosion

Figure 19. A variety of agricultural and field uses are adequately protected with tracts of forest

Figure 20. Percent land use, and Figure 21. Map of land use distribution in Ross Run

Figure 22. Flood plain expansion and pooling
Figure 23. Excess grazing of fields and in-stream pastures

Figure 24. Trampled banks and stream bottom

Figure 25. Downstream streambanks are being undercut, and erosion

. **Figure 26. Unconsolidated instream pastureland**

Figure 27. Unrooted slope and pooling

Figure 28. Silt islands forming from upstream loading

Figure 29. Higher gradient flow expedites flushing in the lower Ross Run watershed

Figure 30. Elevated floodplain minimizes benthic habitat

Figure 31. Unconsolidated banks cause frequent and meandering stream bed

Development of Sediment TMDL

The target TMDL value for the biologically impaired Ross Run was established based on current loading rates for sediment in the reference Mudlick Run. Reducing the loading rates in Ross Run to levels equal to, or less than, the reference watershed should allow for the reversal of current use impairments and maintain its HQ-CWF aquatic life use value. As described in the previous section, sediment loading rates were computed for the reference stream using the MapShed model. The target TMDL value for sediment was determined by multiplying the unit area loading rates for the reference stream by the total area of the biologically impaired one (Table 12.).

Table 12. Target TMDL Using Reference Loading Rate with Total Area of Impaired

Pollutant	Loading Rate in Reference (lb./ac.-yr.)	Total Area Impaired Watershed (ac.)	Target TMDL Value (lb./yr.)	Target TMDL Value (lb./day)
Sediment	**146.4**	**4,920.0**	**720,359.3**	**1,973.6**

The target TMDL value was then used as the basis for load allocations and reductions in the Ross Run, using the following two equations:

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

where:

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

Waste Load Allocation

The waste load allocation (WLA) portion of the sediment 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 no point source discharges within the Ross Run watershed. A WLA allocation of 1% of the Sediment TMDL (**720,359.3** lbs./yr.) was incorporated as a bulk reserve (**7,203.6** lbs./yr.) for the dynamic nature of future permit activity.

WLA = 7,203.6 lbs./yr. or 19.7 lbs./day

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 TMDL for sediment was 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 Ross Run. The MOS used for the Sediment TMDL was set at **72,035.9** lbs./yr.

MOS = 720,359.3 lbs./yr. (TMDL) * 0.1 = 72,035.9 lbs./yr. or 197.4 lbs./day

Load Allocation

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. The LA for the Sediment TMDL was computed by subtracting the MOS value and the WLA from the TMDL value. The LA for the Sediment TMDL was set at **641,119.8** lbs./yr.

LA = 720,359.3 lbs./yr. (TMDL) –72,035.9 lbs./yr. (MOS) – 7,203.6 lbs./yr. (WLA)
LA = 641,119.8 lbs./yr. or 1,756.5 lbs./day

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 nonpoint source loads that are not being considered for reductions (loads not reduced (LNR)) from the LA. The Ross Run was developed to address impairments caused by agricultural activities, including hay/pastureland and cropland, including associated stream banks. Land uses/source loads not reduced (LNR) were carried through at their existing loading values. The ALA for the Sediment TMDL was set at **628,719.8** lbs./yr. (Table 13.)

ALA (adjusted load allocation) **= LA – LNRs**

Table 13. Loads of pollutant sources that will not be reduced (LNRs).

	Sediment (lbs./yr.)
Loads Allocation (LA)	**641,119.8**
Loads Not Reduced (LNR)	**12,400.0**
Forest Low Development Medium Development Open Space	**5,400.0** **4,800.0** **400.0** **1,800.0**
Adjusted Load Allocation (ALA)	**628,719.8 (1,722.5 lbs./day)**

TMDL Summary

The sediment TMDL established for Ross Run consists of a Load Allocation (LA) and a Margin of Safety (MOS). The individual components TMDL are summarized in Table 14.

Table 14. TMDL Components for Ross Run

Parameter	Sediment (lbs./yr.)	Sediment (lbs./day)
TMDL (Total Max Daily Load)	720,359.3	1,973.6
WLA (Waste load Allocation)	7,203.6	19.7
MOS (Margin of Safety)	72,035.9	197.4
LA (Load Allocation)	641,119.8	1,756.5
LNRs (Loads not reduced)	12,400.0	34.0
ALA (Adjusted Load Allocation)	628,719.8	1,722.5

Calculation of Sediment Load Reductions

The adjusted load allocation established in the previous section represents the sediment load that is available for allocation between agricultural activities (cropland and hay/pastureland) and associated stream banks in the Ross Run. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method, Attachment B, was used to distribute the ALA between the two land use types and stream banks. The process is summarized below:

1. Each land use/source load is compared with the total allocable load to determine if any contributor would exceed the allocable load by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load to the receiving waterbody. If the contributor exceeds the allocable load, that contributor would be reduced to the allocable load. This is the baseline portion of EMPR. For this evaluation Cropland was in excess of the adjusted load allocation (ALA).

2. 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 total allocable load. If the allocable load 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. For this evaluation, the allocable load was exceeded.

3. The equal percent reduction, i.e., the ALA divided by the summation of the baselines, worked out to a 2**5.8%** overall reduction in the current sediment loading for agricultural activities (cropland and hay/pastureland), and associated stream banks.

Tables 12. (Annual Values) contains the results of the EMPR in sediment loading. The load allocations for each land use are shown along with the percent reduction of current loads necessary to reach the targeted LA.

Table 12. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Ross Run (Annual Values)

Pollutant Source	Current Loading Rate (lb.s/yr./acre)	Allowable Loading Rate (lbs./yr./acre)	Current Load (lbs./yr.)	Allowable Load (lbs./yr.)	Percent Load Reduction
Cropland	510.9	378.9	376,000.0	278,837.8	**25.8%**
Hay/Pasture	139.5	103.5	165,600.0	122,807.3	**25.8%**
Stream bank	-	-	306,200.0	227,074.8	**25.8%**

Table 13. Sediment Load Allocations/Reductions for Land Uses and Stream Banks in the Ross Run (Daily Values)

Pollutant Source	Current Loading Rate (lbs./d./acre)	Allowable Loading Rate (lbs./d./acre)	Current Load (lbs./d.)	Allowable Load (lbs./d.)	Percent Load Reduction
Cropland	1.4	1.0	1,030.1	763.9	**25.8%**
Hay/Pasture	0.4	0.3	453.7	336.5	**25.8%**
Stream bank	-	-	838.9	622.1	**25.8%**

Recommendations

Sediment loading reductions in the TMDL are allocated to nonpoint sources in the watershed including: agricultural activities, transitional lands and stream banks. Implementation of best management practices (BMPs) in these affected areas are called for according to this TMDL document. The proper implementation of these BMPs should achieve the loading reduction goals established in the TMDL.

From an agricultural perspective, reductions in the amount of sediment reaching the streams in the watershed can be made through the right combination of BMPs including, but not limited to: establishment of cover crops, strip cropping, residue management, no till, crop rotation, contour farming, terracing, stabilizing heavy use areas and proper management of storm water. Vegetated or forested buffers are acceptable BMPs to intercept any runoff from farm fields. For the pasturing of farm animals and animal heavy use areas, acceptable BMPs may include: manure storage, rotational grazing, livestock exclusion fencing and forested riparian buffers. Some of these BMPs were observed in the biologically impaired Ross Run; however, they were more extensively used in the non-impaired, reference watershed of the North Fork Pine Creek with forested riparian buffers being the predominant BMP in use. Since both watersheds have a considerable amount of agricultural activities, it is apparent that the greater use of BMPs, especially forested riparian buffers, in the reference watershed has contributed to its ability to maintain its attainment status as a High Quality - Cold Waters Fishery (HQ-CWF) stream.

Stream banks contribute to the sediment load in Ross Run. Stream bank stabilization projects would be acceptable BMPs for the eroded stream banks in the area. However, the establishment of forested riparian buffers is the most economical and effective BMP at providing stream bank stabilization and protection of the banks from freeze/thaw erosion and scouring flows. Forested riparian buffers are also essential to maintaining the biologically rich yet sensitive HQ-CWF habitat. Forested riparian buffers also provide important natural and durable connectivity of land and water. This connectivity is necessary to provide cover, nesting and nursery sites, shade and stable temperatures, and viable substrate for aquatic organisms of all layers of the food web protected under the HQ-CWF use designation. Important to TMDLs, established forested riparian buffers act as a sediment loading sink. This is because the highly active and concentrated biological communities they maintain will assimilate and remove sediment loading from the water column instead of allowing them to pass downstream, thus forested riparian buffers work directly toward attaining the goals of the TMDL by reducing pollutant loads. These forested riparian buffers also provide the essential conditions necessary to meet the HQ-CWF designated use of the waterway. Forested riparian buffers also provide critical habitat to rare and sensitive amphibious and terrestrial organisms as well as migratory species. While forested riparian buffers are considered the most effective BMP, other possibilities for attaining the desired reductions may exist for the agricultural usages, as well as for the stream banks.

Funding Sources

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/stream bank 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

VII. Public Participation

Public notice of the TMDL will be published in the Pennsylvania Bulletin on May 26, 2018 to foster public comment on the allowable loads calculated. A 30-day period will be provided for the submittal of comments and notice. Any public contribution will be placed in the Comments and Response, Section B, Pg. 49.

VI. References

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Attachment A.

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 Adjusted Load Allocations (ALAs) among the appropriate contributing non-point sources. The load allocation and EMPR procedures were performed using MS Excel and results are presented in Appendix E. 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.

1. a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving water-body. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of EMPR.
2. 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.

FIGURE A1. GWLF Output for Ross Run

GWLF Total Loads for file: RossRunWatershed-0 Period of analysis: 30 years from 1961 to 1990

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	1187	3.4	481.1	82.8	731.2	1062.4	292.1	430.3
Cropland	736	5.9	1092.2	188.0	2828.0	3579.9	310.8	624.6
Forest	2591	2.9	15.8	2.7	328.2	339.0	17.3	21.8
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	23	8.8	5.5	0.9	22.7	26.5	0.5	2.0
Bare Rock	16	8.8	0.1	0.0	9.6	9.7	0.3	0.4
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	364	4.6	0.0	2.4	43.7	132.3	5.9	14.7
MD Mixed	3	13.7	0.0	0.2	1.9	5.6	0.2	0.6
HD Mixed	0	19.8	0.0	0.0	0.0	0.0	0.0	0.0
LD Residential	0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	8.1	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	11.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						1431.5		317.1
Tile Drainage				0.0		0.0		0.0
Stream Bank				153.1		153.1		63.9
Groundwater					13585.0	13585.0	394.7	394.7
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					10.9	10.9	0.0	0.0
Totals	4919.6	8.3	1594.7	430.1	17561.1	20335.8	1021.8	1870.1

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FIGURE A2. GWLF Output for the Mudlick Run

GWLF Total Loads for file: MudlickRun-0   Period of analysis: 30 years from 1961 to 1990

Source	Area (Acres)	Runoff (in)	Tons: Erosion	Tons: Sediment	Total Loads (Pounds): Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	532	3.4	192.7	34.3	327.6	464.8	114.2	161.3
Cropland	353	5.9	672.3	119.7	1355.1	1833.8	130.3	295.0
Forest	2674	2.1	20.9	3.7	237.8	252.7	12.5	17.6
Wetland	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disturbed	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	3	10.5	0.0	0.0	2.5	2.5	0.1	0.1
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	240	4.6	0.0	1.6	28.7	86.9	3.9	9.7
MD Mixed	5	13.7	0.0	0.2	2.7	8.2	0.3	0.8
HD Mixed	0	19.8	0.0	0.0	0.0	0.0	0.0	0.0
LD Residential	0	4.6	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	8.1	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	11.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						1124.4		249.8
Tile Drainage				0.0		0.0		0.0
Stream Bank				119.2		119.3		41.0
Groundwater					6650.2	6650.2	286.6	286.6
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					18.2	18.2	0.0	0.0
Totals	3806.9	6.3	885.9	278.7	8622.8	10560.9	547.9	1061.9

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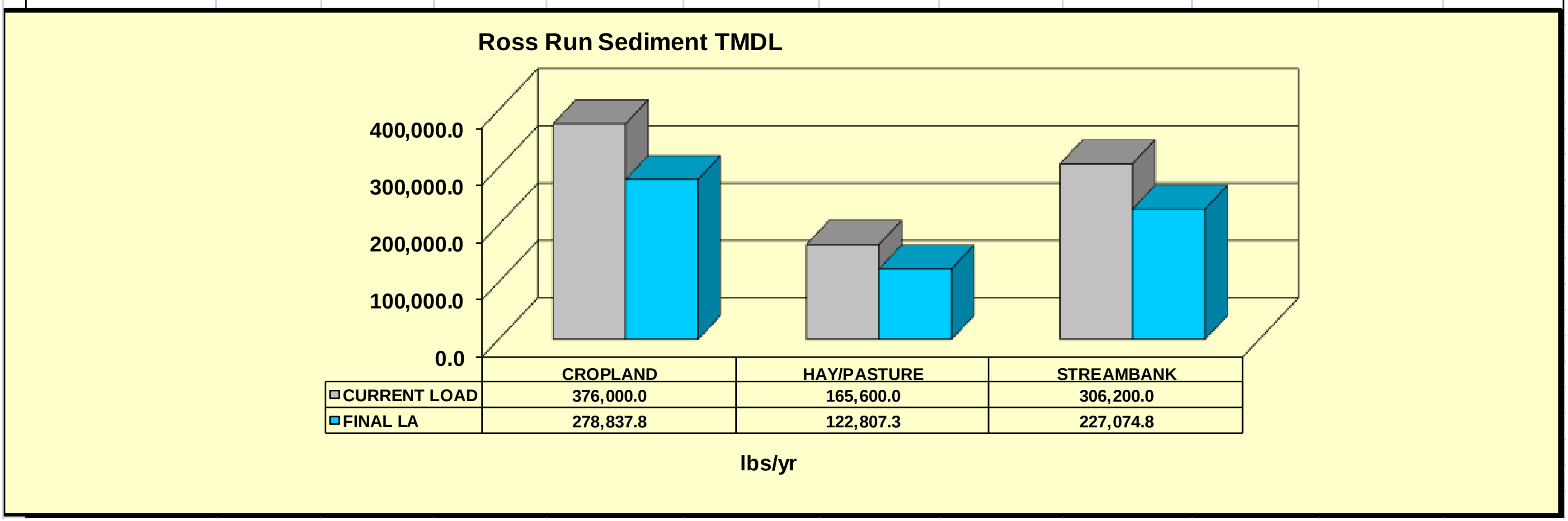
FIGURE A3. Equal Marginal Percent Reduction Calculations for Ross Run

1	TMDL				2	Adjusted LA = TMDL total load - ((MOS) - loads not reduced)						
	TMDL = Sediment loading rate in ref. * Impaired Acres					628719.8	628719.8					
	720359.3											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	376000.0	847800.0	good	376000.0		0.4	97162.2	278837.8	736.0	378.9	25.8%
	HAY/PASTURE	165600.0		good	165600.0	219080.2	0.2	42792.7	122807.3	1187.0	103.5	25.8%
	STREAMBANK	306200.0		good	306200.0		0.4	79125.2	227074.8	0.0		25.8%
					847800.0		1.0		628719.8			
4	All Ag. Loading Rate	208.86										
			Allowable		Current	Current						
		Acres	loading rate	Final LA	Loading Rate	Load	% Red.		CURRENT LOAD		FINAL LA	
5	CROPLAND	736.0	378.9	278837.8	510.9	376000.0	25.8%		CROPLAND	376,000.0	278,837.8	
	HAY/PASTURE	1187.0	103.5	122807.3	139.5	165600.0	25.8%		HAY/PASTURE	165,600.0	122,807.3	
	STREAMBANK	0		227074.8		306200.0	25.8%		STREAMBANK	306,200.0	227,074.8	
				628719.8		847800.0	25.8%					



Attachment B.

Comment and Response

No public comments were received.