KISHACOQUILLAS CREEK WATERSHED ALTERNATIVE RESTORATION PLAN

Mifflin County, Pennsylvania

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DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Executive Summary

Kishacoquillas Creek is a tributary of the Juniata River in Mifflin County, North Central Pennsylvania (PA). Seven impaired subwatersheds within the greater Kishacoquillas Watershed have been identified for restoration. A phased approach to restoration was developed for all of the impaired subwatersheds and will be implemented by the Mifflin County Conservation District as they have a successful history of restoring their local water quality. Phase 1 will occur within five years and will focus on getting all farmers to regulatory compliance with their conservation and nutrient management plans. Phase 2 will occur within ten years and will focus on satisfying the restoration goals for each subwatershed. Phase 1 and 2 modeling scenarios are included in this document so that progress can be measured toward attainment of water quality standards and allow for more targeted implementation in the future. Upon completion of Phase 2, the impairments within the Kishacoquillas Creek Watershed should be remediated.

The Upper Kishacoquillas Creek Subwatershed, in 2005, and the Hungry Run Subwatershed, in 2008, have had specific Watershed Implementation Plans (WIPs) established to guide their restoration. These are also the largest impaired subwatersheds with the Kishacoquillas Creek Watershed. The Mifflin County Conservation District has made significant progress implementing the Best Management Practices (BMPs) prescribed by these WIPs while reducing pollution.

This Alternative Restoration Plan (ARP) established load reductions needed from specific sources in the impaired subwatersheds by first modeling the Upper Kishacoquillas Creek Subwatershed while comparing it to a reference watershed, Spring Creek. Next, the existing pollutant loads in the other six impaired subwatersheds within the greater Kishacoquillas Watershed were determined by multiplying the area of their basins by the loading rates from the Upper Kishacoquillas Creek Subwatershed. Finally, the loading rates of the reference watershed, Spring Creek, were applied to the basins of the impaired subwatersheds to determine necessary reductions to the pollutants of concern. For the Upper Kishacoquillas Creek and Hungry Run Subwatersheds, a further comparison was made to determine the remaining load reductions needed by subtracting those already attained through ongoing WIP implementation. This enabled visualization of the extent that these sources remain in need of reduction.

Future scenarios were modeled to display potential pollutant load reductions in all seven impaired subwatersheds. Phase 1 demonstrated all farms attaining regulatory compliance. Phase 2 consists of adding animal waste management systems and runoff controls as well as a small amount of BMPs necessary to meet water quality goals. Phase 2 also demonstrates 100% WIP implementation for the two subwatersheds with WIPs. Modeling these scenarios goes above and beyond the scope of a regular Total Maximum Daily Load (TMDL) as they are more prescriptive and useful to vested local parties with regard to restoration efforts than general TMDL load allocations. As such, this ARP is meant to eliminate the need for a TMDL as water quality and habitat will be placed on a path of efficient restoration as local parties implement this ARP as an enhanced guide to restoration rather than attempting to meet the far less effective general load allocations of a regular TMDL.

Introduction

The Kishacoquillas Creek Watershed is currently designated as Cold Water Fishes (CWF) and Migratory Fishes (MF), PA Code 25 § 93.9n. Cold Waters Fishes by definition states: CWF – 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. Migratory Fishes by definition states: MF- Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.

This ARP calculation has been prepared for specific segments in the Kishacoquillas Creek Watershed, Attachment A. The watershed of Kishacoquillas Creek is located in Mifflin County. The watershed basin is approximately 33 square miles with 158 stream miles within the watershed listed as impaired for siltation and/or nutrients from agriculture. Agriculture is the dominant land use.

The ARP was completed to address the impairments noted on the 2016 Pennsylvania 303(d) and Integrated Lists. It covers the listed segments shown in Table 2 and Attachment D. Siltation and nutrients from agricultural activities have been listed as causing the impairments. The ARP addresses siltation and nutrients from streambanks, farm animals, hay/pasture lands, and croplands.

Table 2. Integrated Water Quality Monitoring and Assessment Report Listed Segments

State Water Plan (SWP) Subbasin: 12A

HUC: 02050304 – Lower Juniata

Watershed – Kishacoquillas Creek

Source	EPA 305(b) Cause Code	Miles	Designated Use	Use Designation
Agriculture	Nutrients	59.3	CWF, MF	Aquatic Life
Agriculture	Siltation	84.8	CWF, MF	Aquatic Life
Construction	Siltation	1.6	CWF, MF	Aquatic Life
Crop Related Agriculture	Siltation	0.8	CWF, MF	Aquatic Life
Grazing Related Agriculture	Siltation	3.2	CWF, MF	Aquatic Life
Hydromodification	Siltation	2.2	CWF, MF	Aquatic Life
Urban Runoff/ Storm Sewers	Siltation	6.0	CWF, MF	Aquatic Life

HUC= Hydrologic Unit Code
CWF= Cold Water Fishes
MF= Migratory Fishes
The use designations for the stream segments in this APR can be found in PA Title 25 Chapter 93.
See Attachments D & E, for more information on the listings and listing process.

Basic Steps for Determining an ARP

Although all watersheds must be handled on a case-by-case basis when developing restoration plans, 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 ARP 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.

ARP Elements: AL = UF + NPSL + PSL
NPSL = ANPSL + LNR

The Alternative Restoration Plan (ARP) equation consists of a non-point source load (NPSL), a point source load (PSL) and an uncertainty factor (UF) equaling the allowable load (AL). The UF is applied to account for uncertainties in the computational process. The UF may be expressed implicitly by documenting conservative processes in the computations or explicitly by setting aside a portion of the allowable load. The PSL is the portion of the allowable load given to NPDES permitted sources. The NPSL is the portion of the load assigned to all sources in the watershed. The NPSL is divided into the adjusted nonpoint source load (ANPSL) and loads not reduced (LNR). The ANPSL comprises the identified sources that will have their loads reduced such as croplands, pasture lands, farm animals and streambanks. The LNR are sources other than those identified for reductions (i.e. forest, wetlands).

Future Modifications

In the future, the Department may adjust the load allocations to account for new information or circumstances that are developed or discovered during the implementation of the ARP when a review of the new information or circumstances indicate that such adjustments are appropriate. New information generated during ARP implementation may include, among other things, monitoring data, best management practice (BMP) effectiveness information, and land use information.

ARP Approach

The ARP developed for the Kishacoquillas Creek Watershed addresses sediment and nutrients. Because neither Pennsylvania nor EPA has water quality criteria for sediment or nutrients, a method was developed to determine water quality objectives for these pollutants that should result in the impaired stream segments attaining their designated uses. The method employed for this ARP is termed the Reference Watershed Approach.

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 impaired watershed. This approach is based on selecting a non-impaired, reference, watershed and estimating its current loading rates for the pollutants of concern. The objective of the process is to reduce loading rates of those pollutants 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.

There are factors that should be considered when selecting a suitable reference watershed: impairment status, similarity of physical properties, and size of the watershed. First, a watershed that the Department has assessed and determined to be attaining water quality standards shall be used as the reference. Second, a watershed that closely resembles the impaired watershed in physical properties such as land use/land cover, elevation, slope and soils should be chosen. Finally, the size of the reference watershed should be approximately within 30% of the impaired watershed area.

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, 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. The suitability of the chosen watershed was confirmed through discussions with Department staff as well as through field verification of conditions.

Based on the above criteria, the Spring Creek Watershed was selected as the reference watershed for developing the Kishacoquillas Creek Watershed ARP, Figure 1. Spring Creek is a tributary to White Deer Hole Creek. Spring Creek is located in Lycoming and Union Counties, Pennsylvania. Spring Creek is attaining its designated uses. The attainment of designated uses is based on biological sampling done by the Department. Table 4 compares the two watersheds in terms of size, location, and other physical characteristics.

Table 4. Comparison of the Upper Kishacoquillas Creek Subwatershed and Spring Creek Watershed

	Kishacoquillas Creek Watershed	Spring Creek Watershed
Area, ac	21,072	13,397
Land Use Distribution	55% Agriculture 37% Forest 8% Other	39% Agriculture 55% Forest 6% Other
Soils	23% Group A 49% Group B 6% Group C 22% Group D	22% Group A 36% Group B 16% Group C 26% Group D
Average Rainfall, inches	40.6, 30 years	42.5, 30 years
Average Runoff, inches	2.9, 30 years	3.4, 30 years

The analysis of value counts for each pixel of the Multi-Resolution Land Characterization (MRLC) grid revealed that land cover/use distributions in both watersheds are similar. Agriculture is a significant land use category in both the Upper Kishacoquillas Creek Subwatershed and Spring Creek Watershed.

The soil types are similar between the watersheds thus producing similar influences on the sediment loads among them.

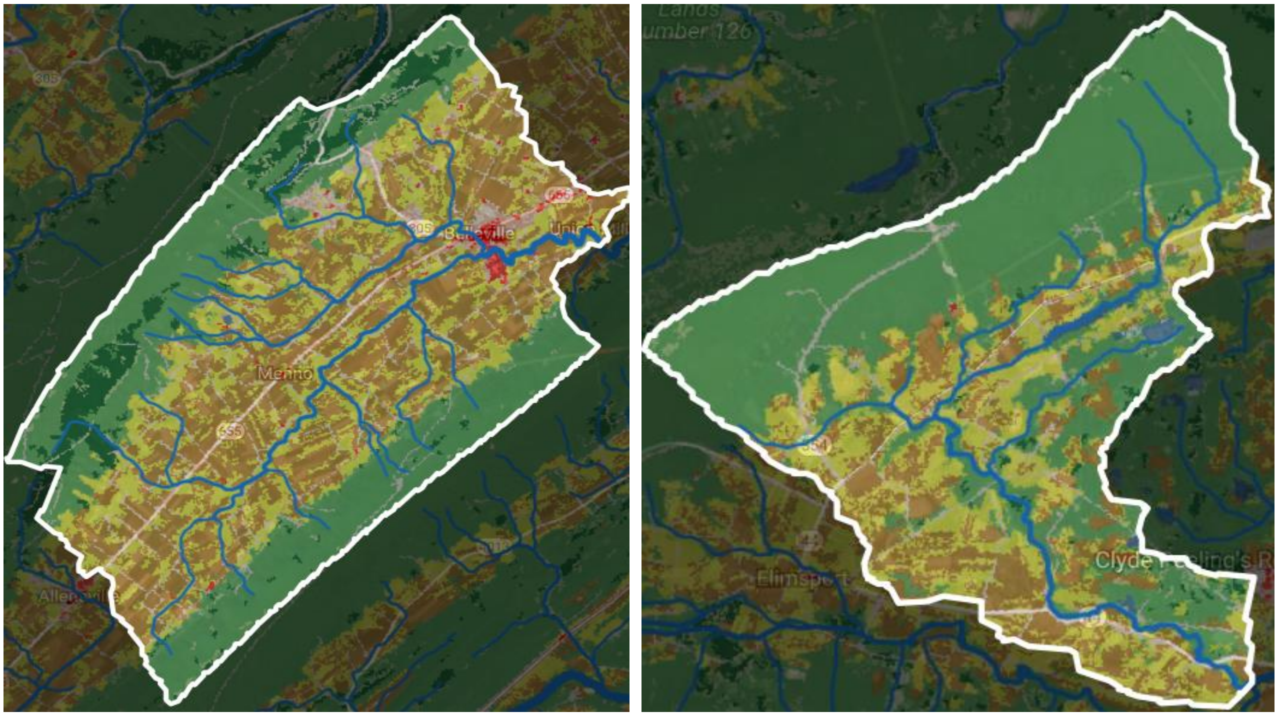

Figure 1. Upper Kishacoquillas Creek Subwatershed (left side/impaired) and Spring Creek Watershed (right side/reference) land cover. Of note, riparian forest buffers (green) are mostly absent in the impaired watershed while mostly present in the reference watershed.

Hydrologic / Water Quality Modeling

Part 1. Model Overview & Data Compilation

The ARP for this watershed was calculated using the MapWindow GIS and the MapShed watershed model.

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 MapWindow, and tested extensively in the U.S. and elsewhere.

The MapShed model provides the ability to simulate runoff and sediment load 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 loads based on the daily water balance accumulated to monthly values.

MapShed 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 in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but simply aggregates the loads from each source area into a watershed total; in other words, there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is simply computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

With respect to the major processes simulated, MapShed 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 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 MapShed 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 ArcView GIS software (versions 3.2 or 3.3) is used to parameterize input data for the MapShed 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 MapShed 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 years of temperature and precipitation data for seventy-eight 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 MapShed 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 MapShed-formatted weather files are also included for the seventy-eight weather stations around the state. Table 5 lists GIS datasets and shapefiles used for these ARP calculations via MapShed and provides explanations of how they were used for development of the input files for the MapShed model.

Table 5. 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 landslope 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 MapShed 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 Upper Kishacoquillas Creek Subwatershed and Spring Creek Watershed. MapShed outputs have been attached to this APR as Attachment C. Department staff visited the Upper Kishacoquillas Creek Subwatershed and Spring Creek Watershed to get a better understanding of existing conditions that might influence the MapShed model. For general observations, see pages 13-14. The individual watershed characteristics included:

Upper Kishacoquillas Creek Subwatershed (impaired)

- limited or absent riparian buffers in the agricultural areas
- livestock in the stream
- barn yard waste and runoff from animal heavy use areas reporting to the stream

Spring Creek Watershed (reference)

- established and protected riparian forest buffers
- livestock exclusion fencing and rotational grazing

Based on field observations adjustments may be made to specific parameters used in the MapShed model. Any adjustments were as follows:

Upper Kishacoquillas Creek Subwatershed

- No changes to the model were necessary for the Upper Kishacoquillas Creek Subwatershed.

Spring Creek Watershed

- No changes to the model were necessary for the Spring Creek Watershed.

Figure 2. Unstable streambanks, animal heavy use area lacking BMPs and cattle with free access to the stream in the Upper Kishacoquillas Creek Subwatershed

Figure 3. Riparian forest buffer in agricultural lands in the Spring Creek Watershed

The MapShed model produced area information and pollutant loading based on land use (Tables 6 and 7).

Table 6. Existing Sediment and TP Loading Values for Upper Kishacoquillas Creek, impaired					
Source	Area ac	Sediment, lbs/yr	Unit Area Load, lbs/ac/yr	TP, lbs/yr	Unit Area Load, lbs/ac/yr
HAY/PAST	4,798	3,348,000	698	4,315.1	0.9
CROPLAND	6,753	7,124,800	1,055	8,233.3	1.2
FOREST	7,588	10,400	1	34.5	0.0
BARE ROCK	3	0	0	0.0	0.0
Ld_Mixed	1,737	16,400	9	50.1	0.0
Md_Mixed	131	6,800	52	16.0	0.1
Hd_Mixed	62	3,200	52	7.6	0.1
Stream Bank		2,680,200		599.7	
Point Sources				1,583.0	
Farm Animals				23,491.2	
Groundwater				2,436.2	
total	21,072	13,189,800	626	40,766.7	1.9

Table 7. Existing Sediment and TP Loading Values for Spring Creek, reference					
Source	Area, ac	Sediment, lbs/yr	Unit Area Load, lb/ac/yr	TP, lbs/yr	Unit Area Load, lbs/ac/yr
HAY/PAST	2,850	1,314,200	461	1,748.3	0.6
CROPLAND	2,426	3,393,800	1,399	3,632.0	1.5
FOREST	7,496	19,200	3	55.3	0.0
WETLAND	7	0	0	0.2	0.0
Open_Land	9	400	45	0.5	0.1
Ld_Mixed	606	6,400	11	19.5	0.0
Md_Mixed	2	0	0	0.1	0.1
Hd_Mixed	2	0	0	0.1	0.1
Stream Bank		672,200		130.1	
Groundwater				1,011.0	
Farm Animals				6,080.1	
total	13,397	5,406,200	404	12,677.2	0.9

For Tables 6 and 7 the stream bank, farm animal, groundwater and point source pollutant loads are not calculated by area.

Development of ARP

The AL for the Upper Kishacoquillas Creek Subwatershed was established based on current loading rates for sediment and total phosphorus in the Spring Creek reference watershed. Spring Creek is currently designated as Cold Waters Fishes (CWF) and previous biological assessments have determined that the watershed is attaining its designated uses. Reducing the loading rates of sediment in the Upper Kishacoquillas Creek Subwatershed, also Cold Waters Fishes (CWF), to levels equal to or less than the reference watershed should allow for the reversal of current use impairments.

As described in the previous section, sediment loading rates were computed for the Spring Creek Watershed using the MapShed model. The allowable load (AL) for sediment was determined by multiplying the unit area loading rates for the Spring Creek Watershed by the total watershed area of the Upper Kishacoquillas Creek Subwatershed, Table 8.

(Unit Area Loading Rate in Reference Watershed * Area of Impaired Watershed) = AL

Table 8. AL Values for the Upper Kishacoquillas Creek Subwatershed

Pollutant	Loading Rate in Reference, lb/ac/yr	Total Area in Kishacoquillas Creek Watershed, ac	AL, lb/yr	AL, lb/day
Sediment	404	21,072	8,503,413	23,297
Total Phosphorus	1	21,072	19,940	55

* takes into account rounding in previous calculations

The AL was then used as the basis for load allocations and reductions in the Upper Kishacoquillas Creek Subwatershed as follows for sediment and total phosphorus.

Sediment is displayed as the example:

AL = UF + ∑NPSL + ∑PSL
NPSL = ∑ANPSL + ∑LNR

where:

AL = Allowable Load
UF = Uncertainty Factor
NPSL = Non-Point Source Load
PSL = Point Source Load
ANPSL = Adjusted Nonpoint Source Load
LNR = Loads Not Reduced

Uncertainty Factor

The UF 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 UF is explicit. Ten percent of the AL was reserved as the UF. Using 10% of the AL is based on professional judgment and will provide an additional level of protection to the designated uses of Upper Kishacoquillas Creek Subwatershed.

8,503,413 lbs/yr AL * 0.1 = 850,341 lbs/yr UF Sediment

Non-Point Source Load

The NPSL is the portion of the AL assigned to all sources. The NPSL contains loads identified for reduction and background loads that are not identified for reduction. The NPSL was computed by subtracting the UF from the AL value.

8,503,413 lbs/yr AL – 850,341 lbs/yr UF = 7,653,071 lbs/yr NPSL Sediment

Loads Not Reduced and Adjusted Nonpoint Source Load

The NPSL is comprised of LNR and the ANPSL. The LNR are the background source loads in the watershed that are not identified for reduction. The ANPSL is made up of the nonpoint source loads that are identified to receive reductions in order to attain the overall reduction goal. The ANPSL is the base load that all non-point source loads being reduced must collectively not exceed and is calculated as follows:

The sum of the LNR is calculated first.

10,400 lbs/yr Forest + 16,400 lbs/yr Low Density Mixed Development + 6,800 lbs/yr Medium Density Mixed Development + 3,200 lbs/yr High Density Mixed Development = 36,800 lbs/yr LNR Sediment

Then the sum of the LNR is subtracted from the NPSL, Table 10.

7,653,071 lbs/yr NPSL – 36,800 lbs/yr LNR = 7,616,271 lbs/yr ANPSL Sediment

The ANPSL is further analyzed using the Equal Marginal Percent Reduction (EMPR) allocation method described in Attachment B. EMPR calculates the sediment load reductions per targeted sources in order to meet the AL. Although the Upper Kishacoquillas Creek Subwatershed ARP was developed to address impairments caused by agricultural activities such as hay/pastureland and cropland, these sources were not the only sources considered for reductions. Farm animals and stream banks are also significant contributors to the pollutant loads in the watershed and were included in the ANPSL for reduction, Tables 12 and 13.

Table 10. NPSL, LNR and ANPSL

	Sediment, (lbs./yr.)	TP (lbs./yr.)
NPSL	7,653,071	16,363
LNR:		
Forest	10,400	35
Ld_Mixed	16,400	50
Md_Mixed	6,800	16
Hd_Mixed	3,200	8
Groundwater		2,436
ANPSL	7,616,271	13,819
PSL		1,583

Point Sources

There is one permitted discharge in the Upper Kishacoquillas Creek Subwatershed that has effluent limits. The total annual allowable total phosphorus (TP) for the Union Township Sewage Treatment Plant, NPDES permit number PA0024708 is 1,583 pounds per year (daily allowable load calculated based on Chesapeake Bay TMDL). This point source is not responsible for the phosphorus impairment in the watershed as it is located at the bottom of the watershed (see Figure A1) with no influence on any of the phosphorus impairments in the watershed. Then 1.13 miles below the Union Township STP discharge, the Upper Kishacoquillas empties to the mainstem Kishacoquillas which meets water quality standards until its confluence with the Juniata River. Therefore, this ARP will hold the Union Township STP to the cap load issued in the Chesapeake Bay TMDL, but will recommend a biological assessment point and monitoring of the 1.13 mile impaired stretch of the Upper Kishacoquillas Creek Subwatershed be conducted in the future.

ARP Summary

The sediment AL established for the Upper Kishacoquillas Creek Subwatershed consists of an uncertainty factor (UF) and non-point source load (NPSL). The NPSL is broken into Loads Not Reduced (LNR) and Adjusted Nonpoint Source Load (ANPSL) for further analysis. The individual components of the Upper Kishacoquillas Creek Subwatershed ARP are summarized in Table 11.

Table 11. AL Components for the Kishacoquillas Creek Watershed

Component	Sediment (lbs./yr.)	TP (lbs./yr.)
AL (Allowable Load)	8,503,413	19,940
UF (Uncertainty Factor)	850,341	1,994
NPSL (Non-Point Source Load) = (LNR+ANPSL)	7,653,071	16,363
LNR (Loads Not Reduced)	36,800	2,544
ANPSL (Adjusted Nonpoint Source Load)	7,616,271	13,819
PSL (Point Source Load)		1,583

Critical Conditions

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

Seasonal Variations

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

Background Contributions

The MapShed model accounts for all landuses within the watershed and their respective contributions to the pollutant loads. The background sources of pollution within the watershed are from sources such as forests, developments, groundwater and point sources. There are no additional upstream sources of pollution to this watershed as it was modeled from the mainstem to the headwaters. The landuses in this ARP that are targeted for reductions are nonpoint sources of pollution to the watershed and will not be considered background. They include sources such as stream banks, hay/pasture, cropland and farm animals.

Calculation of Load Reductions Needed

The adjusted nonpoint source load (ANPSL) established in the previous section represents the pollutant load that is available for allocation between Hay/Pasture, Cropland, farm animals and stream banks in the Upper Kishacoquillas Creek Subwatershed. 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 ANPSL between the NPS agricultural land use types, farm animals and stream banks as outlined 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 Farm Animals were in excess of the ANPSL for nutrients.

2. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all 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 for total phosphorus but not for sediment. The equal percent reduction, i.e., the ANPSL divided by the summation of the baselines, worked out to a 48.8% reduction for all the sources except farm animal which received a 69.9% reduction for total phosphorus. The targeted sources all received a 42.1% reduction for sediment.

Tables 12 and 13 contain the results of the EMPR for Hay/Pasture, Cropland, farm animals and stream banks in the Upper Kishacoquillas Creek Subwatershed. The load allocation for each source is shown along with the percent reduction of current loads necessary to reach the targeted ANPSL.

Table 12. Sediment Reductions Needed from Sources in the Upper Kishacoquillas Creek Subwatershed, Annual Values

		Allowable Loading	Allowable Load	Current Loading	Current Load	
Source	Acres	lbs/acre/yr	lbs./yr	lbs/acre/yr	lbs/yr	Reduction
Cropland	6,753.4	610.9	4,125,629.9	1055.0	7,124,800.0	42.1%
Hay/Pasture	4,798.0	404.1	1,938,666.2	697.8	3,348,000.0	42.1%
Stream Banks			1,551,975.2		2,680,200.0	42.1%
Total			7,616,271.3		1,3153,000.0	42.1%

Table 13. Total Phosphorus Reductions Needed from Sources in the Upper Kishacoquillas Creek Subwatershed, Annual Values						
		Allowable Loading	Allowable Load	Current Loading	Current Load	
Land Use	Acres	lbs/acre/day	lbs/day	lbs./acre/day	lbs/day	Reduction
Cropland	6,753.4	0.6	4,219.0	1.2	8,233.3	48.8%
Hay/Pasture	4,798.0	0.5	2,211.2	0.9	4,315.1	48.8%
Farm Animals			7,081.0		23,491.2	69.9%
Stream banks			307.3		599.7	48.8%
Total			13,818.5		36,639.3	62.3%

Calculation of Load Reductions Needed from Subwatersheds of the Kishacoquillas Watershed

UNT 12431 to Kishacoquillas Creek, Hungry Run, UNT 12463 to Laurel Creek, UNT 12483 to Honey Creek, UNT 12518 to Honey Creek, and UNT 12496 to Havice Creek subwatersheds within the Kishacoquillas Creek Watershed are listed as being impaired for sediment. Hungry Run and UNT 12431 are also listed for nutrients.

These subwatersheds are too small in area to model accurately using MapShed. Thus, unit area loading rates for sediment and total phosphorus from the Upper Kishacoquillas Creek Subwatershed were applied to the area (acres) of these impaired subwatersheds to calculate their existing pollutant loads. Then the reference loading rates from Spring Creek were applied to those areas to determine needed reductions. By calculating these loads, it was determined that UNT 12463, UNT 12483, UNT 12496, UNT 12518, UNT 12431, and Hungry Run watersheds required a 35 percent reduction for sediment. Hungry Run and UNT 12431 require a reduction of 53 percent for total phosphorus. Table 14 displays the reductions needed for the subwatersheds.

Table 14. NPSL in the Impaired Subwatersheds of Kishacoquillas Creek Watershed						
Source	Acres	Current Loading Rate	Allowable Loading Rate	Current Load	Allowable Load	Reduction
Sediment		lbs/acre/day	lbs./acre/day	lbs/day	lbs/day	
UNT 12463	1,096	1.715	1.107	1,880	1,213	35%
UNT 12483	4,923	1.715	1.107	8,443	5,449	35%
UNT 12496	631	1.715	1.107	1,082	698	35%
UNT 12518	249	1.715	1.107	427	276	35%
Hungry Run	5,358	1.715	1.107	9,189	5,930	35%
UNT 12431	1,786	1.715	1.107	3,063	1,977	35%
Total Phosphorus						
Hungry Run	5,358	0.005	0.002	28	13	53%
UNT 12431	1,786	0.005	0.002	9	4	53%

Calculation of Current Load Reductions Attained by WIP Implementation

The Upper Kishacoquillas Creek and Hungry Run Subwatersheds have Watershed Implementation Plans (WIPs) established for them. The ongoing implementation of these WIPs by the Mifflin County Conservation District has resulted in reductions of the pollutants of concern in these subwatersheds. Tables 15 and 16 below, display the reductions called for in this ARP, the reductions achieved by WIP BMP implementation to date and the remaining reductions to be met to restore water quality in the Upper Kishacoquillas Creek Subwatershed.

Table 15. WIP BMP Load Reductions Attained to date in the Upper Kishacoquillas Creek Subwatershed						
Source/ Subwatershed	Current Load	Allowable Load	Reduced Load	Reduction Goal	Reduction Achieved	Reduction Remaining
Sediment	lbs/day	lbs/day	lbs/day			
Upper Kish	36,136	23,297	26,084	42%	28%	14%
Total Phosphorus						
Upper Kish	112	55	84	62%	25%	37%

Table 16. Source Load Pollution Reduction Goals, Reductions Achieved to date and Reductions Outstanding in the Upper Kishacoquillas Creek Subwatershed to date, Annual Values						
	Sediment Reduction	Sediment Reduction	Sediment Reduction	TP Reduction	TP Reduction	TP Reduction
Source	Goal	Achieved	Remaining	Goal	Achieved	Remaining
Hay/Past	42%	6%	36%	49%	10%	39%
Cropland	42%	40%	2%	49%	43%	6%
Stream Bank	42%	22%	20%	49%	23%	26%
Farm Animals				70%	26%	44%
Total Subwatershed	42%	28%	14%	62%	25%	37%

See Attachment C for BMP entries.

As displayed in Tables 15 and 16, significant reductions to sediment and nutrients have been achieved in the Upper Kishacoquillas Creek Subwatershed to date as the result of the restoration efforts put forth by MCCD. Continued implementation of the BMPs prescribed in the WIP will result in further reductions to these pollutants and attainment of the goals outlined in this ARP. Table 16 is a further breakdown of the BMP results applying reductions to targeted source loads in the Upper Kishacoquillas Subwatershed. Cropland BMP implementation has nearly attained the goals of this ARP while Hay/Pature, Stream Banks and Farm Animals remain in significant need of targeted BMP implementation and load reductions.

Phased Future Restoration Milestones

Restoration of all seven impaired subwatersheds within the Kishacoquillas Creek Watershed will be conducted in two five year phases.

Phase 1 – Regulatory Compliance by 2022

Phase 1 has begun with outreach to farmers by the Mifflin County Conservation District. During Phase 1, every farm in the targeted subwatersheds will have a Conservation Plan and a Nutrient Management Plan developed and implemented. Conservation Plans are represented by BMP 4 in the model. Nutrient Management Plans are represented by BMP 6 in the model. A future scenario of Phase 1 BMPs was run for all seven impaired subwatersheds with BMPs 4 and 6 both set to 100%. The Phase 1 BMP entries for the Hungry Run and Upper Kishacoquillas Subwatersheds includes

BMPs 4 and 6 at 100% as well as the BMPs that have already been constructed to date by WIP implementation. Phase 1 is projected to conclude by 2022.

Phase 2 – Attaining Restoration Goals by 2027

A future scenario of Phase 2 BMPs was run for all seven subwatersheds with Animal Waste Management Systems and Runoff Control both set to 100% and added to the BMPs of Phase 1. The Phase 2 BMP entries for the Hungry Run and Upper Kishacoquillas Creek Subwatersheds also include 100% implementation of their respective WIPs. Phase 2 BMPs include the implementation of a 30% effective suite of BMPs for sediment and a 40% effective suite of BMPs for phosphorus in the UNT Subwatersheds to bring them under the allowable load. The additional suites of BMPs could contain a combination of highly effective BMPs such as: Cover Crops, Conservation Tillage, Grazing Land Management, Vegetated Buffer Strips, Streambank Fencing and Streambank Stabilization.

Tables 17 and 18 demonstrate the untreated pollutant loads and the allowable loads that should restore water quality. A further comparison is made to display the load reductions already achieved by WIP implementation as well as the reductions anticipated as a result of Phase 1 and 2. Total load reductions are calculated for each Phase of implementation to demonstrate attainment of the ALs.

Table 17. Phased Sediment Load Reductions

Source	Current Load	Existing WIP BMP Reduced Load	Phase 1 Load	Allowable Load	Phase 2 Load
Sediment	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
UNT 12463	1,880	1,880	1,729	1,213	1,211
UNT 12483	8,443	8,443	7,768	5,449	5,437
UNT 12496	1,082	1,082	996	698	697
UNT 12518	427	427	393	276	275
Hungry Run	9,189	6,784	6,087	5,930	4,067
UNT 12431	3,063	3,063	2,818	1,977	1,973
Upper Kish	36,136	26,084	22,418	23,297	12,654
Total	60,221	47,763	42,209	38,840	26,314
Aggregated Load Reductions		12,457	18,012	21,380	33,907
Aggregated % Reductions		21%	30%	36%	56%

Table 18. Phased Total Phosphorus Load Reductions

Source	Current Load	Existing WIP BMP Reduced Load	Phase 1 Load	Allowable Load	Phase 2 Load
TP	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Hungry Run	28	24	20	13	*17
UNT 12431	9	9	7	4	4
Upper Kish	**112	**84	**72	55	**40
Total	149	117	99	73	65
Aggregated Load Reductions		32	50	76	84
Aggregated % Reductions		21%	34%	51%	56%

*The significantly higher animals numbers used to develop the loading rate of Upper Kish and applied Hungry Run estimated high TP in this small watershed.

**Upper Kish Total Phosphorus Loads have 4 lbs/day added to them to account for the point source.

Monitoring

Nutrient and sediment impairments have a significant lag time between BMP implementation and a quantifiable rebound in macroinvertebrate colonization. However, pebble counts can be used to demonstrate important progress along the substrate of a stream soon after BMPs are constructed. Pebble counts should be monitored to demonstrate sediment BMP effectiveness and the return of available interstitial spaces created as silt is progressively replaced by larger pebbles and cobble. Water chemistry also responds faster than macroinvertebrate recolonization making it an important indicator of restoration that should also be monitored.

As the habitat of the streams and water chemistry improve, macroinvertebrates will then slowly begin to recolonize them. A robust recolonization by sensitive and diverse macroinvertebrate communities is one of the goals of restoration as well as the trigger for delisting waters from the Integrated List of Impaired Waters.

Significant monitoring has already been conducted as displayed in Figure 4. Periodic monitoring during and after Phase 1 and Phase 2 should also be conducted and analyzed with existing data. It is recommended to add one sampling station at the downstream end of the impairment in the Upper Kishacoquillas Creek Subwatershed to quantify the effects of the point source. Pebble counts, water chemistry and macroinvertebrates should all be sampled to demonstrate progress being made in habitat quality, water quality and macroinvertebrate recolonization. This monitoring will document progress toward attainment of water quality standards and allow for more targeted implementation in the future.

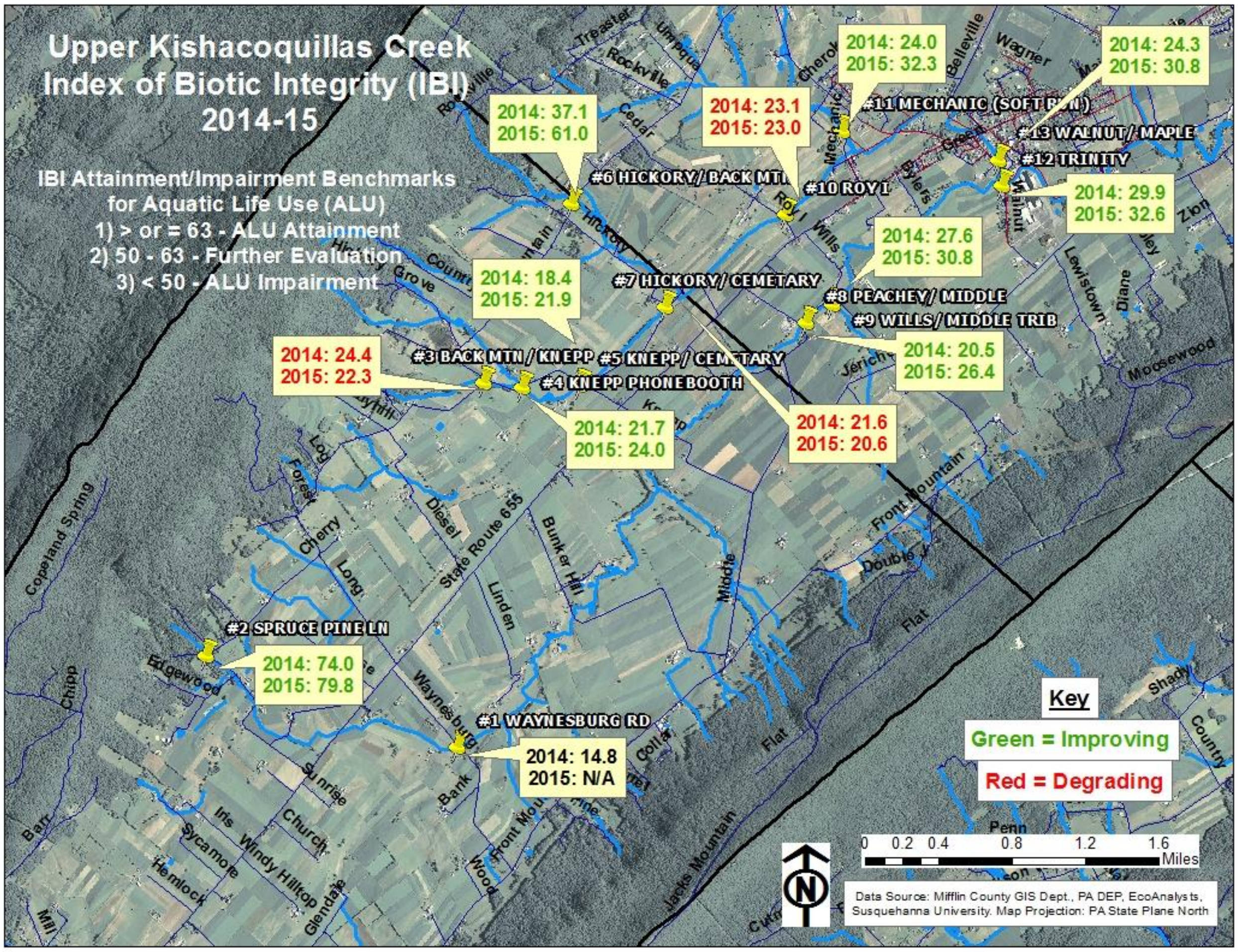

Figure 4. Macroinvertebrate sampling results in the Upper Kishacoquillas Creek Subwatershed provided by Mifflin County Conservation District.

Recommendations

Pollution reductions in the ARP are allocated to nonpoint sources in the watershed including agricultural activities and stream banks. Implementation of regulatory requirements and BMPs outlined in Phases 1 and 2 as well as the BMPs of the Upper Kishacoquillas Creek and Hungry Run WIPs is called for according to this ARP. The proper implementation of Water Quality Regulations and Phases 1 and 2 BMPs should achieve the loading reduction goals established in the ARP. As these goals are attained, water chemistry and habitat quality will return to the point of restoring a viable aquatic ecosystem meeting the designated uses of the Kishacoquillas Creek Watershed.

Regulations:

All Pennsylvania farmers are required by law to operate within regulatory compliance by implementing the requirements outlined in the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Chapters: § 91.36(b) Manure Management, § 92a.29 CAFO and § 102.4(a) Agricultural Erosion and Sediment Control.

Water quality regulations can be found at: http://www.pacode.com/secure/data/025/025toc.html
Agricultural regulations are designed to reduce the amount of sediment and nutrients reaching the streams and ground water in a watershed.

Construction regulations are also designed to reduce the amount of sediment and nutrients reaching the streams and ground water in a watershed. Regulatory compliance is achieved by implementing the requirements outlined in the Pennsylvania Clean Streams Law, Title 25 Environmental Protection, Chapter § 102.4(b) Construction Related Erosion and Sediment Control.

Watershed Implementation Plans (WIPs):

The Upper Kishacoquillas and Hungry Run Watershed Implementation Plans can be found at: http://www.dep.pa.gov/Business/Water/PlanningConservation/NonpointSource/Pages/Plans.aspx
The development and implementation of the Upper Kishacoquillas Creek and Hungry Run Watershed Implementation Plans has resulted in significant pollution reductions in both subwatersheds as displayed in Tables 15 through 18. It is recommended that the WIPs continue to be implemented while ensuring the regulatory compliance called for in Phase 1 as well as the BMP implementation called for in Phase 2 within all the impaired subwatersheds is conducted as described in this ARP.

The Upper Kishacoquillas WIP is being updated to include new modeling information and the load reduction goals of this ARP. It is recommended that the five impaired subwatersheds without their own WIPs should be included in the Upper Kishacoquillas WIP if they have not been restored and delisted from the Integrated List of Impaired Waters by the time of the update. Inclusion in a WIP ensures eligibility to receive Federal Act 319 restoration funds. Pennsylvania's Growing Greener Grant Program is also a significant source of restoration funds recommended to help restore this watershed.

Public Participation

Public notice of the draft ARP was published in the *Pennsylvania Bulletin* on July 29, 2017 to foster public comment on the allowable loads calculated.

Literature Cited

Haith, D. A.; Mandel, R.; Wu, R. S. for Cornell University *Generalized Watershed Loading Functions Version 2.0 User's Manual*; Ithaca, NY, 1992.

Evans, B. M.; Lehning, D. W.; Corradini, K. J. for The Pennsylvania State University *MapShed Version 7.1 Users Guide*; University Park, PA, 2007.

Attachment A
Map of Impaired Subwatersheds

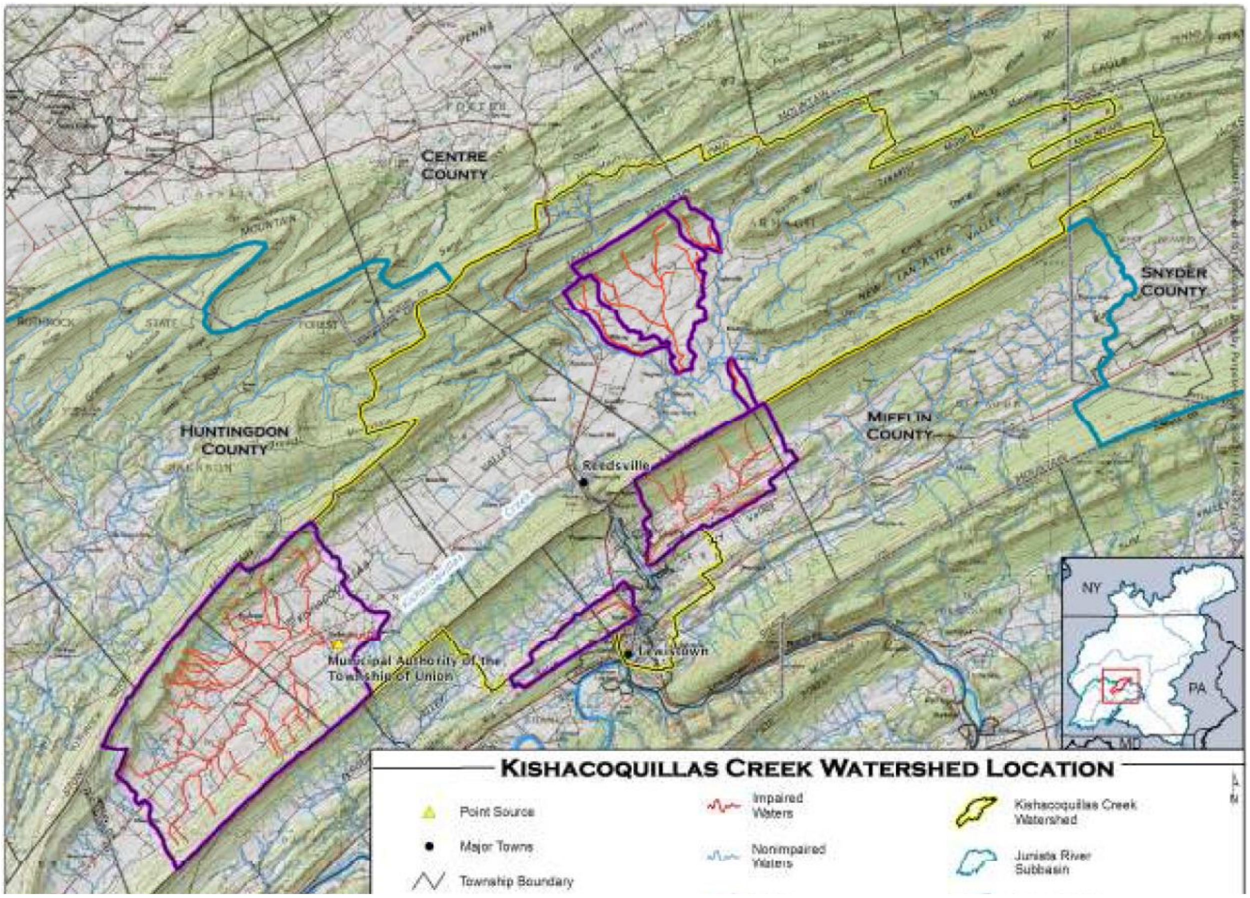

Figure A1. Kishacoquillas Creek Watershed with impaired subwatersheds addressed by this ARP

Attachment B
Equal Marginal Percent Reduction Method

Equal Marginal Percent Reduction
An Adjusted Nonpoint Source Load Allocation Strategy

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

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

Step 2: Calculation of ANPSLA based on AL, Margin of Safety, and existing loads not reduced.

Step 3: Actual EMPR Process:

a. Each land use/source load is compared with the total ANPSLA to determine if any contributor would exceed the ANPSLA 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 ANPSLA, that contributor would be reduced to the ANPSLA. If a contributor is less than the ANPSLA, 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 ANPSLA. If the ANPSLA 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.

1	AL				2	ANPSL = (AL - MOS) - LNR						
	AL = Sediment loading rate in ref. * Impaired Acres					7616271.3	7616271.3					
	8503412.5											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	7124800.0	13153000.0	good	7124800.0		0.5	2999170.1	4125629.9	6753.4	610.9	42.1%
	HAY/PASTURE	3348000.0		good	3348000.0	5536728.7	0.3	1409333.8	1938666.2	4798.0	404.1	42.1%
	STREAMBANK	2680200.0		good	2680200.0		0.2	1128224.8	1551975.2			42.1%
					13153000.0		1.0		7616271.3			
4	All Ag. Loading Rate	524.98										
			Allowable		Current	Current						
		Acres	loading rate	Final ANPSLA	Loading Rate	Load	% Red.			CURRENT LOAD	FINAL ANPSLA	
5	CROPLAND	6753.4	610.9	4125629.9	1055.0	7124800.0	42.1%		CROPLAND	7,124,800	4,125,630	
	HAY/PASTURE	4798.0	404.1	1938666.2	697.8	3348000.0	42.1%		HAY/PASTURE	3,348,000	1,938,666	
	STREAMBANK			1551975.2		2680200.0	42.1%		STREAMBANK	2,680,200	1,551,975	
				7616271.3		13153000.0	42.1%					

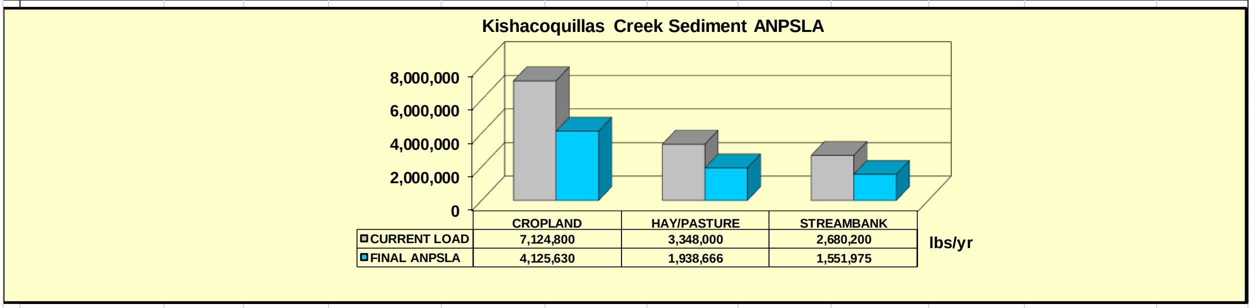

Table B1. Sediment Equal Marginal Percent Reduction calculations for the Upper Kishacoquillas Creek Subatershed

1	AL				2	ANPSL = (AL - MOS) - LNR						
	AL = Sediment loading rate in ref. * Impaired Acres					13818.5	13818.5					
	19939.9											
		Annual				Recheck	% reduction	Load			Allowable	%
3		Avg. Load	Load Sum	Check	Initial Adjust	Adjust	allocation	Reduction	Initial LA	Acres	Loading Rate	Reduction
	CROPLAND	8233.3	36639.3	good	8233.3		0.3	4014.3	4219.0	6753.4	0.6	48.8%
	HAY/PASTURE	4315.1		good	4315.1	13148.1	0.2	2103.9	2211.2	4798.0	0.5	48.8%
	FARM ANIMALS	23491.2		bad	13818.5		0.5	6737.5	7081.0			69.9%
	STREAMBANK	599.7		good	599.7		0.0	292.4	307.3			48.8%
					26966.6		1.0		13818.5			
4	All Ag. Loading Rate	1.17										
			Allowable		Current	Current						
		Acres	loading rate	Final ANPSLA	Loading Rate	Load	% Red.			CURRENT LOAD	FINAL ANPSLA	
5	CROPLAND	6753.4	0.6	4219.0	1.2	8233.3	48.8%		Cropland	8,233	4,219	
	HAY/PASTURE	4798.0	0.5	2211.2	0.9	4315.1	48.8%		Hay/Pasture	4,315	2,211	
	FARM ANIMALS			7081.0		23491.2	69.9%		Farm Animals	23,491	7,081	
	STREAMBANK			307.3		599.7	48.8%		Streambank	600	307	
				13818.5		36639.3	62.3%					

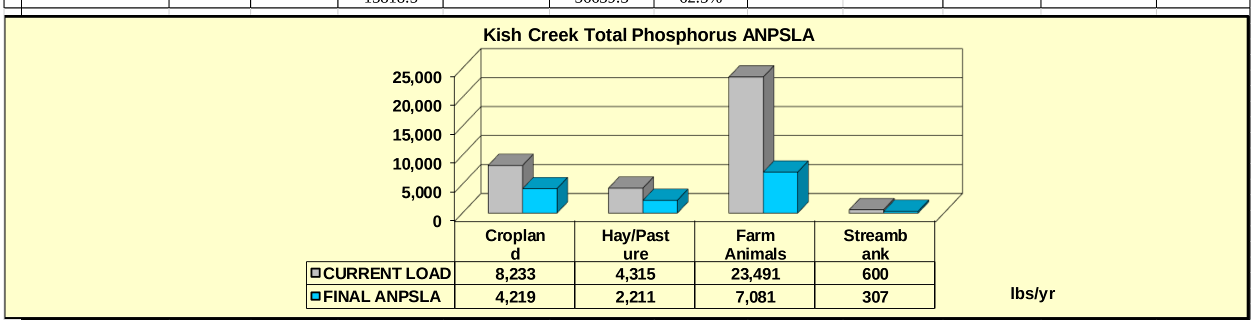

Table B2. Total Phosphorus Equal Marginal Percent Reduction calculations for the Upper Kishacoquillas Creek Subwatershed

Attachment C
MapShed Generated Data Tables, BMP Key, and BMPs

GWLF Total Loads for file: UpperKishWithAnimalsNoBMI 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	4798	3.6	13964.0	1674.0	3762.0	10458.1	1317.7	4315.1
Cropland	6753	3.6	29716.3	3562.4	15645.0	29894.7	1854.8	8233.3
Forest	7588	1.5	43.7	5.2	477.1	498.0	25.1	34.5
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	2	8.2	0.0	0.0	1.4	1.4	0.0	0.0
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	1737	4.1	0.0	8.2	147.8	447.8	20.0	50.1
MD Mixed	131	9.7	0.0	3.4	50.9	154.3	6.4	16.0
HD Mixed	62	13.4	0.0	1.6	24.2	73.2	3.0	7.6
LD Residential	0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						95217.9		23491.2
Tile Drainage				0.0		0.0		0.0
Stream Bank				1340.1		1340.4		599.7
Groundwater					253777.4	253777.4	2436.2	2436.2
Point Sources					1739.4	1739.4	317.5	317.5
Septic Systems					407.3	407.3	0.0	0.0
Totals	21072.4	2.90	43724.0	6595.0	276032.6	394010.1	5980.7	39501.0

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Table C1. Outputs for the Upper Kishacoquillas Creek Subwatershed

GWLF Total Loads for file: SpringCkAnimals-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	2850	3.6	4803.8	657.1	2191.7	4819.9	723.1	1748.3
Cropland	2426	5.8	12406.0	1696.9	9139.5	15927.0	984.4	3632.0
Forest	7496	2.4	70.2	9.6	766.6	805.0	40.3	55.3
Wetland	7	10.9	0.1	0.0	3.3	3.3	0.2	0.2
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	9	8.5	1.6	0.2	8.6	9.4	0.2	0.5
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	606	4.3	0.0	3.2	57.5	174.3	7.8	19.5
MD Mixed	1	10.6	0.0	0.0	0.4	1.2	0.0	0.1
HD Mixed	1	14.8	0.0	0.0	0.4	1.2	0.0	0.1
LD Residential	0	4.3	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.7	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	9.1	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						24091.2		6080.1
Tile Drainage				0.0		0.0		0.0
Stream Bank				336.1		335.1		130.1
Groundwater					60782.5	60782.5	1011.0	1011.0
Point Sources					0.0	0.0	0.0	0.0
Septic Systems					3.6	3.6	0.0	0.0
Totals	13397.0	3.40	17281.6	2703.1	72954.1	106953.9	2767.1	12677.2

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Table C2. Outputs for the Spring Creek Watershed

Rural Land BMP Scenario Editor

	Hectares		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2,733	% Existing	35.4	46.8	19.0	14.8	0.0	19.8		0.0
Hay/Pasture	1,942	% Existing				9.5	0.0	12.7	11.9	0.0

Streams in Agricultural Areas	43.2	Km
Total Stream Length	65.7	Km
Unpaved Road Length	0.0	Km

	% Existing
AWMS (Livestock)	63.0
AWMS (Poultry)	100
Runoff Control	11.0
Phytase in Feed	100

	Existing Km
Stream Km with Vegetated Buffer Strips	9.9
Stream Km with Fencing	17.0
Stream Km with Bank Stabilization	1.8
Unpaved Road Km with E and S Controls	0.0

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Table C3. Upper Kishacoquillas Creek Subwatershed WIP BMPs Implemented

GWLF Total Loads for file: UpperKishWanimalsBMPs-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	4798	3.6	13964.0	1572.9	3476.9	9665.5	1187.9	3889.8
Cropland	6753	3.6	29716.3	2127.3	9714.9	18563.3	1055.4	4685.0
Forest	7588	1.5	43.7	5.2	477.1	498.0	25.1	34.5
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	2	8.2	0.0	0.0	1.4	1.4	0.0	0.0
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	1737	4.1	0.0	8.2	147.8	447.8	20.0	50.1
MD Mixed	131	9.7	0.0	3.4	50.9	154.3	6.4	16.0
HD Mixed	62	13.4	0.0	1.6	24.2	73.2	3.0	7.6
LD Residential	0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						71247.4		17483.4
Tile Drainage				0.0		0.0		0.0
Stream Bank				1041.7		1111.1		463.0
Groundwater					237464.3	237464.3	2337.2	2337.2
Point Sources					1739.4	1739.4	317.5	317.5
Septic Systems					407.3	407.3	0.0	0.0
Totals	21072.4	2.90	43724.0	4760.4	253504.1	341373.0	4952.5	29283.9

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Table C4. Outputs for Upper Kishacoquillas Creek Subwatershed WIP BMPs Implemented

Rural Land BMP Scenario Editor

	Hectares		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2,733	% Existing	35.4	46.8	19.0	100.	0.0	100.		0.0
Hay/Pasture	1,942	% Existing				100.	0.0	100.	11.9	0.0

Streams in Agricultural Areas	43.2	Km
Total Stream Length	65.7	Km
Unpaved Road Length	0.0	Km

	% Existing
AWMS (Livestock)	63.0
AWMS (Poultry)	100
Runoff Control	11.0
Phytase in Feed	100

	Existing Km
Stream Km with Vegetated Buffer Strips	9.9
Stream Km with Fencing	17.0
Stream Km with Bank Stabilization	1.8
Unpaved Road Km with E and S Controls	0.0

Urban BMP Editor | Save File | Export to JPEG | Close

Table C5. Upper Kishacoquillas Creek Subwatershed Phase 1 BMPs

GWLF Total Loads for file: UpperKishPhase1-0 Period of analysis: 30 years from 1961 to 1990

			Tons		Total Loads (Pounds)			
Source	Area (Acres)	Runoff (in)	Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	4798	3.6	13964.0	1330.5	2442.1	6788.9	637.8	2088.5
Cropland	6753	3.6	29716.3	1700.7	6889.0	13163.6	567.1	2517.1
Forest	7588	1.5	43.7	5.2	477.1	498.0	25.1	34.5
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	2	8.2	0.0	0.0	1.4	1.4	0.0	0.0
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	1737	4.1	0.0	8.2	147.8	447.8	20.0	50.1
MD Mixed	131	9.7	0.0	3.4	50.9	154.3	6.4	16.0
HD Mixed	62	13.4	0.0	1.6	24.2	73.2	3.0	7.6
LD Residential	0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						71247.4		17483.4
Tile Drainage				0.0		0.0		0.0
Stream Bank				1041.7		1111.1		463.0
Groundwater					206202.7	206202.7	1848.6	1848.6
Point Sources					1739.4	1739.4	317.5	317.5
Septic Systems					407.3	407.3	0.0	0.0
Totals	21072.4	2.90	43724.0	4091.3	218381.9	301835.2	3425.4	24826.2

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Table C6. Outputs for Upper Kishacoquillas Creek Subwatershed Phase 1

Rural Land BMP Scenario Editor

	Hectares		BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2,733	% Existing	86.0	84.0	52.0	100.	0.0	100.		0.0
Hay/Pasture	1,942	% Existing				100.	0.0	100.	11.9	0.0

Streams in Agricultural Areas	43.2	Km
Total Stream Length	65.7	Km
Unpaved Road Length	0.0	Km

	% Existing
AWMS (Livestock)	100
AWMS (Poultry)	100
Runoff Control	100
Phytase in Feed	100

	Existing Km
Stream Km with Vegetated Buffer Strips	42.0
Stream Km with Fencing	42.0
Stream Km with Bank Stabilization	3.7
Unpaved Road Km with E and S Controls	0.0

Urban BMP Editor | Save File | Export to JPEG | Close

Table C7. Upper Kishacoquillas Creek Subwatershed Phase 2 BMPs

GWLF Total Loads for file: Phase2UpperKish-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	4798	3.6	13964.0	1330.5	2442.1	6788.9	637.8	2088.5
Cropland	6753	3.6	29716.3	342.9	1938.6	3704.3	148.0	657.1
Forest	7588	1.5	43.7	5.2	477.1	498.0	25.1	34.5
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	2	8.2	0.0	0.0	1.4	1.4	0.0	0.0
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	1737	4.1	0.0	8.2	147.8	447.8	20.0	50.1
MD Mixed	131	9.7	0.0	3.4	50.9	154.3	6.4	16.0
HD Mixed	62	13.4	0.0	1.6	24.2	73.2	3.0	7.6
LD Residential	0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
MD Residential	0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
HD Residential	0	8.4	0.0	0.0	0.0	0.0	0.0	0.0
Farm Animals						38976.2		9390.4
Tile Drainage				0.0		0.0		0.0
Stream Bank				617.4		789.3		269.0
Groundwater					182764.1	182764.1	1848.6	1848.6
Point Sources					1739.4	1739.4	317.5	317.5
Septic Systems					407.3	407.3	0.0	0.0
Totals	21072.4	2.90	43724.0	2309.3	189992.9	236344.2	3006.4	14679.0

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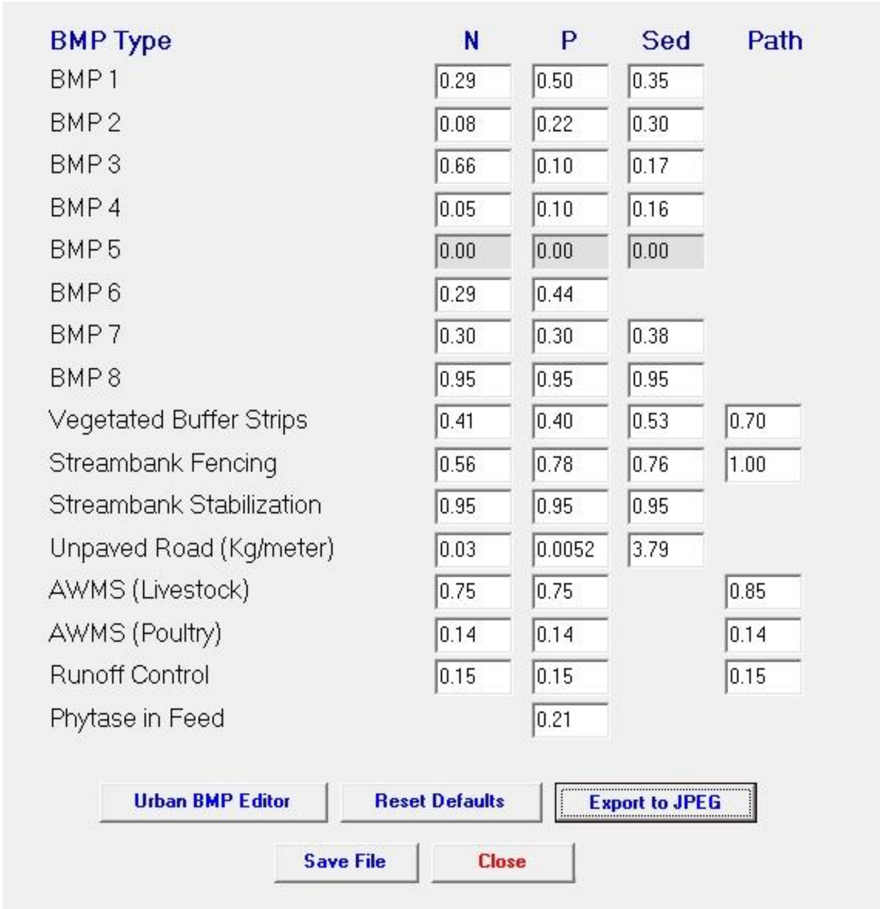
Table C8. Outputs for Upper Kishacoquillas Creek Subwatershed Phase 2

BMP Key

- BMP 1 - Cover Crops
- BMP 2 - Conservation Tillage
- BMP 3 - Stripcropping & Contour Farming
- BMP 4 - Conservation Plan
- BMP 5 - User Defined
- BMP 6 - Nutrient Management
- BMP 7 - Grazing Land Management
- BMP 8 - Agricultural Land Retirement

Table C9. BMP Key



BMP Type	N	P	Sed	Path
BMP 1	0.29	0.50	0.35	
BMP 2	0.08	0.22	0.30	
BMP 3	0.66	0.10	0.17	
BMP 4	0.05	0.10	0.16	
BMP 5	0.00	0.00	0.00	
BMP 6	0.29	0.44		
BMP 7	0.30	0.30	0.38	
BMP 8	0.95	0.95	0.95	
Vegetated Buffer Strips	0.41	0.40	0.53	0.70
Streambank Fencing	0.56	0.78	0.76	1.00
Streambank Stabilization	0.95	0.95	0.95	
Unpaved Road (Kg/meter)	0.03	0.0052	3.79	
AWMS (Livestock)	0.75	0.75		0.85
AWMS (Poultry)	0.14	0.14		0.14
Runoff Control	0.15	0.15		0.15
Phytase in Feed		0.21		

Table C10. BMP Efficiencies

Ag BMPs	Percent of Total	MapShed Entry		
Cover Crop	35	BMP 1		% Total Row Crop Acres
Conservation Tillage	47	BMP 2		% Total Row Crop Acres
Strip Cropping/ Contour Farming	19	BMP 3		% Total Row Crop Acres (includes hay/alfalfa)
Conservation Plan	24	BMP 4	Crops 14.8%, Pasture 9.5%	% Total Ag Acres
Nutrient Management	32	BMP 6	Crops 19.8%, Pasture 12.7%	% Total Ag Acres
Grazing Land Management	12	BMP 7		% Total Pasture Acres
Manure Storage (Livestock)	63	AWMS (Livestock)		% Total Animals (dairy, heifers, calves, beef, hogs)
Manure Storage (Poultry)	100	AWMS (Poultry)		% Total Birds
Barnyard Runoff Control	11	Runoff Control		% Total Animals (dairy, heifers, beef)
Phytase	100	Phytase in Feed		% Total Animals (poultry and swine)

Table C11. Upper Kishacoquillas Subwatershed Aggregated Agricultural BMPs Implemented to date provided by Mifflin County Conservation District

	Buffer Length (ft)	Bank Stab.Length (ft)	Fencing/ Livestock Ex. Length
	1,050	0	1,525
	2,150	72	4,300
	1800	48	3600
	1475	0	2950
	1,100	48	2200
	900	64	1800
	200	102	200
	1000	0	1000
	210	48	420
	2795	72	5590
	1152	48	2304
	1400	2800	2800
	900	36	1800
	1837	68	3940
	1800	1800	0
	1331	475	2578
	1100	0	2200
	1624	16	1624
	1715	24	2,405
	1080	0	2160
	1400	0	2800
	1600	0	3200
	1120	16	2238
	140	0	140
	350	0	700
	1207	0	1207
MapShed Entry (Km)	**9.9**	**1.7**	**17.0**

Table C12. Upper Kishacoquillas Subwatershed Aggregated streambank protection BMPs Implemented to date provided by Mifflin County Conservation District

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

Table D1. Kishacoquillas Creek Watershed Listing of Impaired Stream Segments

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

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Hydrologic Unit Code: 02050304-Lower Juniata			
Havice Creek Unnamed Of (ID:66203193) HUC: 02050304			
Aquatic Life (329) - 0.54 miles			
Agriculture	Siltation	2002	2015
Havice Creek Unnamed Of (ID:66203207) HUC: 02050304			
Aquatic Life (329) - 0.1 miles			
Agriculture	Siltation	2002	2015
Havice Creek Unnamed Of (ID:66203253) HUC: 02050304			
Aquatic Life (329) - 0.46 miles			
Agriculture	Siltation	2002	2015
Havice Creek Unnamed To (ID:133431083) HUC: 02050304			
Aquatic Life (329) - 2.66 miles			
Agriculture	Siltation	2002	2015
Havice Creek Unnamed To (ID:66203221) HUC: 02050304			
Aquatic Life (329) - 1.6 miles			
Agriculture	Siltation	2002	2015
Honey Creek Unnamed Of (ID:66203275) HUC: 02050304			
Aquatic Life (330) - 0.31 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Honey Creek Unnamed Of (ID:66203283) HUC: 02050304			
Aquatic Life (330) - 0.48 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Honey Creek Unnamed Of (ID:66203297) HUC: 02050304			
Aquatic Life (330) - 1.55 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Honey Creek Unnamed Of (ID:66203359) HUC: 02050304			
Aquatic Life (331) - 0.6 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

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

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Honey Creek Unnamed Of (ID:66203409)			
HUC: 02050304			
Aquatic Life (331) - 2.82 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Honey Creek Unnamed To (ID:66203605)			
HUC: 02050304			
Aquatic Life (330) - 3.27 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Aquatic Life (331) - 1.38 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Honey Creek Unnamed To (ID:66203619)			
HUC: 02050304			
Aquatic Life (282) - 0.82 miles			
Crop Related Agric	Siltation	2002	2015
Kishacoquillas Creek			
HUC: 02050304			
Aquatic Life (366) - 4.66 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Aquatic Life (497) - 2.21 miles			
Agriculture	Siltation	2002	2015
Urban Runoff/Storm Sewers	Flow Alterations	2002	2015
Aquatic Life (608) - 1.34 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Kishacoquillas Creek Unnamed Of (ID:66204605)			
HUC: 02050304			
Aquatic Life (2728) - 0.72 miles			
Hydromodification	Siltation	2002	2015
	Water/Flow Variability	2002	2015
Kishacoquillas Creek Unnamed Of (ID:66206333)			
HUC: 02050304			
Aquatic Life (365) - 0.81 miles			
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015
Kishacoquillas Creek Unnamed Of (ID:66206355)			
HUC: 02050304			
Aquatic Life (365) - 1.34 miles			
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Stream Name
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date

Kishacoquillas Creek Unnamed Of (ID:66206379)
HUC: 02050304

Aquatic Life (365) - 0.19 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Kishacoquillas Creek Unnamed Of (ID:66206637)
HUC: 02050304

Aquatic Life (365) - 0.21 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Kishacoquillas Creek Unnamed Of (ID:66206767)
HUC: 02050304

Aquatic Life (365) - 0.98 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Kishacoquillas Creek Unnamed Of (ID:66207383)
HUC: 02050304

Aquatic Life (607) - 1.19 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015

Kishacoquillas Creek Unnamed Of (ID:66207783)
HUC: 02050304

Aquatic Life (607) - 0.64 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015

Kishacoquillas Creek Unnamed To (ID:133431311)
HUC: 02050304

Aquatic Life (608) - 1.64 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Kishacoquillas Creek Unnamed To (ID:66204815)
HUC: 02050304

Aquatic Life (1634) - 1.58 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015
Construction		2002	2015

Kishacoquillas Creek Unnamed To (ID:66204919)
HUC: 02050304

Aquatic Life (2728) - 1.53 miles

Source	Cause	Date Listed	TMDL Date
Hydromodification	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Kishacoquillas Creek Unnamed To (ID:66205975)
HUC: 02050304

Aquatic Life (365) - 2.49 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Kishacoquillas Creek Unnamed To (ID:66206487)			
HUC: 02050304			
Aquatic Life (365) - 1.56 miles			
Agriculture	Siltation	2002	2015
	Water/Flow Variability	2002	2015
Kishacoquillas Creek Unnamed To (ID:66206845)			
HUC: 02050304			
Aquatic Life (608) - 0.4 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Kishacoquillas Creek Unnamed To (ID:66206947)			
HUC: 02050304			
Aquatic Life (608) - 1.19 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Kishacoquillas Creek Unnamed To (ID:66207013)			
HUC: 02050304			
Aquatic Life (370) - 1.58 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Kishacoquillas Creek Unnamed To (ID:66207153)			
HUC: 02050304			
Aquatic Life (608) - 0.72 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Kishacoquillas Creek Unnamed To (ID:66207169)			
HUC: 02050304			
Aquatic Life (607) - 2.42 miles			
Agriculture	Siltation	2002	2015
Aquatic Life (608) - 0.65 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Laurel Creek Unnamed Of (ID:66203383)			
HUC: 02050304			
Aquatic Life (351) - 0.4 miles			
Grazing Related Agric	Siltation	2002	2015
Urban Runoff/Storm Sewers	Water/Flow Variability	2002	2015
Laurel Creek Unnamed To (ID:66203541)			
HUC: 02050304			
Aquatic Life (351) - 2.82 miles			
Grazing Related Agric	Siltation	2002	2015
Urban Runoff/Storm Sewers	Water/Flow Variability	2002	2015

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Little Kishacoquillas Creek HUC: 02050304			
Aquatic Life (370) - 0.65 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Aquatic Life (1436) - 1.98 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Urban Runoff/Storm Sewers	Flow Alterations	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015
Aquatic Life (1437) - 1.58 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed Of (ID:133431127) HUC: 02050304			
Aquatic Life (370) - 0.26 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed Of (ID:66205777) HUC: 02050304			
Aquatic Life (1437) - 0.44 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed Of (ID:66205831) HUC: 02050304			
Aquatic Life (1437) - 0.38 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed Of (ID:66205931) HUC: 02050304			
Aquatic Life (1437) - 0.79 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed Of (ID:66205933) HUC: 02050304			
Aquatic Life (1437) - 1.61 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Stream Name
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date

Little Kishacoquillas Creek Unnamed Of (ID:66206045)
HUC: 02050304

Aquatic Life (370) - 0.8 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed Of (ID:66206159)
HUC: 02050304

Aquatic Life (370) - 1.37 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed Of (ID:66206205)
HUC: 02050304

Aquatic Life (370) - 1.12 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed Of (ID:66206239)
HUC: 02050304

Aquatic Life (370) - 0.43 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed Of (ID:66206281)
HUC: 02050304

Aquatic Life (370) - 0.33 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed Of (ID:66206407)
HUC: 02050304

Aquatic Life (370) - 0.38 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed To (ID:133431131)
HUC: 02050304

Aquatic Life (370) - 1.26 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015

Little Kishacoquillas Creek Unnamed To (ID:66205403)
HUC: 02050304

Aquatic Life (1436) - 2.45 miles

Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Urban Runoff/Storm Sewers	Flow Alterations	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015

Stream Name / HUC / Use Assessed (Assessment ID) - Miles / Source	Cause	Date Listed	TMDL Date
Little Kishacoquillas Creek Unnamed To (ID:66205719)			
HUC: 02050304			
Aquatic Life (1437) - 0.63 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed To (ID:66205887)			
HUC: 02050304			
Aquatic Life (1437) - 0.72 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Little Kishacoquillas Creek Unnamed To (ID:66206195)			
HUC: 02050304			
Aquatic Life (370) - 1.75 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Smith Gap Run			
HUC: 02050304			
Aquatic Life (1436) - 1.53 miles			
Agriculture	Nutrients	2002	2015
	Siltation	2002	2015
Urban Runoff/Storm Sewers	Flow Alterations	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015
Soft Run			
HUC: 02050304			
Aquatic Life (367) - 2.99 miles			
Agriculture	Nutrients	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015
Soft Run Unnamed To (ID:66205445)			
HUC: 02050304			
Aquatic Life (367) - 1.43 miles			
Agriculture	Nutrients	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015
Soft Run Unnamed To (ID:66205475)			
HUC: 02050304			
Aquatic Life (367) - 0.91 miles			
Agriculture	Nutrients	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015

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Stream Name
HUC
Use Assessed (Assessment ID) - Miles

Source	Cause	Date Listed	TMDL Date

Soft Run Unnamed To (ID:66205483)
HUC: 02050304

Aquatic Life (367) - 0.48 miles

Source	Cause	Date Listed	TMDL Date
Agriculture	Nutrients	2002	2015
	Other Habitat Alterations	2002	2015
	Siltation	2002	2015

Attachment F
Comment and Response

MIFFLIN COUNTY
CONSERVATION DISTRICT
20 Windmill Hill #4 • Burnham, PA 17009 • (717) 248-4695 • Fax (717) 248-6589

August 25, 2017

Attn: Scott N. Heidel
Pennsylvania Department of Environmental Protection
400 Market Street
Harrisburg, PA 17105

Comments on the "Kishacoquillas Creek Watershed Alternative Restoration Plan"

1.Throughout the report references are made to both the Upper Kishacoquillas Creek Watershed and the greater Kishacoquillas Creek Watershed. Several references are made to the Kishacoquillas Creek Watershed when it appears they should be referencing the Upper Kishacoquillas Creek Watershed. In addition, the statistics stated on page 5 paragraph 2 seem to be referencing different watersheds as well: square miles match the Upper Kish and impaired stream miles more closely represent the entire Kishacoquillas Creek Watershed.

2. Does the source of BMP data for modeling (reference on page 22 to appendix C) need to be clarified? The MCCD and DEP know that those numbers came from MCCD's records, but should the source be listed in the report to clarify what BMPs were accounted for? Should there be more explanation in the text of BMP numbers/inventories?

- Mifflin County Conservation District

DEP Responses:

1) *The Alternate Restoration Plan was written to address all of the sediment and nutrient impairments in the entire Kishacoquillas Watershed. These impairments are found in seven subwatersheds of the Kishacoquillas Watershed. One of these impaired subwatersheds was of sufficient size to model independently, Upper Kishacoquillas Creek Subwatershed. Once loading rates were determined for the Upper Kishacoquillas Creek Subwatershed and the reference watershed, Spring Creek, those rates were applied to the land areas of the other six impaired subwatersheds to determine their pollutant loads and subsequent load reductions. Wording was clarified throughout the document to reflect this methodology.*

2) *Additional wording, BMP tables and a BMP Key were added and attached to the document to account for BMP numbers implemented by the Mifflin County Conservation District.*

EPA Comments:

1) EPA would like the document to better explain why PADEP believes alternative restoration plan, rather than a TMDL, is a more effective tool to achieve WQS. There are many indications throughout time that a TMDL was planned. The following are examples of this.

- The 2016 IR public noticed Kishacoquillas Creek as a TMDL priority.
- The NPDES Permit No. PA0024708 states, "On April 30, 2011, the Total Maximum Daily Load was developed to provide a full picture of and solution to water quality problems identified in the Kishacoquillas Creek Subwatershed. Once the Kishacoquillas Creek Subwatershed TMDL is finalized, the Department may reopen the permit to reflect the allocated Total Suspended Solids and Phosphorus loading addressed in the TMDL."
- The 319 Watershed Implementation Plan for the Upper Kishacoquillas Creek states, "At this time, TMDLs have not been developed for the Upper Kish watershed; however they are expected to be established as soon as 2008. Once completed, the calculated loads will be compared with the loads projected for this watershed by PRedICT and adjustments will be made accordingly."
- The 319 Watershed Implementation Plan for Hungry Run states, "At this time, TMDLs have not been developed for the Hungry Run watershed; however they are expected to be established as soon as 2015. Once completed, the calculated loads will be compared with the loads projected for this watershed by PRedICT and adjustments will be made accordingly."

If a TMDL was planned, then there has been a change of course. Considering the document resembles a traditional TMDL that has been modified to not make mention of TMDLs, would it not have been more practicable to meet the requirement of the Clean Water Act with a TMDL?

DEP Response: A traditional TMDL is not as effective as an ARP because the general Load Allocations of a TMDL are not as specific or informative as the goals presented by an ARP. Future modeling scenarios are not run in traditional TMDLs. ARPs take additional steps to accurately guide restoration efforts by doing future model runs making them more effective and efficient at restoring local watersheds. These additional steps also enable vested local parties to focus on the most efficient use of their efforts and assests.

2) Please provide a justification for how the Bay WLA for the Municipal Authority of the Township of Union is protective of local water quality.

DEP Response: This point source is not responsible for the phosphorus impairment in the watershed as it is located at the bottom of the watershed (see Figure A1) with no influence on any of the phosphorus impairments in the watershed. Then 1.13 miles below the Union Township STP discharge, the Upper Kishacoquillas empties to the mainstem Kishacoquillas which meets water quality standards until its confluence with the Juniata River. Therefore, this ARP will hold the Union Township STP to the cap load issued in the Chesapeake Bay TMDL, but will *recommend a biological assessment point and monitoring of the 1.13 mile impaired stretch of the Upper Kishacoquillas Creek Subwatershed be conducted in the future.*

3) The element to identification of all the impaired waters was not satisfied. Only waters within the subwatershed referred to as the Upper Kishacoquillas Creek Watershed was included in Attachment D.

DEP Response: Attachment D and Table 2 have been updated to include all impairments in the Kishacoquillas Creek Watershed.

4) Please identify the size threshold that PADEP uses as a cut-off for modeling purposes in MapShed. The size of the Hungry Run watershed is 5358 acres, which is slightly larger than proposed reference watershed in another TMDL.

DEP Response: A watershed of two square miles would be the minimum size to model using MapShed.

5) The implementation plan for the ARP is incomplete. The ARP concludes that the 319 WIPs should be continued to be implemented and proper implementation of the state regulations is needed. The Upper Kishacoquillas Creek and Hungry Run 319 WIPs include the BMPs needed to address the agricultural sources and timelines, but the timeline is only detailed up to 2009 and 2012, respectively. The ARP does not specify what has actually occurred since the WIPs were developed. For example, a high rate of implementation and cooperation may help justify a low priority for TMDL development. While Table 15 alludes to this, there is no support in the document from Mifflin County Conservation District to provide data for the inputs in the rural land BMP Scenerio in Tables C3 and C4. It is unclear if WIPs need adjustments to meet the load allocations (i.e. are there still BMPs in the WIPs that have not been implemented that could be implemented), or if the WIPs need to be updated to reflect additional BMPs. There is not a "future" run to show that the remaining BMPs in the WIPs would be sufficient to meet the load allocations. The ARP does not include any commitment by any party to update the WIPs (if necessary) or to conduct compliance activities to ensure the state regulations have been properly implemented.

DEP Response: Attachment C has been updated to include current and future implementation. Pages 20-22 also describe a two Phased approach to restoration that will be conducted to restore the impaired subwatersheds.

6) There are no 319 WIPs for the impaired waters outside of the Upper Kishacoquillas Creek and Hungry Run, thus there is no implementation plan (actions and milestones) for these waters. The ARP does not fill this gap nor is there a commitment to fill this gap.

DEP Response: These waters will be worked on in two Phases as described on pages 21 and 22. When the existing WIPs are updated, it may also be possible to pull the UNTs into a larger WIP.

7) There is no estimate or projection of the time when WQS will be met.

DEP Response: Implementation will occur in two five year Phases. Phase 1 is already in progress.

8) PADEP could make this ARP stronger by including any water quality data that shows there has been a water quality improvement. The ARP does not include a plan for effectiveness monitoring to: to demonstrate progress made toward achieving WQS following implementation; identify needed improvement for adaptive management as the project progresses; and evaluate the success of actions and outcome.

DEP Response: Figure 4 in the Monitoring Section demonstrates the progress already realized. This will be used as the baseline data set to compare future monitoring results.

9) What plans does PADEP have to periodically evaluate the alternative restoration approach to determine if is on track?

DEP Response: Monitoring will occur during and after both Phases of restoration. This will include pebble counts, water chemistry and macroinvertebrates.