



**MILL CREEK WATERSHED IMPLEMENTATION PLAN**  
**TRIBUTARY FOCUSED SUPPLEMENT**



LANCASTER COUNTY  
CONSERVATION DISTRICT

**Prepared by**

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## **Background and History of the Mill Creek Watershed Implementation Plan**

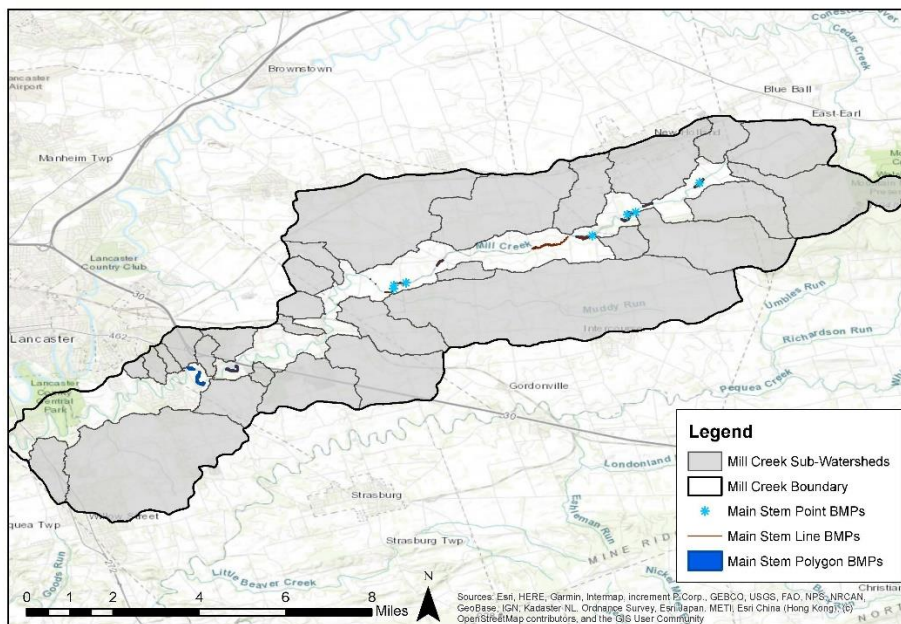
In 2006, the Lancaster County Conservation District ventured into the realm of creating a Watershed Implementation Plan for the Mill Creek Watershed. We were approached by the Pennsylvania Department of Environmental Protection (PADEP) on the creation of this new style of restoration plan with its distinct elements that spelled out the ways to improve an entire watershed system. After much discussion throughout the District and the Mill Cr. Watershed, we took on this new challenge and produced the Mill Cr. WIP in the summer of 2006. The document was shared with the Conservation District Board, local municipalities in the watershed, other conservation non-profits working in and around the Mill Cr., and the Millcreek Preservation Association, the local watershed association in the watershed. The idea was to partner with as many folks as possible to accomplish as much as we could within the 2006 WIP. The District did not want to be the lone entity pushing this plan, we wanted this to be a combined collaborative effort of many.

Fast forward ten years to 2016, and the District and partners working on the Mill Cr. WIP thought a lot was taking place on the mainstem of the Mill Cr. but perhaps a tributary-focused supplement to the Mill Cr. WIP would be of more benefit to all working in the watershed. Once again working with PADEP, we applied for a Section 319 Nonpoint Source Pollution Prevention grant to create this supplement to the original Mill Cr. WIP. The idea of the supplement is centered around the program's new goal of having smaller sub-watersheds within the WIP to pinpoint specific improvements in these smaller watersheds thus improving the whole watershed over time faster.

The first 2006 WIP was focused on the watershed as a whole, but most of the initial work focused on the mainstem of the Mill Cr. As shown in Map 1 below a lot has taken place within the mainstem of the Mill Cr. These improvements have made a difference locally in those areas but we are not seeing the water quality improvements we were hoping for on a much broader watershed-wide scale. We wanted this new supplement to still have a piece that focused on the mainstem but wanted the majority of the document to attack the smaller sub-watersheds in the Mill Cr. and projects that could be accomplished in these areas to improve local water quality more efficiently and faster.



### Mill Creek Main Stem Stream Restoration BMPs



Map 1: Showing mostly stream restoration, riparian buffer, streambanks fencing, and livestock crossing projects carried out since the 2006 WIP was created on the mainstem.



The improvements that have been made within the Mill Cr. Watershed to date can be seen simply by updating the three tables that were in the original 2006 Mill Cr. WIP. These tables divided the watershed into three sections and specific BMPs that were either existing or planned in these areas and what that goal looked like. We have taken the liberty of updating Tables A, B, and C from the original WIP to demonstrate what has taken place since 2006 and what remains. Please remember due to the size of the Mill Creek Watershed PA DEP decided to assess parts of the watershed at various times over the years. The Muddy Run Watershed was assessed in September of 1998 (Table A) and its TMDL was completed in February 2001. The Unnamed Tributaries of Mill Creek with the TMDL developed for them was assessed in May of 2000 (Table B) and the TMDL was completed in August of 2004. The Big Spring Run Watershed was assessed in June and July of 2000 and the Groff Run Watershed was assessed in October of 1997. The rest of Mill Creek and its tributaries were assessed between September 1998 and June 2000 (Table C).

The tables that follow only illustrate the BMPs that were installed with the assistance of either the Conservation District or NRCS. Many times, landowners will implement BMPs on their property without the assistance of District or NRCS staff and no record of this BMP will be recorded. It does not mean a BMP was not installed, it just means it was not accounted for in the Conservation District and/or NRCS records.

**Table A: Existing (2006)/Implemented Since 2006/Future Planned BMPs in the Muddy Run Watershed**

<b>Muddy Run</b>					
<b>Agricultural Practices</b>					
	Existing (2006)	Implemented Since 2006-Present	Future as noted in 2006 WIP document	Difference (Green met goal, Red remaining goal)	Unit
<b>ROW CROP BMP'S</b>					
<b>Cropland Protection</b>	231.7	1,196.4	689.6	-506.8	Acres
<b>Conservation Tillage</b>	0.0	704.4	104.8	-599.6	Acres
<b>Strip Cropping/Contour Farming</b>	5.0	13.2	325.0	311.8	Acres
<b>Nutrient Management</b>	414.4	208.9	892.5	683.6	Acres
<b>Terraces/Diversions</b>	0	192	0	-192	Feet
<b>HAY PASTURE BMP'S</b>					
<b>Grazing Land Management (Hay/Pasture)</b>	24.0	55.4	224.5	169.1	Acres
<b>ADDITIONAL BMP'S</b>					
<b>Waterway</b>	1.5	5.4	3.1	-2.3	Acres
<b>Filter Strip</b>	0	0	0	0	Acres
<b>Barnyard Controls</b>	5	18	20	2	Qty
<b>Underground outlet</b>	0	2318	0	-2318	Feet
<b>Waste Facility</b>	8	13	6	-7	Qty

<b>Field Borders</b>	0	0	800	800	Feet
<b>Waste System</b>	6	9	10	1	Qty
<b>Stream miles w/ Vegetative buffer strip</b>	0	0	7	7	Miles
<b>Miles of Streambank Stabilized</b>	0.30	0.02	2.00	1.98	Miles
<b>Stream Miles Fenced</b>	1.5	2.0	7.0	5.0	Miles

\*-existing period ends September 1998(TMDL Date)

**Table B: Existing (2006)/Implemented Since 2006/Future Planned BMPs in the UNT Mill Creek Watershed**

<b>UNT to Mill Creek</b>					
<b>Agricultural Practices</b>					
Practices	Existing (2006)	Implemented Since 2006-Present	Future as noted in 2006 WIP document	Difference (Green met goal, Red remaining goal)	Unit
<b>ROW CROP BMP'S</b>					
<b>Cropland Protection</b>	0.0	851.2	83.3	-767.9	Acres
<b>Conservation Tillage</b>	0.0	363.1	7.2	-355.9	Acres
<b>Strip Cropping/Contour Farming</b>	0.0	0.0	0.0	0.0	Acres
<b>Nutrient Management</b>	0.0	116.1	135.3	19.2	Acres
<b>Terraces/Diversions</b>	0	0	0	0	Feet
<b>HAY PASTURE BMP'S</b>					
<b>Grazing Land Management (Hay/Pasture)</b>	0.0	69.8	0.0	-69.8	Acres
<b>ADDITIONAL BMP'S</b>					
<b>Waterway</b>	0.0	0.1	1.5	1.4	Acres
<b>Filter Strip</b>	0	0	0	0	Acres
<b>Barnyard Controls</b>	0	2	4	2	Qty
<b>Underground outlet</b>	0	0	0	0	Feet
<b>Waste Facility</b>	0	3	0	-3	Qty
<b>Field Borders</b>	0	0	0	0	Feet
<b>Waste System</b>	0	1	2	1	Qty
<b>Stream miles w/ Vegetative buffer strip</b>	1	0	3	3	Miles

<b>Miles of Streambank Stabilized</b>	0.00	0.00	1.00	1.00	Miles
<b>Stream Miles Fenced</b>	0.8	0.2	3.4	3.2	Miles

\*-existing period ends May 2000 (TMDL Date)

**Table C: Existing (2006)/Implemented Since 2006/Future Planned BMPs in the Mill Creek Watershed**

(Not including Muddy Run & UNT Mill Creek Watersheds)

<b>Mill Creek</b>					
<b>Agricultural Practices</b>					
	Existing	2006-Present	Future as noted in the document	Difference	Units
<b>ROW CROP BMP'S</b>					
<b>Cropland Protection</b>	569.2	5,745.6	1,328.3	-4,417.3	Acres
<b>Conservation Tillage</b>	303.5	2,270.9	427.5	-1,843.4	Acres
<b>Strip Cropping/Contour Farming</b>	475.8	212.4	816.7	604.3	Acres
<b>Nutrient Management</b>	1243.2	973.2	1,942.4	969.2	Acres
<b>Terraces/Diversions</b>	3112	8,679	12,250	3,571	Feet
<b>HAY PASTURE BMP'S</b>					
<b>Grazing Land Management (Hay/Pasture)</b>	115.5	1,245.0	481.5	-763.5	Acres
<b>ADDITIONAL BMP's</b>					
<b>Waterway</b>	4.6	1,326.6	21.8 acres	-1304.8	Acres
<b>Filter Strip</b>	65	6	1	-5	Acres
<b>Barnyard Controls</b>	14	32	42	10	Qty
<b>Underground outlet</b>	250	6,077	880	-5,197	Feet
<b>Waste Facility</b>	15	38	11	-27	Qty
<b>Field Borders</b>	0	1	22	21	Acres
<b>Waste System</b>	11	7	1	-6	Qty
<b>Stream miles w/ Vegetative buffer strip</b>	0.3	38 acres	24		Miles
<b>Miles of Streambank Stabilized</b>	0.40	22.46	10.00	-12.46	Miles
<b>Stream Miles Fenced</b>	3.4	3.6	18.5	14.9	Miles
<b>All Fence</b>		11.7			Miles
<b>Urban Practices</b>					
<i>High Density BMPs</i>					
<b>Constructed Wetlands</b>	0		30		
<b>Detention Basins</b>	0		0		
<b>Stream Length</b>	0		0		
<b>Streambank Stabilized</b>	0		1000		Feet
<i>Low Density BMPs</i>					
<b>Constructed Wetlands</b>	0		30		
<b>Detention Basins</b>	0		0		
<b>Stream Length</b>	0		0		
<b>Streambank Stabilized</b>	0		1000		
<i>Additional BMPs</i>					

<b>Impervious Reduction</b>	0	5338.64	40 (Future units not given)		Sq Ft
<b>Infiltration Practices (<i>critical area</i>)</b>	0	0.25	10 (Future units not given)		Acres
<b>Filtering Practices (<i>vegetated treatment</i>)</b>	0	0.44	21 (Future units not given)		Acres
<b>Erosion &amp; Sedimentation Control (<i>Access Road?</i>)</b>	0	4	1 (Future units not given)		Qty
<b>Rooftop Runoff</b>	0	28	15 (Future units not given)		Qty

\*-existing period ends June 2000 (Assessment Date)

Once again, to improve upon the 2006 WIP plan we have also revised the Cost estimates for the BMP's planned in the WIP to reflect current market conditions and to make it more relevant in today's economy. These revised BMP cost estimates can be seen in Table D below.

**Table D: Cost estimate per BMP and maintenance plus potential funding sources**

BMP	Design & Construction Cost	Annual Operations & Maintenance Cost*	Potential Sources of Funding
*Waste Storage System (313)	\$80,000	\$4,000.00	Growing Greener, Section 319 Program, & other sources
#Conservation Crop Rotation (328)	\$11/acre	\$0.50	Growing Greener, Section 319 Program, & other sources
#Residue Management, No-till (329A)	\$19/acre	\$1.00	Growing Greener, Section 319 Program, & other sources
#Contour Farming (330)	\$8/acre	\$0.50	Growing Greener, Section 319 Program, & other sources
*Cover Crop (340)	\$20/acre	\$1.00	Growing Greener, Section 319 Program, & other sources
*Residue Management, Seasonal (344)	\$20/acre	\$1.00	Growing Greener, Section 319 Program, & other sources
*Barnyard Runoff Control (357)	\$22,000	\$2,000.00	Growing Greener, Section 319 Program, & other sources
^Stream bank Fencing (382)	\$8/ft	\$0.25	Growing Greener, Section 319 Program, & other sources
#Field Borders (386)	\$150/acre	\$10.00	Growing Greener, Section 319 Program, & other sources
^Riparian Buffer (assumes 50' width) (391)	\$2,500/acre	\$0.50	Growing Greener, Section 319 Program, & other sources
#Filter Strip (393)	\$200/acre	\$12.00	Growing Greener, Section 319 Program, & other sources
#Grassed Waterway (412)	\$4,500/acre	\$200.00	Growing Greener, Section 319 Program, & other sources
#Pasture/Hayland Planting (512)	\$300/acre	\$10.00	Growing Greener, Section 319 Program, & other sources
*Prescribed Grazing (528A)	\$50/acre	\$5.00	Growing Greener, Section 319 Program, & other sources



^Stream bank Stabilization (580)	\$130/linear ft	\$5.00	Growing Greener, Section 319 Program, & other sources
#Stripcropping, Contour (585)	\$2/acre	\$0.75	Growing Greener, Section 319 Program, & other sources
#Nutrient Management Plan (590)	\$8/acre	\$0.50	Growing Greener, Section 319 Program, & other sources
#Terraces (600)	\$4/ft	\$0.25	Growing Greener, Section 319 Program, & other sources
#Constructed Wetlands (656)	\$12,000/impervious acre	\$1,000.00	Growing Greener, Section 319 Program, & other sources
Floodplain Restoration	\$900/linear ft	\$5.00	Growing Greener, Section 319 Program, & other sources
Dam Removal	Varies from project to project depending on size, scope, and overall goal.		Growing Greener, Section 319 Program, & other sources
Impervious Surface Reduction	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Filtering Practices	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Rooftop Runoff Management	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Infiltration Practices	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
E & S Controls	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources

\*-LCCD cost estimate, #-EQIP cost estimate, ^-cost estimate came from another source

### **Mill Creek Watershed Implementation Plan Tributary Focused Supplement**

The Mill Creek Watershed Implementation Plan Tributary Focused Supplement is a supplement to the original Mill WIP created in 2006 by the Lancaster County Conservation District. The idea behind the Tributary-Focused Supplement is really to hone in on priority tributary watersheds in the Mill Cr. Watershed that could benefit from focused conservation efforts in the future. This tributary-focused approach looks at each tributary now and what is happening presently in that sub-watershed. It then goes into modeling future land use and conservation efforts in that sub-watershed using the WikiWatershed model developed by Stroud Water Research Center. The concept is simple and the idea is to prioritize each watershed in an approach to improve each sub-watershed over time.

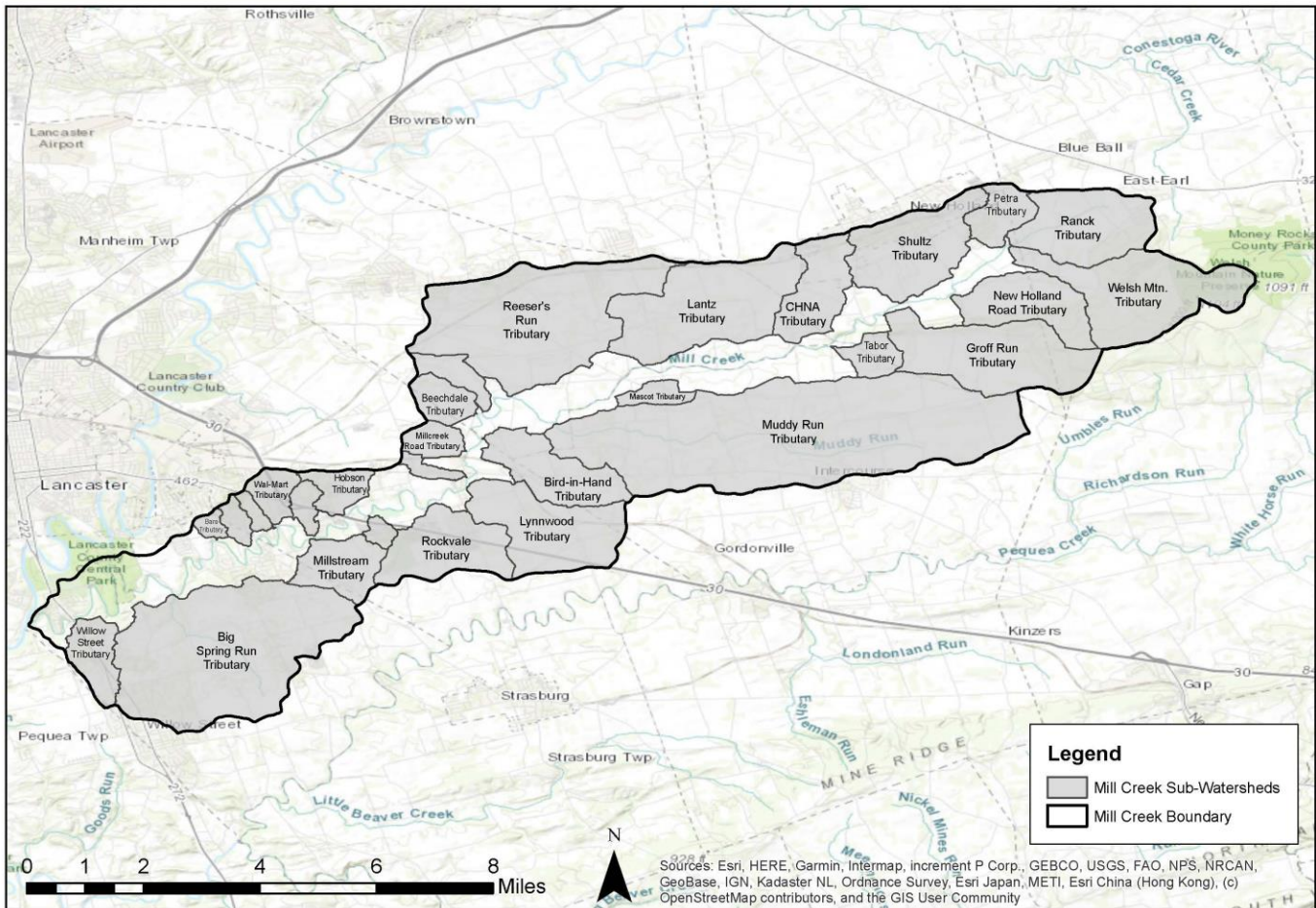
The layout for this Tributary-Focused Supplement is as follows.

- Name/Number of Sub-Watershed (Title)
- Priority Level assessment for the sub-watershed being looked at. Priority Level 1 is the best chance for water quality improvements, Priority 2 is the next best chance after Priority 1 for water quality improvements, Priority Level 3 is a medium chance for water quality improvements, and Priority 4 is the least or lowest opportunity for improved water quality. This priority-level classification system is also used for funding future projects down the road. Future 319 Non-Point Source Pollution Prevention funding should be directed toward priority 1-level watershed projects over other priority levels. But other projects in priority 2 subwatersheds could still apply for Section 319 funding, if BMP implementation efforts in priority 1 subwatersheds have been exhausted, if landowners for BMP implementation in priority 1 subwatersheds are unable to be identified, if implementation projects in the subwatershed could lead to

a potential delisting of the stream. Section 319 funds could be spent on projects in priority 3 projects if there is significant justification for the project. Examples include if BMP implementation efforts in priority 1 and 2 watersheds have been exhausted, the project will connect one or two implementation projects leading to a larger-connected restored area, could cause additional landowners in the subwatershed to agree to BMP implementation on their project increasing the likelihood of the subwatershed being delisted in the future, or lead to the delisting of the subwatershed in the future

- A brief description of the location of the watershed in relationship to the entire watershed with road names and intersections. This is followed by if the stream is a NAHD named stream and its impairments status according to the 2022 Integrated List. It then briefly goes into what is known to be in place in the watershed from an ag land use standpoint from pulling data from PracticeKeeper (PK) and getting an approximate percentage of plans and conservation practices in place according to this database. Development pressure and other land use challenges are also discussed here as well.
- Next is a small map of the sub-watershed being reviewed from USGS Stream Stats.
- This is followed by USGS Stream Stats information for the watershed. Things like Latitude and Longitude of its confluence with the mainstem of Mill Cr., percent of the watershed developed, percent of the watershed forested, percent of the watershed in certain types of development (low and medium development), and even average elevations within the basin.
- Next is a recap of the WikiWatersheds delineation of the watershed. This includes land use acres, soil types, elevations, and even estimated animal numbers for the sub-watershed being reviewed.
- After this are various pictures from throughout the sub-watershed being studied taken while ground-truthing the WikiWatershed data set.
- Then the load allocations for the sub-watershed as per WikiWatershed are detailed in tabular form. This is done for the entire watershed and then it is broken down per land uses as well.
- Next, we recap in narrative form, what will be modeled. This includes what the model is simulating as far as what is on the ground now and what is proposed in the future. This is done for both urban and agricultural BMP's.
- We show the result of the model run described in the narrative and load reductions achieved through these present and proposed BMP's in tabular form. These modeled load reductions assume nearly a 100% implementation rate across the watershed. In reality that implementation rate will more than likely be around 80%. This 80% implementation rate is more consistent with real-world opportunities and this percentage also matches our County-wide Implementation Plan numbers as well.
- Then we combined the 2006 WIP with the supplemental version with projects that were in the original WIP that are in these specific Sub-Watersheds. This is a way to tie the 2006 WIP to the new version. In this area, we also put approx. coordinates for these projects, sizes of BMP's, updates on completed BMP's thus far, and revised cost estimates to 2022 BMP costs if available.
- Finally, we wrap the entire Sub-Watershed section up with a map of the sub-watershed being reviewed showing BMP's completed in that Sub-Watershed since 2006. Once again trying to connect the 2006 WIP with the supplement and showing what remains.

## Mill Creek Sub-Watersheds



Map 2: Showing the tributaries focused in on this supplement in comparison to the Mill Cr. Watershed.

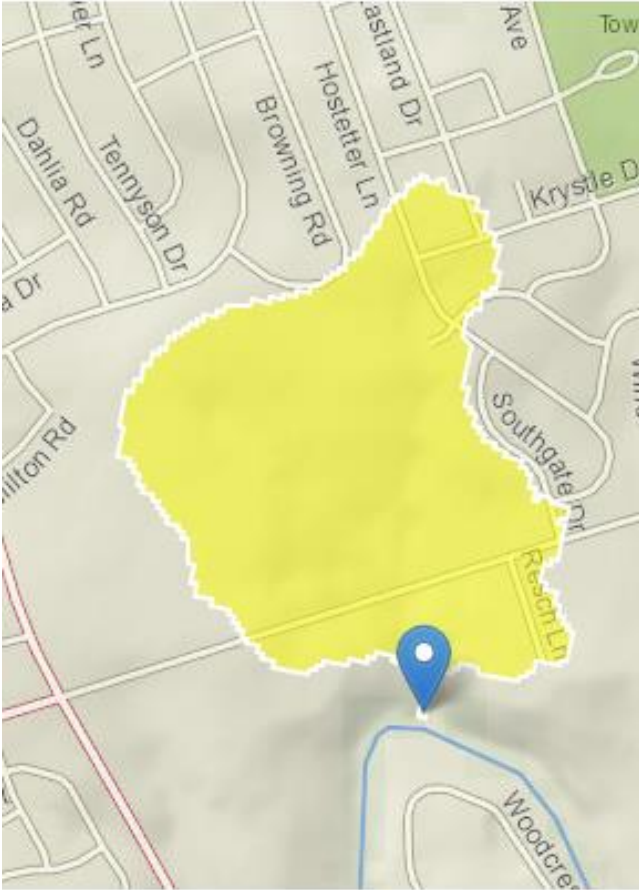
There was one issue we did notice using the Wiki Watershed model that we feel needs noted in this supplement document. For a small few of the Sub-Watershed model runs Wiki Watersheds ran the loading rates for urban and ag areas did not match up with the actual land use for that sub-basin. The District looked into this discrepancy to see what was going on but was unable to determine what transpired and was unable to get an explanation from the Wiki Watershed support team on this issue. We believe the issue stems from when the Wiki Watershed model took the land use surveys for that area and how that is being interpreted through the model.

We would like to note this issue for several watersheds but also feel it should not diminish the overall results of this supplement. The reason for saying that is for Sub-Watersheds 4C, 4D, 14, and 15 Wiki Watersheds reported fairly high urban loading rates but these watersheds have very limited urban land uses. But then on Sub-Watersheds 5, 17, and 19 Wiki Watersheds has no urban loading rates for these basins but they have a fair number of urban land uses. We feel in the bigger picture these discrepancies cancel each other out over the entire watershed. For the Sub-Watershed level, we are getting slightly skewed results but overall these issues are canceling themselves out watershed-wide. We will continue to search for answers as to why this issue is occurring in the Wiki Watershed model but at the same time, we wanted to move forward with this supplement to get it approved for the community because we feel it is that important.

## Sub-Watershed 1 “Bare” Tributary

### Priority Level 3

Sub-Watershed 1, the “Bare” Tributary, is a 0.15 square mile watershed located east of the Lampeter and Millport Road intersection. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential, institutional, and agricultural land uses. The one farm located in the watershed has a conservation plan, and nutrient management plan and has been inspected by the Conservation District to verify these plans. In addition, the agricultural operation is doing no-till farming, cover crops, and has a vegetative treatment area that has been implemented on the farm.



Map 1-1: Stream Stat Map of Sub-Watershed 1

Table 1-1: Stream Stats Table for Sub-Watershed 1

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0226
Longitude of confluence	-76.2577
Mean basin slope in degrees	2.64°
Percent of basin with urban development	0.23%
Mean basin elevation	357 ft
Percent of area covered by forest	9.53%
Maximum basin elevation	408 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	38.02%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	8.10%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity



Table 1-2: Wiki Watershed Facts for Sub-Watershed 1

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated crops</i>	36.36	54.13
<i>Pasture/hay</i>	12.86	19.14
<i>Developed, open space</i>	5.54	8.25
<i>Developed, low intensity</i>	4.21	6.27
<i>Mixed forest</i>	3.99	5.94
<i>Developed, medium intensity</i>	3.33	4.95
<i>Deciduous forest</i>	0.44	0.66
<i>Developed, high intensity</i>	0.22	0.33
<i>Shrub/scrub</i>	0.22	0.33
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	49.22	73.27
<i>Slow Infiltration</i>	14.63	21.78
<i>High Infiltration</i>	3.33	4.95
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	351 ft	
<i>Minimum</i>	276 ft	
<i>Maximum</i>	386 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,077	0
<i>Pigs/hogs/swine</i>	39	0
<i>Turkeys</i>	23	0
<i>Cows, dairy</i>	12	0
<i>Horses</i>	1	0
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	20



Photos of Sub-Watershed 1 "Bare" Tributary

Table 1-3: Wiki Watershed Loads Calculations for Sub-Watershed 1

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	86,639	2,587	193
<i>Loading rates (lbs/ac)</i>	1,282	38	3
<i>Mean Annual Concentration (ppm)</i>	365	11	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0	3	1
<i>Cropland</i>	43	359	91
<i>Wooded Areas</i>	0.01	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.02	1	0
<i>Medium-Density Mixed</i>	0.18	6	1
<i>High-Density Mixed</i>	0.01	0	0
<i>Low-Density Open Space</i>	0.03	2	0
<i>Farm Animals</i>	0	346	87
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	1,863	14
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	11	0
<b>TOTAL</b>	<b>43.42</b>	<b>2,593</b>	<b>193</b>

Sub-Watershed 1 is under tremendous development pressure and will more than likely be developed in the next 10 years with residential development. Looking at the surrounding watershed, all indications point to this happening. For this reason, we proposed additional Green Infrastructure (GI) BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 2.3 acres in the developed areas, Green Infrastructure approaches on 4 acres of Low-Density development, and 3 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 500 ft. of the farm that will be developed in the future.

Agricultural BMP Scenario:

Since the one farm in this watershed has a conservation plan, practices no-till farming, has cover crops, and a fully implemented nutrient management plan, all 36 acres of cropland were considered in conservation protection measures. If by chance the farm would stay agricultural in the future, we proposed about 2.3 acres of additional riparian buffer from what is already there which would amount to a total of about 2,000 ft. We also proposed if the farm stays in place to add 1,200 ft. of streambank fencing which is currently not in place along with about

500 ft. of streambank stabilization measures. All of this could go away again if the farm is developed which is what is expected in the future.

Table 1-4: Wiki Watershed Load Reductions for Sub-Watershed 1

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	86,769	2,592	193	86,771	717	179
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	34,806	62	53	34,806	62	53
Loads Removed w/ Existing Agricultural BMP's	55,167	825	171	55,167	825	171
Loads Removed w/ Proposed Agricultural BMP's	13,669	79	14	13,669	79	14
<b>TOTAL Loads Removed</b>	103,642	965	237	103,642	965	237
<b>New Reduced Load</b>	(16,873)	1,626	(44)	(16,871)	(248)	(58)
<b>Percent Reduction</b>	<b>119%</b>	<b>37%</b>	<b>123%</b>	<b>119%</b>	<b>135%</b>	<b>133%</b>
<b>TOTAL Baseline Load</b>	31,602	1,767	23	31,604	(107)	8
<b>TOTAL Loads Removed from Baseline</b>	48,475	141	66	48,475	141	66
<b>Percent Reduction from Baseline Load</b>	<b>153%</b>	<b>8%</b>	<b>294%</b>	<b>153%</b>	<b>-131%</b>	<b>804%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 1-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **\*Site # 172 (High Priority)** – lat. 40.0251; long. -76.2582 (W. Lampeter Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

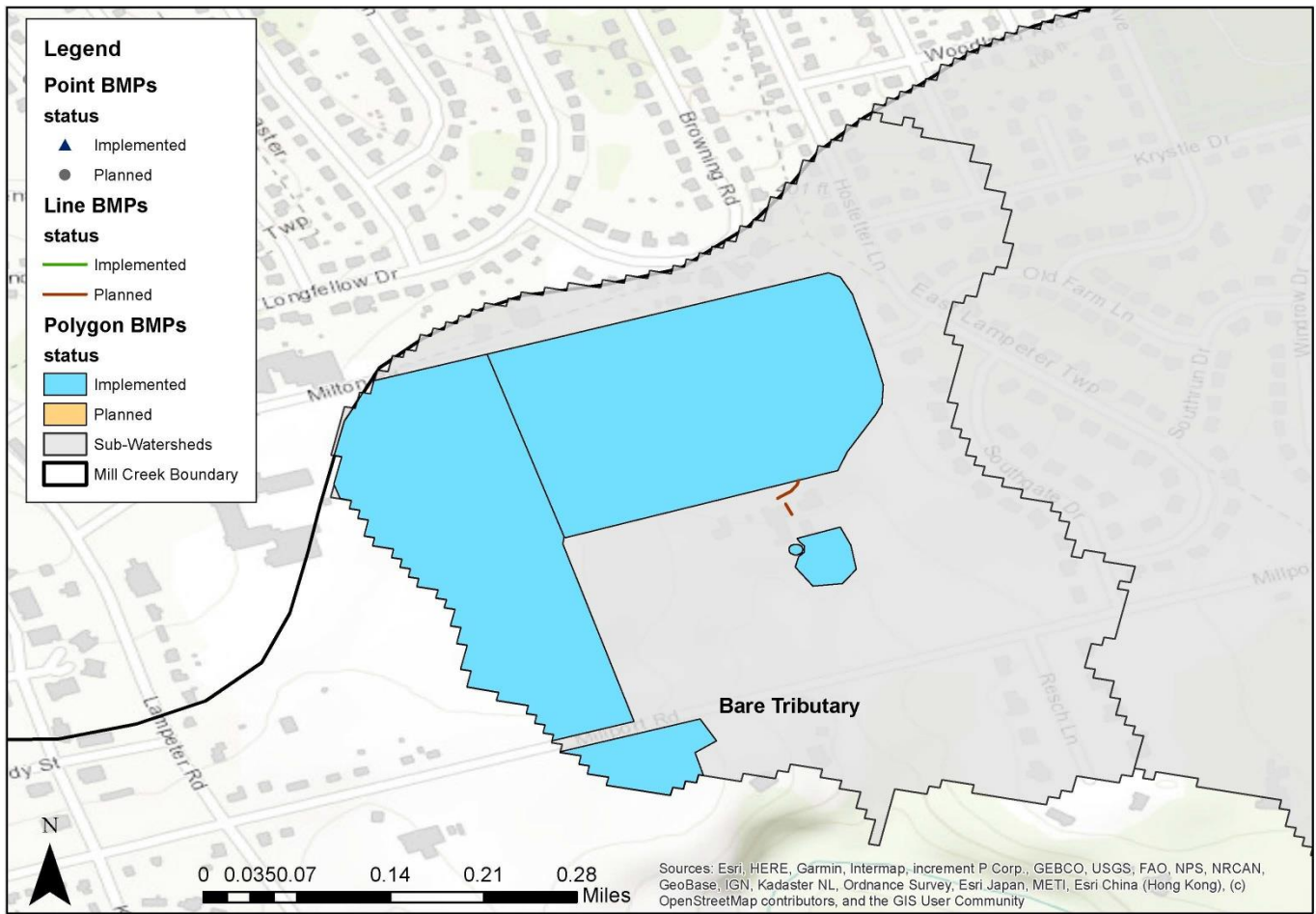
Table 1-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Conservation crop rotation	39.1 ac	\$11	\$430
Cover crop	39.1 ac	\$20	\$782
Residue Management, no-till	39.1 ac	\$19	\$743
Pasture/hayland planting	21.9 ac	\$300	\$6,570
Contour farming	19.1 ac	\$8	\$153
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$8,678</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Streambank Fencing	1,200'	\$8	\$9,600
Riparian buffer	1.0 ac	\$2,500	\$2,500
Prescribed grazing	0.3 ac	\$50	\$15
Barnyard runoff controls	1	\$22,000	\$22,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	1.3 ac	\$2,500	\$3,250
Green Infrastructure	7 ac	Varies	Varies
Stream bank Stabilization	500'	\$130	\$65,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$102,365</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP



# Bare Tributary BMPs



Map1-2: Completed & planned BMP's in the Sub-Watershed 1 according PracticeKeeper (2022)

## Sub-Watershed 1A “Waterfront Estates” Tributary

### Priority Level 3

Sub-Watershed 1A, the “Waterfront Estates” Tributary, is a 0.23 square mile watershed located east of Lampeter Road, south of Route 462, and west of Strasburg Pike. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is mostly residential development with varying parcel sizes and with a public park at the headwaters of the watershed. There are no current agricultural operations or commercial development within this sub-watershed. With this in mind, the Wiki Watershed animal and ag numbers need to be considered.



Map 1A-1: Stream Stat Map of Sub-Watershed 1A

Table 1A-1: Stream Stats Table for Sub-Watershed 1A

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0208
Longitude of confluence	-76.2498
Mean basin slope in degrees	2.03°
Percent of basin with urban development	1.39%
Mean basin elevation	362 ft
Percent of area covered by forest	12.87%
Maximum basin elevation	420 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	72.29%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	17.69%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 1A-2: Wiki Watershed Facts for Sub-Watershed 1A

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Pasture/Hay</i>	15.74	40.11
<i>Developed, Open Space</i>	9.09	23.16
<i>Developed, Low Intensity</i>	7.54	19.21
<i>Mixed Forest</i>	2.88	7.34
<i>Developed, Medium Intensity</i>	2.00	5.08
<i>Evergreen Forest</i>	2.00	5.08
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	30.82	78.53
<i>Slow Infiltration</i>	8.43	21.47
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	328 ft	
<i>Minimum</i>	289 ft	
<i>Maximum</i>	349 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	638	0
<i>Pigs/hogs/swine</i>	23	0
<i>Turkeys</i>	13	0
<i>Cows, dairy</i>	7	0
<i>Horses</i>	1	0
<i>Sheep</i>	0	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	0



Photos of Sub-Watershed 1A "Waterfront Estates" Tributary

Table 1A-3: Wiki Watershed Loads Calculations for Sub-Watershed 1A

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	3,096	1,110	63
<i>Loading rates (lbs/ac)</i>	78	28	2
<i>Mean Annual Concentration (ppm)</i>	25	9	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	1.38	14	4
<i>Cropland</i>	0	0	0
<i>Wooded Areas</i>	0.01	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.05	2	0
<i>Medium-Density Mixed</i>	0.06	2	0
<i>High-Density Mixed</i>	0	0	0
<i>Low-Density Open Space</i>	0.06	3	0
<i>Farm Animals</i>	0	206	52
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	879	7
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	7	0
<b>TOTAL</b>	<b>1.55</b>	<b>1,113</b>	<b>63</b>

Sub-Watershed 1A is a fully developed watershed with no agriculture in the watershed and only residential development. Most of the development is single-lot housing on 1+ acres. There is an extensive amount of mowed turf grass and minimal riparian buffers. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, and other GI approaches are needed now and, in the future.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 10 acres of Low-Density development, and 2 acres on Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 300 ft. somewhere in the developed area which is possible.

Agricultural BMP Scenario:

Since there is no agriculture in the watershed, 2 changes are needed to make the model run work. First, since there was no cropland land use found by the model 0.01 cropland was added to have a value in the model. Due to there being no animals in the watershed, as it is all developed, 1 sheep was added to have several animal units in the watershed - assuming a sheep is equivalent to several residential dogs in the watershed.



Table 1A-4: Wiki Watershed Load Reductions for Sub-Watershed 1A

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	2,993	1,110	63	2,999	224	56
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	34,696	61	53	34,696	61	53
Loads Removed w/ Existing Agricultural BMP's	-	154	39	-	154	39
Loads Removed w/ Proposed Agricultural BMP's	-	-	-	-	-	-
<b>TOTAL Loads Removed</b>	34,696	215	91	34,696	215	91
<b>New Reduced Load</b>	(31,704)	895	(29)	(31,697)	9	(35)
<b>Percent Reduction</b>	<b>1,159%</b>	<b>19%</b>	<b>146%</b>	<b>1,157%</b>	<b>96%</b>	<b>163%</b>
<b>TOTAL Baseline Load</b>	2,993	956	24	2,999	69	17
<b>TOTAL Loads Removed from Baseline</b>	34,696	61	53	34,696	61	53
<b>Percent Reduction from Baseline Load</b>	<b>1,159%</b>	<b>6%</b>	<b>220%</b>	<b>1,157%</b>	<b>88%</b>	<b>305%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 1A-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 187 (Medium-Low Priority)** – lat. 40.0231; long. -76.2514 (W. Lampeter Twp.)

Table 1A-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	1 ac	\$2,500	\$2,500

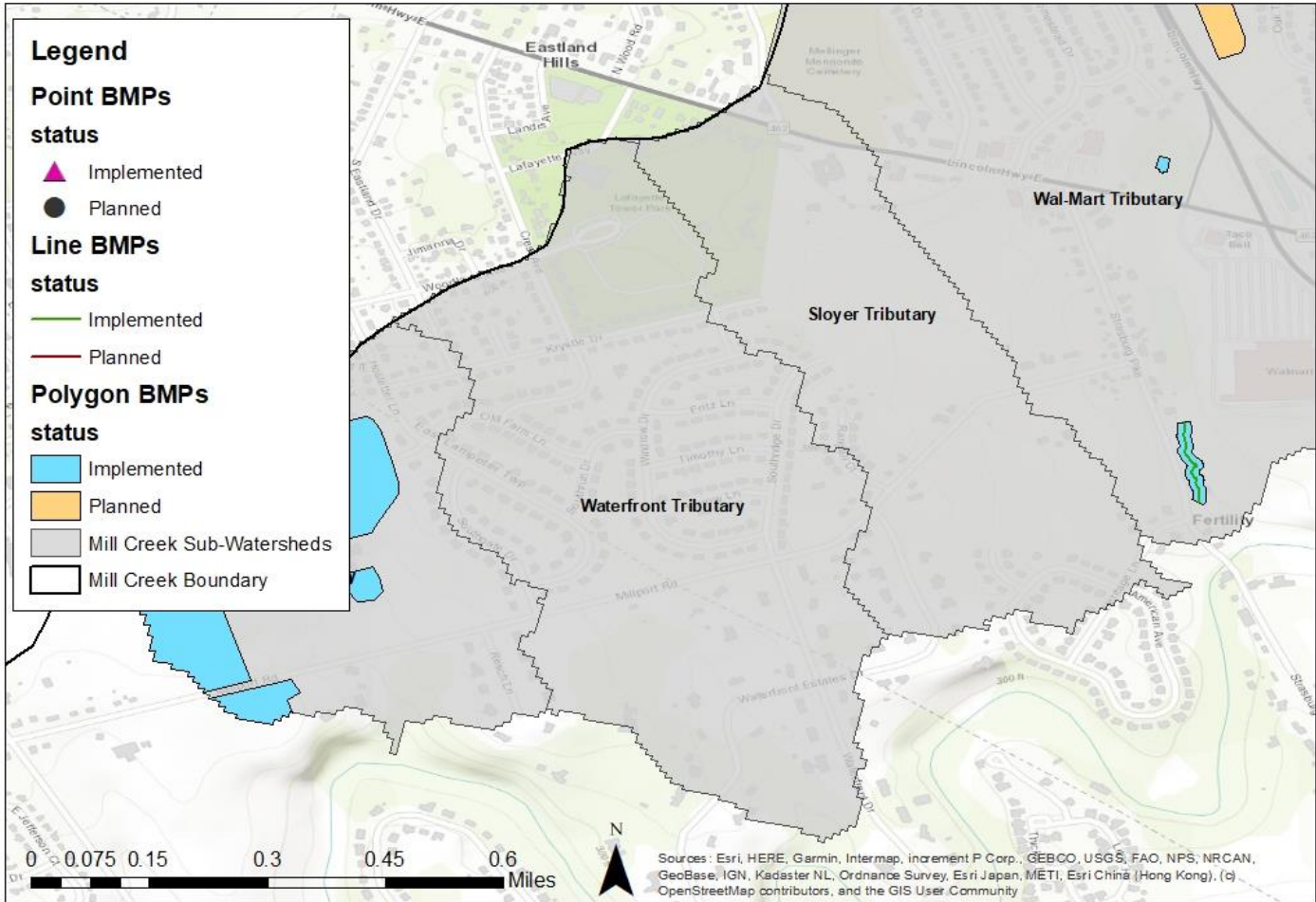
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	9 ac	\$2,500	\$22,500
Green Infrastructure	12 ac	Varies	Varies
Stream bank Stabilization	300'	\$130	\$39,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$64,000</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional buffer and/or stormwater BMP work needed in this sub-watershed, but with so many individual residential properties it was difficult to access and see every section of this tributary.



### Waterfront and Sloyer Tributaries BMPs

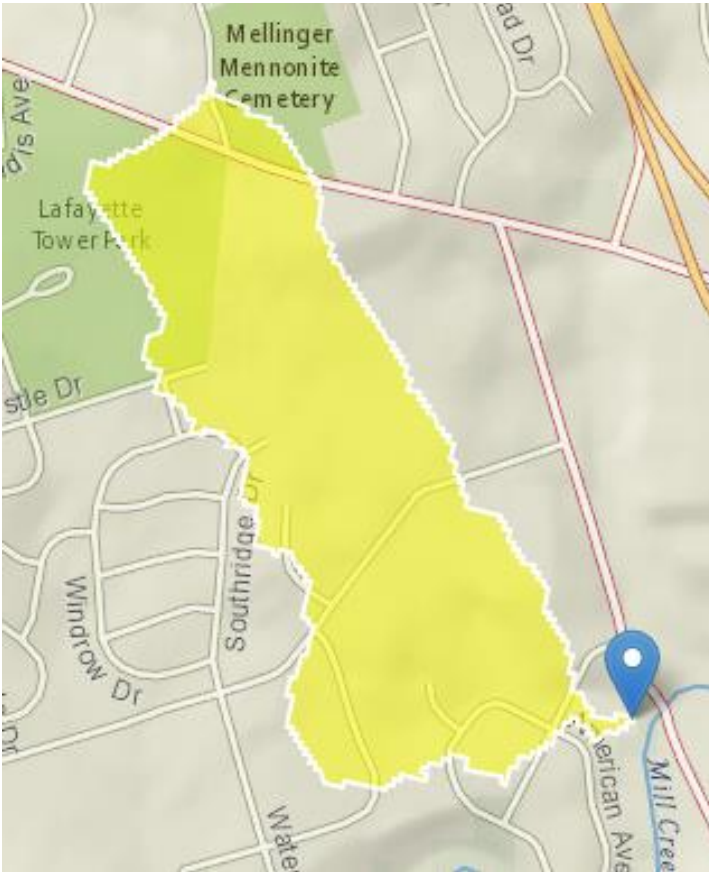


Map1A-2: Completed & planned BMP's in the Sub-Watershed 1A according PracticeKeeper (2022)

## Sub-Watershed 2 “Sloyer” Tributary

### Priority Level 2

Sub-Watershed 2, the “Sloyer” Tributary, is a 0.23 square mile watershed located south of Route 462 and west of Strasburg Pike. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential, institutional, and agricultural land uses. Headwaters of this tributary starts in a public park and a cemetery across Route 462. There are two farms located in the watershed and neither one has a conservation plan on record with the Conservation District, so this should be a priority. Neither farm has animals, but this should be confirmed with site visits in the future.



Map 2-1: Stream Stat Map of Sub-Watershed 2

Table 2-1: Stream Stats Table for Sub-Watershed 2

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0258
Longitude of confluence	-76.2427
Mean basin slope in degrees	3.22°
Percent of basin with urban development	11.40%
Mean basin elevation	365 ft
Percent of area covered by forest	3.94%
Maximum basin elevation	420 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	50.57%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	16.23%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 2-2: Wiki Watershed Facts for Sub-Watershed 2

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	48.11	48.44
<i>Developed, Open Space</i>	16.85	16.96
<i>Developed, Low Intensity</i>	14.19	14.29
<i>Developed, Medium Intensity</i>	7.98	8.04
<i>Pasture/Hay</i>	7.98	8.04
<i>Developed, High Intensity</i>	3.10	3.13
<i>Grassland/Herbaceous</i>	1.11	1.12
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	57.42	57.81
<i>High Infiltration</i>	41.46	41.74
<i>Slow Infiltration</i>	0.44	0.45
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	360 ft	
<i>Minimum</i>	298 ft	
<i>Maximum</i>	413 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,556	0
<i>Pigs/hogs/swine</i>	56	0
<i>Turkeys</i>	33	0
<i>Cows, dairy</i>	17	0
<i>Horses</i>	2	0
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	0



Photo of Sub-Watershed 2 "Sloyer" Tributary

Table 2-3: Wiki Watershed Loads Calculations for Sub-Watershed 2

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	2,562	2,561	154
<i>Loading rates (lbs/ac)</i>	26	26	2
<i>Mean Annual Concentration (ppm)</i>	7	7	0
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.72	7	2
<i>Cropland</i>	0	77	10
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.08	4	0
<i>Medium-Density Mixed</i>	0.27	12	1
<i>High-Density Mixed</i>	0.10	4	0
<i>Low-Density Open Space</i>	0.09	5	0
<i>Farm Animals</i>	0	498	125
<i>Stream Bank Erosion</i>	0.02	0	0
<i>Subsurface Flow</i>	0	1,935	15
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	25	0
<b>TOTAL</b>	<b>1.28</b>	<b>2,567</b>	<b>154</b>

Sub-Watershed 2 is another watershed under tremendous development pressure and will more than likely be developed in the next 10-15 years with residential or commercial development. Looking at the surrounding watershed, all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 20 acres of Low-Density development, and 5 acres of Medium-Density development. We did not propose stream restoration in the developed area, but this could happen if the two farms in the watershed are developed because both have stream frontage on them.

Agricultural BMP Scenario:

Since neither of the farms in this watershed is in the Conservation District's PracticeKeeper system, we are left wondering if either of them has a conservation plan, nutrient management plan, or any other conservation practices on their operations. For this reason, all agricultural BMP's for this watershed scenario were proposed until they can be confirmed as being on the ground. This is also assuming this land stays in agricultural land use

in the future. That being stated, we proposed 48 acres of conservation planning and nutrient management planning on the farms, along with 1,000 ft. of streambank stabilization and 1,000 ft. of streambank fencing if animals were once again brought back to the farms. Finally, we assumed about 3.2 acres of buffers already exist on the ag lands and that 9 acres of new buffer could be added if the operations stay in agriculture. Also, for this model run, we had to add in 1 sheep since there are no animals in this watershed and the model did not pick up any forest land use so 0.01 acres of scrub/shrub was added to the watershed to get buffer numbers calculated in the model. If these numbers were not added, the model would not have functioned properly.

Table 2-4: Wiki Watershed Load Reductions for Sub-Watershed 2

	<b>ENTIRE WATERSHED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	2,381	2,562	154	2,379	603	138
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	428	8	1	428	8	1
Loads Removed w/ Existing Agricultural BMP's	-	383	94	-	383	94
Loads Removed w/ Proposed Agricultural BMP's	2,563	397	18	2,563	397	18
<b>TOTAL Loads Removed</b>	2,991	788	114	2,991	788	114
<b>New Reduced Load</b>	(610)	1,774	40	(612)	(185)	25
<b>Percent Reduction</b>	<b><u>126%</u></b>	<b><u>31%</u></b>	<b><u>74%</u></b>	<b><u>126%</u></b>	<b><u>131%</u></b>	<b><u>82%</u></b>
<b>TOTAL Baseline Load</b>	2,381	2,179	59	2,379	220	44
<b>TOTAL Loads Removed from Baseline</b>	2,991	405	19	2,991	405	19
<b>Percent Reduction from Baseline Load</b>	<b><u>126%</u></b>	<b><u>19%</u></b>	<b><u>32%</u></b>	<b><u>126%</u></b>	<b><u>185%</u></b>	<b><u>44%</u></b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 2-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 47 (Medium Priority)** – lat. 40.0291; long. -76.2472 (E. Lampeter Twp.)



Table 2-5: Existing, Proposed, and New BMP's Estimated Cost

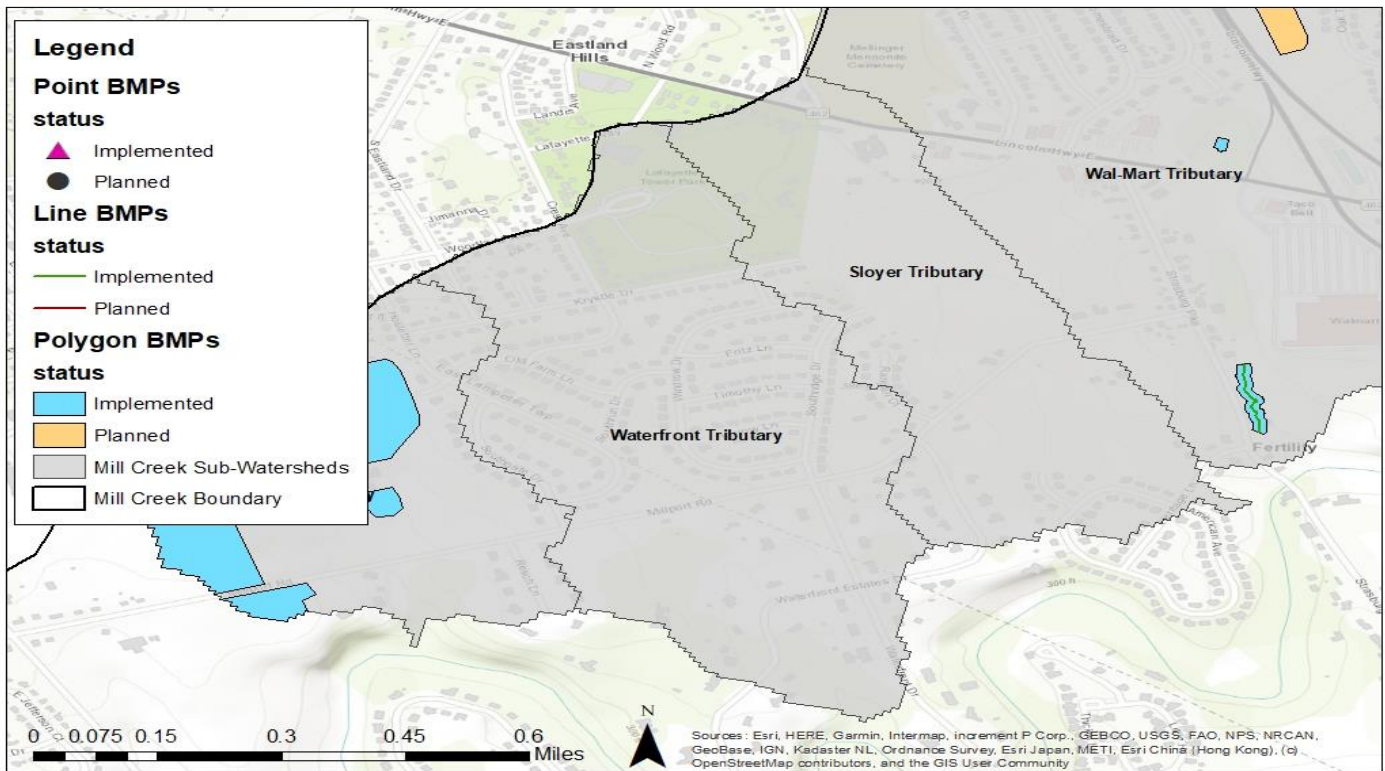
<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	0.4 ac	\$2,500	\$1,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Nutrient Management Plan	48 ac	\$8	\$384
Riparian buffer	18.6 ac	\$2,500	\$46,500
Cover Crop	48 ac	\$20	\$960
Green Infrastructure	25 ac	Varies	Varies
Stream bank Stabilization	1,000'	\$130	\$130,000
Streambank Fencing	1,000'	\$8	\$8,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$186,844</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional buffer and/or stormwater BMP work needed in this sub-watershed but with so many individual residential properties it was difficult to access and see every section of this tributary.



### Waterfront and Sloyer Tributaries BMPs



Map2-2: Completed & planned BMP's in the Sub-Watershed 2 according PracticeKeeper (2022)

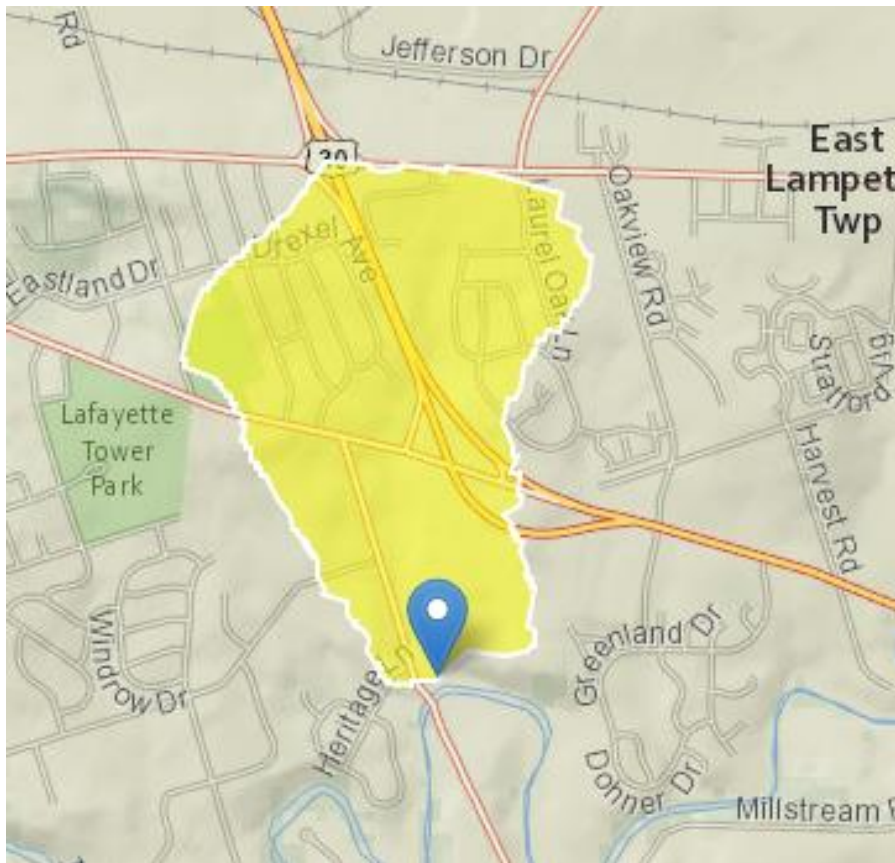
### Sub-Watershed 3 “Wal-Mart” Tributary

#### Priority Level 3

Sub-Watershed 3, the “Wal-Mart” Tributary, is a 0.77 square mile watershed located with headwaters north of Route 30 crossing under Lincoln Highway and entering Mill Cr. East of Strasburg Pike at Flory Park. The stream is a Warm Water Fishery NAHD named stream 0.67 miles long.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57464063	2050306004752	0.67	Site Clearance (Land Development or Redevelopment)	Siltation	High

The tributary is a mix of residential, commercial, and agricultural land uses. The one farm located in the headwaters of the watershed has a conservation plan and has been inspected by the Conservation District. There are no animals on the farm, so no nutrient management plan was needed for the operation. This tributary then goes through a large development before it travels under the Route 30 interchange and reemerges next to several commercial sites including a Wal-Mart. The stream then flows through a few residential properties before entering Mill Cr. in Flory Park. East Lampeter Township has conducted some stream restoration work on the bottom end of the tributary within Flory Park, completed in 2009. This includes bank regrading and riparian buffer installation.



Map 3-1: Stream Stat Map of Sub-Watershed 3

Table 3-1: Stream Stats Table for Sub-Watershed 3

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0267
Longitude of confluence	-76.2421
Mean basin slope in degrees	4.13°
Percent of basin with urban development	39.55%
Mean basin elevation	367 ft
Percent of area covered by forest	7.88%
Maximum basin elevation	418 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	81.23%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	30.25%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 3-2: Wiki Watershed Facts for Sub-Watershed 3

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Developed, Medium Intensity</i>	47.45	30.27
<i>Developed, Low Intensity</i>	46.34	29.56
<i>Developed, Open Space</i>	24.61	15.70
<i>Developed, High Intensity</i>	19.95	12.73
<i>Pasture/Hay</i>	8.87	5.66
<i>Shrub/Scrub</i>	3.33	2.12
<i>Cultivated Crops</i>	3.33	2.12
<i>Mixed Forest</i>	2.66	1.70
<i>Deciduous Forest</i>	0.22	0.14
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	100.66	64.21
<i>High Infiltration</i>	27.94	17.82
<i>Slow Infiltration</i>	18.18	11.60
<i>Medium/Very Slow Infiltration</i>	9.98	6.36
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	370 ft	
<i>Minimum</i>	298 ft	
<i>Maximum</i>	404 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	2,517	0
<i>Pigs/hogs/swine</i>	91	0
<i>Turkeys</i>	54	0
<i>Cows, dairy</i>	28	0
<i>Horses</i>	4	0
<i>Sheep</i>	2	0
<i>Chicken, layers</i>	1	0
<i>Cows, beef</i>	0	0





Photos of upper section of watershed and also a permeable pavement installation in the watershed



Photos of lower reaches of the watershed

Table 3-3: Wiki Watershed Loads Calculations for Sub-Watershed 3

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
Total loads (lbs)	24,678	3,477	250
Loading rates (lbs/ac)	157	22	2
Mean Annual Concentration (ppm)	42	6	0

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.70	7	2
<i>Cropland</i>	3.21	27	7
<i>Wooded Areas</i>	20	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.30	17	2
<i>Medium-Density Mixed</i>	1.50	64	7
<i>High-Density Mixed</i>	0.63	27	3
<i>Low-Density Open Space</i>	0.16	9	1
<i>Farm Animals</i>	0	830	208
<i>Stream Bank Erosion</i>	5.86	9	2
<i>Subsurface Flow</i>	0	2,344	19
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	151	0
<b>TOTAL</b>	<b>12.37</b>	<b>3,485</b>	<b>250</b>

Sub-Watershed 3 is yet another watershed under tremendous development pressure and will more than likely be developed in the next 10 years. Looking at the surrounding watershed, all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future and captures 2 existing Urban BMP's already on the ground. There was stream restoration done on the lower end of this sub-watershed by East Lampeter Township around 2009. In addition, one commercial development adjacent to Route 30 was required to put in a permeable parking lot around 2015, so both of these Urban BMP's were added to the model. Proposed Urban BMP's include riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 20 acres of Low-Density development, and 10 acres of Medium-Density development.

Agricultural BMP Scenario:

Since the one farm in this watershed has a conservation plan, practices no-till farming, has cover crops, and has no animals, all 3 acres of cropland were considered in conservation protection measures. For the model, we did have to put in 1 sheep animal unit for the model to function correctly. Since the farm in this watershed is only 3 acres in size and at the top of the watershed, no further agricultural BMP's were proposed for this operation currently or in the future. Finally, we are also proposing about 2,000 ft. of streambank stabilization measures.



Table 3-4: Wiki Watershed Load Reductions for Sub-Watershed 3

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	24,413	3,476	249	24,404	981	230
Loads Removed w/ Existing Urban BMP's	57,872	99	87	57,872	99	87
Loads Removed w/ Proposed Urban BMP's	3,101	15	2	3,101	15	2
Loads Removed w/ Existing Agricultural BMP's	3,268	990	165	3,268	990	165
Loads Removed w/ Proposed Agricultural BMP's	-	-	-	-	-	-
<b>TOTAL Loads Removed</b>	64,242	1,104	254	64,242	1,104	254
<b>New Reduced Load</b>	(39,829)	2,372	(5)	(39,837)	(124)	(24)
<b>Percent Reduction</b>	<b>263%</b>	<b>32%</b>	<b>102%</b>	<b>263%</b>	<b>113%</b>	<b>111%</b>
<b>TOTAL Baseline Load</b>	(36,728)	2,387	(3)	(36,736)	(109)	(22)
<b>TOTAL Loads Removed from Baseline</b>	3,101	15	2	3,101	15	2
<b>Percent Reduction from Baseline Load</b>	<b>-8%</b>	<b>1%</b>	<b>-59%</b>	<b>-8%</b>	<b>-14%</b>	<b>-9%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 3-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 48 (High-Medium Priority)** – lat. 40.0278; long. -76.2429 (E. Lampeter Twp.)

Table 3-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	1.6 ac	\$2,500	\$4,025
Stream bank Stabilization	2,000'	\$130	\$260,000

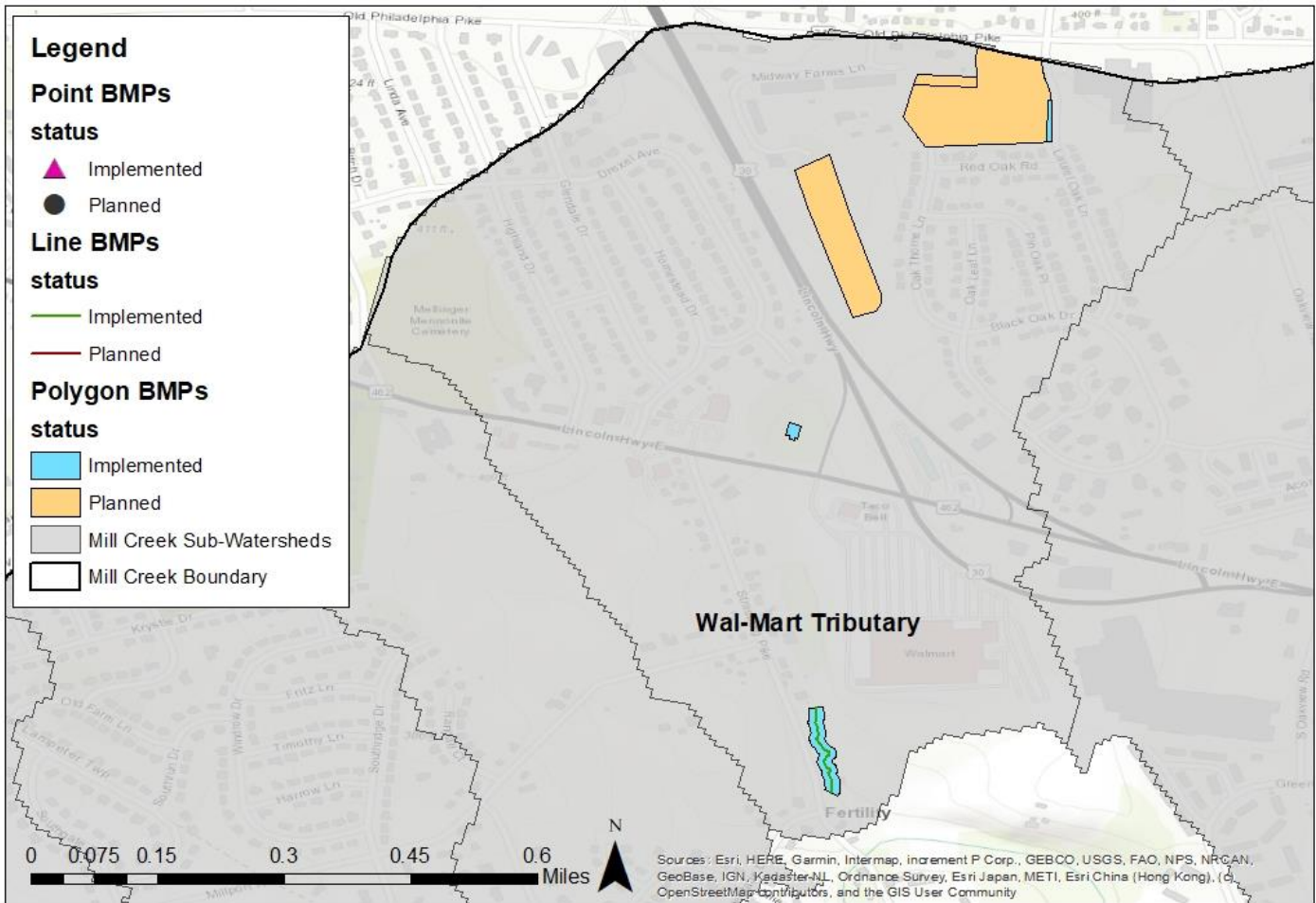
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	8.4 ac	\$2,500	\$21,000
Green Infrastructure	30 ac	Varies	Varies
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$285,025</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional buffer and/or stormwater BMP work needed in this sub-watershed but with so many individual residential properties it was difficult to access and see every section of this tributary.



### Wal-Mart Tributary BMPs



Map3-2: Completed & planned BMP's in the Sub-Watershed 3 according PracticeKeeper (2022)

**Sub-Watershed 3A “East Town Mall” Tributary**

**Priority Level 4**

Sub-Watershed 3A, the “East Town Mall” Tributary, is a 0.26 square mile watershed located east of the Route 30 interchange. The stream is not a NAHD named stream and predominately is an interment stream. The tributary is a mix of residential and commercial land uses. There are no farms in the watershed so the Wiki Watershed animal and ag numbers should be reviewed. There are lots of impervious surfaces within this watershed along with development, so stormwater influences are high in this watershed.



*Map 3A-1: Stream Stat Map of Sub-Watershed 3A*

*Table 3A-1: Stream Stats Table for Sub-Watershed 3A*

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0235
Longitude of confluence	-76.2333
Mean basin slope in degrees	2.94°
Percent of basin with urban development	48.77%
Mean basin elevation	360 ft
Percent of area covered by forest	5.19%
Maximum basin elevation	409 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	87.19%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	39.87%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 3A-2: Wiki Watershed Facts for Sub-Watershed 3A

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Developed, Medium Intensity</i>	23.95	28.88
<i>Developed, High Intensity</i>	21.73	26.20
<i>Developed, Low Intensity</i>	21.28	25.67
<i>Developed, Open Space</i>	7.98	9.63
<i>Pasture/Hay</i>	7.76	9.36
<i>Mixed Forest</i>	0.22	0.27
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Slow Infiltration</i>	53.65	64.71
<i>Moderate Infiltration</i>	17.07	20.59
<i>Very Slow Infiltration</i>	12.19	14.71
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	350 ft	
<i>Minimum</i>	299 ft	
<i>Maximum</i>	382 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,305	0
<i>Pigs/hogs/swine</i>	47	0
<i>Turkeys</i>	28	0
<i>Cows, dairy</i>	14	0
<i>Horses</i>	2	0
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	0



Photo of Sub-Watershed 3A “East Town Mall” Tributary

Table 3A-3: Wiki Watershed Loads Calculations for Sub-Watershed 3A

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	3,253	1,474	121
<i>Loading rates (lbs/ac)</i>	40	18	1
<i>Mean Annual Concentration (ppm)</i>	11	5	0
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.14	6	2
<i>Cropland</i>	0	0	0
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.15	9	1
<i>Medium-Density Mixed</i>	0.65	32	3
<i>High-Density Mixed</i>	0.39	29	3
<i>Low-Density Open Space</i>	0.06	3	0
<i>Farm Animals</i>	0	416	105
<i>Stream Bank Erosion</i>	0.04	0	0
<i>Subsurface Flow</i>	0	908	8
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	74	0
<b>TOTAL</b>	<b>1.43</b>	<b>1,477</b>	<b>122</b>

Sub-Watershed 3A is completely built out with development so everything done in this watershed would have to retrofit existing infrastructure. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 15 acres of Low-Density development, and 10 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 300 ft. of existing development at the bottom end of the watershed. The developer has reached out to the District and the Township about this potential project in the past so, this is a possibility.

Agricultural BMP Scenario:

Since there are no farms in this watershed, no ag BMP's were proposed in the model. Also, cropland acreage of 0.01 needed to be added along one sheep animal unit to have the model work correctly in this watershed.



Table 3A-4: Wiki Watershed Load Reductions for Sub-Watershed 3A

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	2,746	1,473	121	2,751	492	114
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	35,200	72	54	35,200	72	54
Loads Removed w/ Existing Agricultural BMP's	-	312	79	-	312	79
Loads Removed w/ Proposed Agricultural BMP's	-	-	-	-	-	-
<b>TOTAL Loads Removed</b>	35,200	384	132	35,200	384	132
<b>New Reduced Load</b>	(32,454)	1,090	(11)	(32,449)	108	(19)
<b>Percent Reduction</b>	<b>1,282%</b>	<b>25%</b>	<b>109%</b>	<b>1,280%</b>	<b>78%</b>	<b>116%</b>
<b>TOTAL Baseline Load</b>	2,746	1,161	43	2,751	180	35
<b>TOTAL Loads Removed from Baseline</b>	35,200	72	54	35,200	72	54
<b>Percent Reduction from Baseline Load</b>	<b>1,282%</b>	<b>6%</b>	<b>126%</b>	<b>1,280%</b>	<b>40%</b>	<b>153%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 3A-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

Table 3A-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			

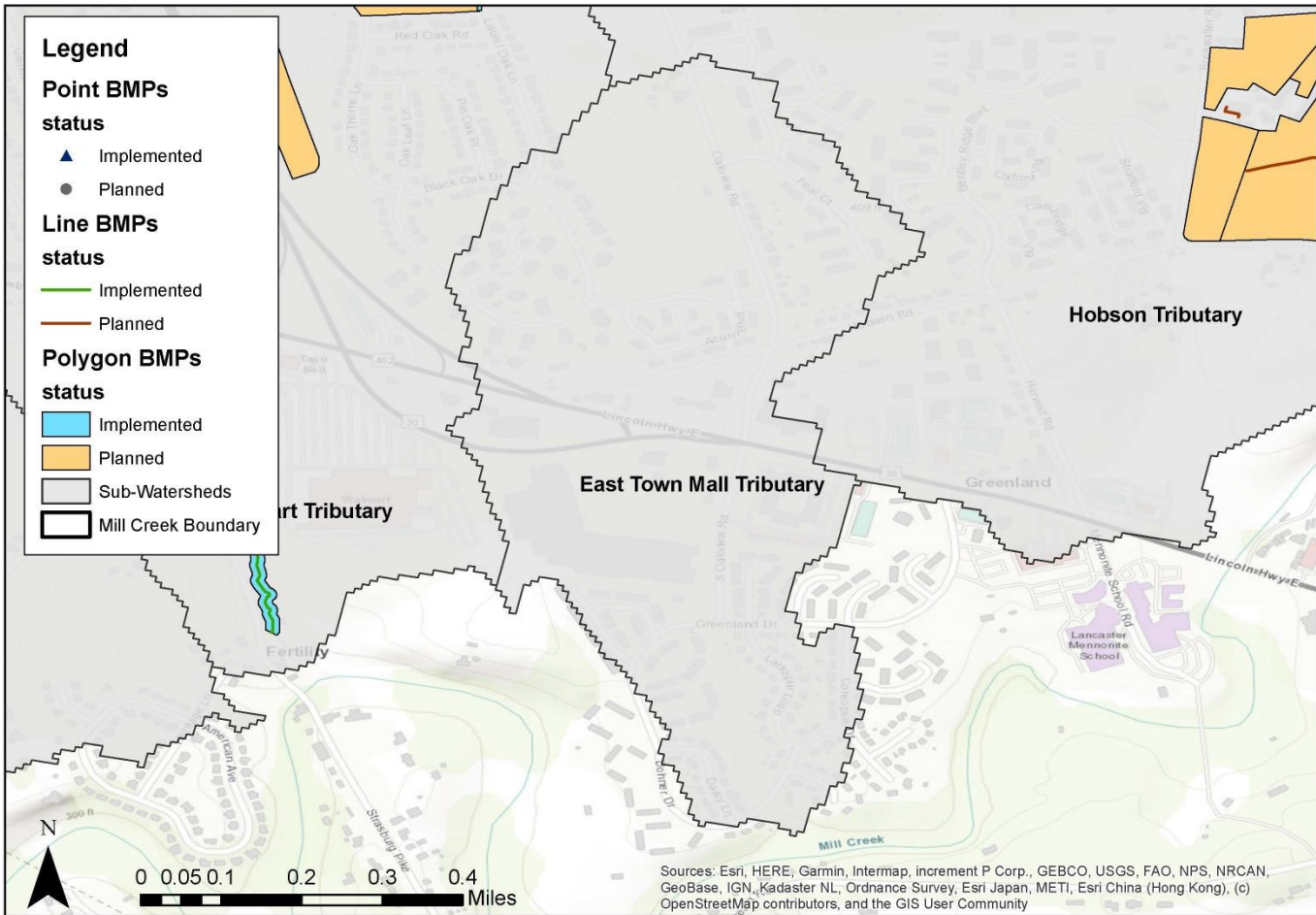
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	10 ac	\$2,500	\$25,000
Green Infrastructure	25 ac	Varies	Varies
Stream bank Stabilization	300'	\$130	\$39,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$64,000</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional buffer and/or stormwater BMP work needed in this sub-watershed but with so many individual residential properties it was difficult to access and see every section of this tributary.



## East Town Mall Tributary BMPs

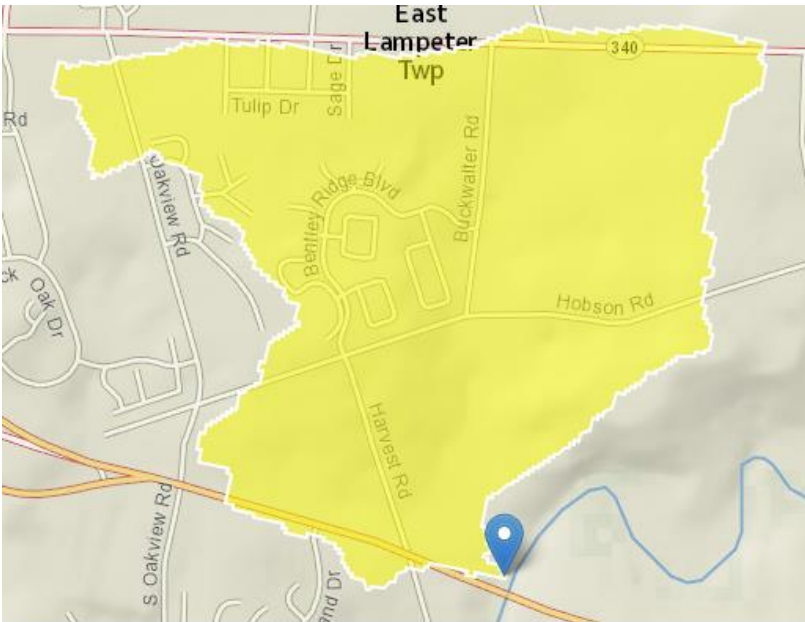


Map3A-2: Completed & planned BMP's in the Sub-Watershed 3A according PracticeKeeper (2022)

## Sub-Watershed 4 “Hobson” Tributary

### Priority Level 1

Sub-Watershed 4, the “Hobson” Tributary, is a 0.49 square mile watershed located north of Route 30 and South of Route 340. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential and agricultural land uses. There are two main farms in the watershed. One has a Conservation and Plan and Nutrient management Plan but not all aspects are implemented. The other farm does not have either plan according to Conservation District records. There are also lots of residential units in the watershed contributing stormwater to the tributary.



Map 4-1: Stream Stat Map of Sub-Watershed 4

Table 4-1: Stream Stats Table for Sub-Watershed 4

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0288
Longitude of confluence	-76.2255
Mean basin slope in degrees	2.54°
Percent of basin with urban development	35.46%
Mean basin elevation	367 ft
Percent of area covered by forest	3.74%
Maximum basin elevation	408 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	73.71%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	25.96%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 4-2: Wiki Watershed Facts for Sub-Watershed 4

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	39.47	26.61
<i>Developed, Open Space</i>	35.70	24.07
<i>Developed, Low Intensity</i>	34.14	23.02
<i>Pasture/Hay</i>	19.29	13.00
<i>Developed, Medium Intensity</i>	13.75	9.27
<i>Developed, High Intensity</i>	2.00	1.35
<i>Grassland/Herbaceous</i>	2.00	1.35
<i>Shrub/Scrub</i>	1.55	1.05
<i>Barren Land (Rock/Sand/Clay)</i>	0.44	0.30
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	103.98	70.10
<i>Slow Infiltration</i>	31.04	20.93
<i>Medium/Very Slow Infiltration</i>	8.87	5.98
<i>High Infiltration</i>	4.43	2.99
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	361 ft	
<i>Minimum</i>	304 ft	
<i>Maximum</i>	401 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	2,380	0
<i>Pigs/hogs/swine</i>	86	0
<i>Turkeys</i>	51	0
<i>Cows, dairy</i>	26	2
<i>Horses</i>	3	4
<i>Sheep</i>	2	0
<i>Chicken, layers</i>	1	15,000
<i>Cows, beef</i>	0	0

\*numbers for one farm, but there are two farms in the watershed



Photos of Sub-Watershed 4 "Hobson" Tributary

Table 4-3: Wiki Watershed Loads Calculations for Sub-Watershed 4

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	105,379	4,249	331
<i>Loading rates (lbs/ac)</i>	708	29	2
<i>Mean Annual Concentration (ppm)</i>	213	9	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	1.72	22	7
<i>Cropland</i>	50.07	382	103
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0.07	1	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.21	11	1
<i>Medium-Density Mixed</i>	0.42	16	2
<i>High-Density Mixed</i>	0.06	2	0
<i>Low-Density Open Space</i>	0.22	12	1
<i>Farm Animals</i>	0	769	194
<i>Stream Bank Erosion</i>	0.03	0	0
<i>Subsurface Flow</i>	0	3,000	23
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	42	0
<b>TOTAL</b>	<b>53</b>	<b>4,258</b>	<b>332</b>

Sub-Watershed 4 has development in the headwaters and along the western edge of the watershed. The rest of the watershed is dominated by two large agricultural operations. Although there is development pressure on these farms, they seem to be fairly stable and do not appear to be threatened by this so we believe they will stay in ag production for the near future. For this reason, we proposed both Green Infrastructure BMP's within this watershed for the future and agricultural BMP's as well. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, and conservation planning and nutrient management planning efforts are needed on the farm operations. Because this is a Priority Level 1 Watershed, the goal would be an 80% implementation rate with the BMP's proposed in this watershed to achieve documented load reductions.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 5 acres in the developed areas, Green Infrastructure approaches on 25 acres of Low-Density development, and 5 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 300 ft. of the farm that will be developed in the future.

Agricultural BMP Scenario:

Since the District only has conservation information from one of the farms presently, we are left to assume additional conservation efforts are needed in the watershed. Such as additional conservation and nutrient management planning efforts for about 19 acres. We are also proposing an additional 11.5 acres of riparian buffer implementation, along with 3,000 ft of streambank fencing, and 2,125 ft. of streambank stabilization measures. The stream corridor on both of these farms is highly visible and needs serious conservation attention.

Table 4-4: Wiki Watershed Load Reductions for Sub-Watershed 4

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> <i>(lbs/yr)</i>	<i>TN</i> <i>(lbs/yr)</i>	<i>TP</i> <i>(lbs/yr)</i>	<i>Sediment</i> <i>(lbs/yr)</i>	<i>TN</i> <i>(lbs/yr)</i>	<i>TP</i> <i>(lbs/yr)</i>
Initial MMW Load	105,178	4,246	331	105,172	1,204	308
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	34,924	65	53	35,924	65	53
Loads Removed w/ Existing Agricultural BMP's	25,902	495	114	25,902	495	114
Loads Removed w/ Proposed Agricultural BMP's	92,882	684	118	92,882	684	118
<b>TOTAL Loads Removed</b>	153,708	1,244	284	153,708	1,244	284
<b>New Reduced Load</b>	(48,530)	3,003	46	(48,536)	(40)	23
<b>Percent Reduction</b>	<b>146%</b>	<b>29%</b>	<b>86%</b>	<b>146%</b>	<b>103%</b>	<b>92%</b>
<b>TOTAL Baseline Load</b>	79,275	3,751	217	79,269	709	194
<b>TOTAL Loads Removed from Baseline</b>	127,806	749	171	127,806	749	171
<b>Percent Reduction from Baseline Load</b>	<b>161%</b>	<b>20%</b>	<b>79%</b>	<b>161%</b>	<b>106%</b>	<b>88%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future



***\*\*Modeling Caveat\*\****

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 4-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **\*Site # 67 (High Priority)** – lat. 40.0354; long. -76.2259 (E. Lampeter Twp.)
- **Site # 66 (Medium Priority)** – lat. 40.0315; long. -76.2266 (E. Lampeter Twp.)

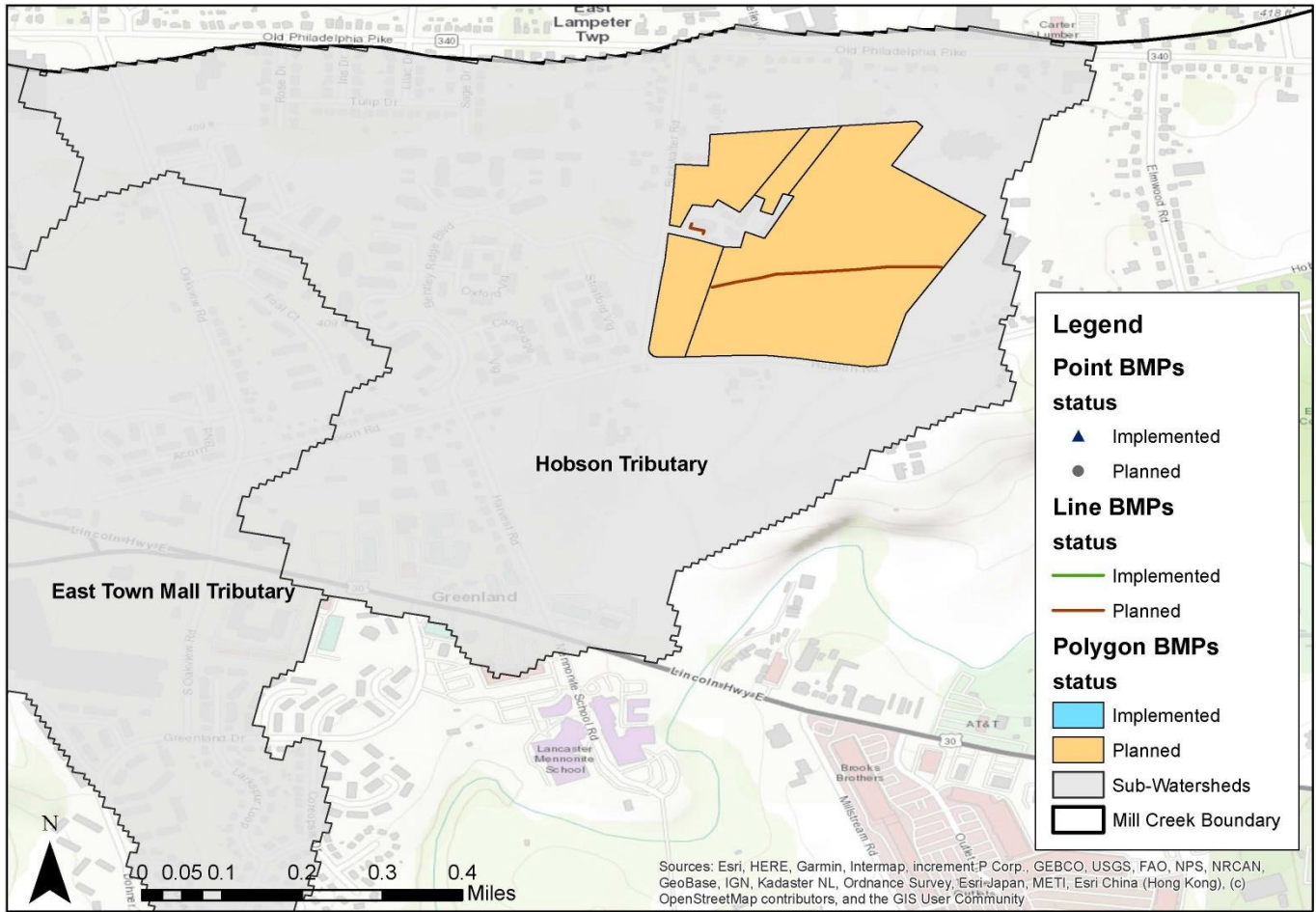
\*denotes project with partially completed BMP's since the 2006 WIP

*Table 4-5: Existing, Proposed, and New BMP's Estimated Cost*

<b><u>BMP's Installed Since the 2006 WIP (Existing)</u></b>	<b><u>Units Installed</u></b>	<b><u>Estimated Cost/Unit</u></b>	<b><u>Cost</u></b>
Nutrient management plan	30 ac	\$8	\$240
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$240</b>
<b><u>BMP's to be Installed From the 2006 WIP (Proposed)</u></b>			
Streambank Fencing	1,400'	\$8	\$11,200
Riparian buffer	2.2 ac	\$2,500	\$5,500
Barnyard runoff controls	1	\$22,000	\$22,000
Waste storage system	1	\$80,000	\$80,000
Stream bank stabilization	2,125'	\$130	\$276,250
<b><u>Additional Future Proposed BMP's (NEW)</u></b>			
Riparian buffer	14.3 ac	\$2,500	\$35,750
Green Infrastructure	30 ac	Varies	Varies
Nutrient Management Plans	19 ac	\$8	\$152
Streambank Fencing	1,600'	\$8	\$12,800
Cover Crop	19 ac	\$20	\$380
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$444,032</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

# Hobson Tributary BMPs



Map4-2: Completed & planned BMP's in the Sub-Watershed 4 according PracticeKeeper (2022)

## Sub-Watershed 4A “Smoketown” Tributary

### Priority Level 4

Sub-Watershed 4A, the “Smoketown” Tributary, is a 0.19 square mile watershed located along Route 340 West of Smoketown. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential, commercial, industrial, and agricultural land uses. There are several small farms in the watershed but it is mostly dominated by commercial and residential land uses along with the Route 340 corridor.



Map 4A-1: Stream Stat Map of Sub-Watershed 4A

Table 4A-1: Stream Stats Table for Sub-Watershed 4A

<u>Stream STATS Facts</u>	
Latitude of confluence	40.0382
Longitude of confluence	-76.1952
Mean basin slope in degrees	2.37°
Percent of basin with urban development	67.85%
Mean basin elevation	373 ft
Percent of area covered by forest	0.61%
Maximum basin elevation	407 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	86.96%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	33.71%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 4A-2: Wiki Watershed Facts for Sub-Watershed 4A

<u>Wiki Watersheds Facts</u>		
<u>LAND USE</u>	<u>ACRES</u>	<u>%</u>
<i>Developed, Medium Intensity</i>	16.85	26.39
<i>Developed, Low Intensity</i>	16.19	25.35
<i>Developed, Open Space</i>	15.08	23.61
<i>Cultivated Crops</i>	9.53	14.93
<i>Developed, High Intensity</i>	5.76	9.03
<i>Mixed Forest</i>	0.44	0.69

<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	52.77	82.64
<i>High Infiltration</i>	9.76	15.28
<i>Medium/Very Slow Infiltration</i>	1.11	1.74
<i>Slow Infiltration</i>	0.22	0.35
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	359 ft	
<i>Minimum</i>	319 ft	
<i>Maximum</i>	380 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,012	0
<i>Pigs/hogs/swine</i>	36	0
<i>Turkeys</i>	21	0
<i>Cows, dairy</i>	11	0
<i>Horses</i>	1	0
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	0



Photo of Sub-Watershed 4A "Smoketown" Tributary

Table 4A-3: Wiki Watershed Loads Calculations for Sub-Watershed 4A

<b><u>SOURCES</u></b>	<b><u>Loads</u></b>		
	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	23,511	1,161	113
<i>Loading rates (lbs/ac)</i>	371	18	2
<i>Mean Annual Concentration (ppm)</i>	106	5	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u> <u>(tons)</u></b>	<b><u>TOTAL NITROGEN</u> <u>(lbs)</u></b>	<b><u>TOTAL</u> <u>PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0	0	0
<i>Cropland</i>	10.83	81	23
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.10	6	1
<i>Medium-Density Mixed</i>	0.54	22	2
<i>High-Density Mixed</i>	0.18	8	1
<i>Low-Density Open Space</i>	0.10	5	1
<i>Farm Animals</i>	0	320	80
<i>Stream Bank Erosion</i>	0.03	0	0
<i>Subsurface Flow</i>	0	670	6
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	53	0
<b>TOTAL</b>	<b>12</b>	<b>1,163</b>	<b>113</b>

Sub-Watershed 4A is under development pressure being at the intersection of two busy roads - Route 340 and Route 896. It is anticipated that this area will be developed in the next 10 years with some sort of commercial development. Looking at the surrounding watershed, all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 5 acres in the developed areas, Green Infrastructure approaches on 20 acres of Low-Density development, and 10 acres of Medium-Density development.

Agricultural BMP Scenario:

The few farms that are currently in this watershed have conservation and nutrient management plans and all other conservation practices are fully implemented. If by chance the farms would stay in agriculture in the future, we proposed about 2.3 acres of additional riparian buffer from what is already there. All of this could go away again if the farm is developed, which is expected in the future. On a side note to make the model run for this watershed 0.01 acres of hay/pastureland was added along with 1 sheep animal unit since there are no animals in the watershed currently.



Table 4A-4: Wiki Watershed Load Reductions for Sub-Watershed 4A

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	23,370	1,158	112	23,373	436	106
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	700	12	1	700	12	1
Loads Removed w/ Existing Agricultural BMP's	11,033	391	84	11,033	391	84
Loads Removed w/ Proposed Agricultural BMP's	10,855	51	10	10,855	51	10
<b>TOTAL Loads Removed</b>	22,588	454	96	22,588	454	96
<b>New Reduced Load</b>	782	704	17	784	(18)	11
<b>Percent Reduction</b>	<b>97%</b>	<b>39%</b>	<b>85%</b>	<b>97%</b>	<b>104%</b>	<b>90%</b>
<b>TOTAL Baseline Load</b>	12,337	767	28	12,339	45	22
<b>TOTAL Loads Removed from Baseline</b>	11,555	63	11	11,555	63	11
<b>Percent Reduction from Baseline Load</b>	<b>94%</b>	<b>8%</b>	<b>40%</b>	<b>94%</b>	<b>141%</b>	<b>51%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 4A-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

Table 4A-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			

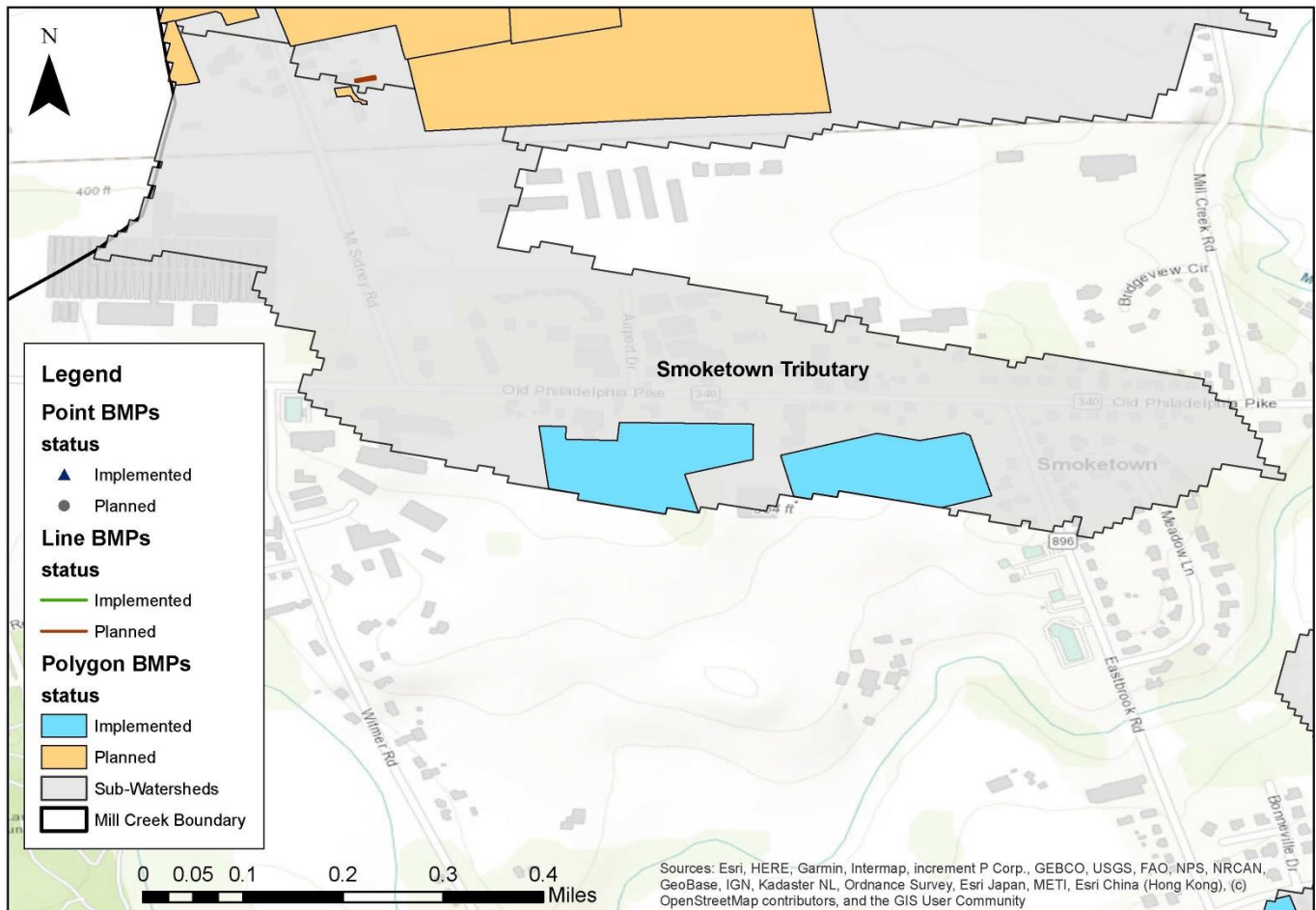
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	7.3 ac	\$2,500	\$18,250
Green Infrastructure	30 ac	Varies	Varies
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$18,250</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional buffer and/or stormwater BMP work needed in this sub-watershed but with so many individual residential properties it was difficult to access and see every section of this tributary.



## Smoketown Tributary BMPs



Map4A-2: Completed & planned BMP's in the Sub-Watershed 4A according PracticeKeeper (2022)

## Sub-Watershed 4B “Millcreek Road” Tributary

### Priority Level 2

Sub-Watershed 4B, the “Millcreek Road” Tributary, is a 0.41 square mile watershed located west of Millcreek Rd., east of Mt. Sidney Rd., and north of the Amtrak rail line. The stream is not a NAHD named stream and predominately is an intermittent stream. The majority of the tributary is agricultural with a small mix of residential areas. Most of the farms in this tributary area have conservation plans and nutrient management plans as well and most of these plans are implemented too.



Map 4B-1: Stream Stat Map of Sub-Watershed 4B

Table 4B-1: Stream Stats Table for Sub-Watershed 4B

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0447
Longitude of confluence	-76.1956
Mean basin slope in degrees	2.90°
Percent of basin with urban development	9.79%
Mean basin elevation	385 ft
Percent of area covered by forest	2.22%
Maximum basin elevation	429 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	15.24%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	3.66%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 4B-2: Wiki Watershed Facts for Sub-Watershed 4B

<b>Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	150.99	92.65
<i>Developed, Open Space</i>	4.66	2.86
<i>Developed, Low Intensity</i>	3.77	2.31
<i>Developed, Medium Intensity</i>	2.22	1.36
<i>Pasture/Hay</i>	0.89	0.54
<i>Developed, High Intensity</i>	0.44	0.27
<b>SOILS</b>	<b>ACRES</b>	<b>%</b>
<i>Moderate Infiltration</i>	146.55	89.93
<i>Slow Infiltration</i>	15.74	9.66
<i>Medium/Very Slow Infiltration</i>	0.67	0.41
<b>ELEVATION</b>	<b>FEET</b>	
<i>Average</i>	373 ft	
<i>Minimum</i>	327 ft	
<i>Maximum</i>	406 ft	
<b>ANIMALS</b>	<b>NUMBERS</b>	<b>Numbers According to PK</b>
<i>Chicken, broilers</i>	2,634	0
<i>Pigs/hogs/swine</i>	96	0
<i>Turkeys</i>	57	0
<i>Cows, dairy</i>	29	199
<i>Horses</i>	4	9
<i>Sheep</i>	2	0
<i>Chicken, layers</i>	1	9
<i>Cows, beef</i>	0	0



Photo of Sub-Watershed 4B "Millcreek Road" Tributary

Table 4B-3: Wiki Watershed Loads Calculations for Sub-Watershed 4B

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	339,788	5,216	619
<i>Loading rates (lbs/ac)</i>	2,063	32	4
<i>Mean Annual Concentration (ppm)</i>	562	9	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.08	1	0
<i>Cropland</i>	167.85	1,397	379
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.02	1	0
<i>Medium-Density Mixed</i>	0.08	3	0
<i>High-Density Mixed</i>	0.02	1	0
<i>Low-Density Open Space</i>	0.02	1	0
<i>Farm Animals</i>	0	862	217
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	2,955	24
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	7	0
<b>TOTAL</b>	<b>168</b>	<b>5,228</b>	<b>620</b>

Sub-Watershed 4B is just outside the urban growth area of East Lampeter Township, so the development pressure in this area is much less compared to other sub-watersheds. For this reason, we proposed only agricultural BMP's within this watershed for the future such as buffers and some stream restoration work. Since this watershed is mostly cropland with only a swale going through most areas, it is difficult to model for streambank fencing and larger buffer areas with no defined stream channel on the properties in question.

Urban BMP Scenario:

No Urban BMP's were proposed for this watershed or scenario due to its ag land use.

Agricultural BMP Scenario:

Since all the farms in this watershed have conservation and nutrient management plans already in place, limited additional ag BMP's are proposed in this watershed. We proposed additional buffer implementation of 1.2 acres and some streambank stabilization measures at the bottom end of the watershed where there is a more defined bed and bank of about 500 ft. worth. 0.01 of scrub/shrub forest was added to this sub-watershed to make the model work since this land use did not show up on the model run initially.



Table 4B-4: Wiki Watershed Load Reductions for Sub-Watershed 4B

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	336,103	5,227	620	336,108	2,265	596
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	171,203	1,970	559	171,203	1,970	559
Loads Removed w/ Proposed Agricultural BMP's	5,318	28	5	5,318	28	5
<b>TOTAL Loads Removed</b>	176,521	1,998	564	176,521	1,998	564
<b>New Reduced Load</b>	159,582	3,229	56	159,587	267	33
<b>Percent Reduction</b>	<b>53%</b>	<b>38%</b>	<b>91%</b>	<b>53%</b>	<b>88%</b>	<b>95%</b>
<b>TOTAL Baseline Load</b>	164,900	3,257	61	164,904	295	38
<b>TOTAL Loads Removed from Baseline</b>	5,318	28	5	5,318	28	5
<b>Percent Reduction from Baseline Load</b>	<b>3%</b>	<b>1%</b>	<b>8%</b>	<b>3%</b>	<b>10%</b>	<b>14%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 4B-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

Table 4B-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			

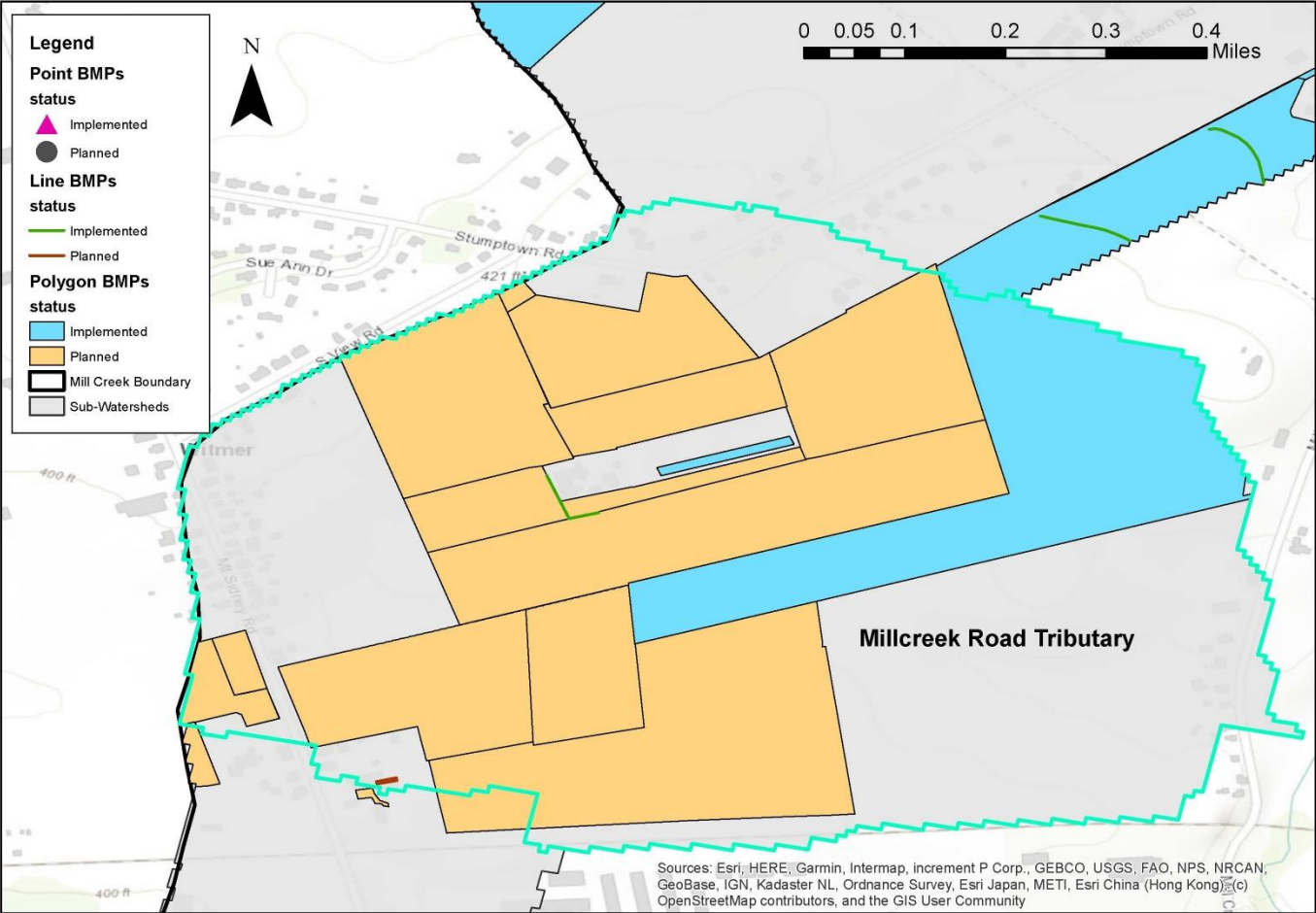
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	1.2 ac	\$2,500	\$3,000
Stream bank Stabilization	500'	\$130	\$65,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$68,000</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.



### Millcreek Road Tributary BMPs



Map4B-2: Completed & planned BMP's in the Sub-Watershed 4B according PracticeKeeper (2022)

## Sub-Watershed 4C “Beechdale” Tributary

### Priority Level 2

Sub-Watershed 4C, the “Beechdale” Tributary, is a 0.54 square mile watershed located northwest of Stumptown & Beechdale Road intersection. The stream is not a NAHD named stream and predominately is an intermittent stream. The majority of the tributary is agricultural with a small mix of residential as well. About 1/3 of the farms in the watershed have conservation and nutrient management plans. The remaining ones will need to be created in the future or verify that a plan exists for the operation.



Map 4C-1: Stream Stat Map of Sub-Watershed 4C

Table 4C-1: Stream Stats Table for Sub-Watershed 4C

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0540
Longitude of confluence	-76.1931
Mean basin slope in degrees	2.77°
Percent of basin with urban development	0.07%
Mean basin elevation	384 ft
Percent of area covered by forest	0.07%
Maximum basin elevation	429 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	7.36%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.82%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 4C-2: Wiki Watershed Facts for Sub-Watershed 4C

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	88.24	47.78
<i>Pasture/Hay</i>	74.27	40.22
<i>Developed, Open Space</i>	10.86	5.88
<i>Developed, Low Intensity</i>	8.43	4.56
<i>Developed, Medium Intensity</i>	2.88	1.56
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	159.19	86.19
<i>Slow Infiltration</i>	13.08	7.08
<i>Medium/Very Slow Infiltration</i>	12.42	6.72
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	380 ft	
<i>Minimum</i>	331 ft	
<i>Maximum</i>	427 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	2,948	45,000
<i>Pigs/hogs/swine</i>	107	0
<i>Turkeys</i>	63	0
<i>Cows, dairy</i>	33	66
<i>Horses</i>	4	7
<i>Sheep</i>	3	0
<i>Chicken, layers</i>	1	0
<i>Cows, beef</i>	0	0

\*Farms listed in PK, still some farms missing data



Photos of lower section of Sub-Watershed 4C "Beechdale" Tributary





Photos of upper section of Sub-Watershed 4C “Beechdale” Tributary

Table 4C-3: Wiki Watershed Loads Calculations for Sub-Watershed 4C

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	207,046	5,570	495
<i>Loading rates (lbs/ac)</i>	1,123	30	3
<i>Mean Annual Concentration (ppm)</i>	367	10	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
	<b><u>(tons)</u></b>	<b><u>(lbs)</u></b>	<b><u>(lbs)</u></b>
<i>Hay/Pasture</i>	6.07	52	18
<i>Cropland</i>	97.43	699	204
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.06	3	0
<i>Medium-Density Mixed</i>	0.12	4	0
<i>High-Density Mixed</i>	0	0	0
<i>Low-Density Open Space</i>	0.07	4	0
<i>Farm Animals</i>	0	969	243
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	3,842	30
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	11	0
<b>TOTAL</b>	<b>104</b>	<b>5,583</b>	<b>496</b>



Sub-Watershed 4C is mostly all agriculture in land use. There are a couple of residential units scattered among this area but no urban areas. For this reason, we are proposing only agricultural BMP's for this sub-watershed now and in the future.

Urban BMP Scenario:

No urban BMP's were modeled for this watershed.

Agricultural BMP Scenario:

Since only about 1/3 of the farms in this sub-watershed have registered conservation and nutrient management plans with the District, we are left to assume the remaining farms do not have these plans currently and they are not practicing additional conservation practices at this time. For this reason, the following scenarios were modeled to achieve reduction totals. 28 acres of conservation planning, nutrient management planning, and conservation tillage practices are currently being implemented in this watershed. An additional 62 acres of these practices will need to be implemented in the future to achieve the reductions desired. Only 2.3 acres of riparian buffer was proposed since the majority of the stream corridor is a swale among cropland with limited area for buffers or streambank fencing and restoration efforts. Finally, because the model did not have any forest land use detected 0.01 acres of scrub/shrub was added to make the model work for this sub watershed.

Table 4C-4: Wiki Watershed Load Reductions for Sub-Watershed 4C

	<b>ENTIRE WATERHSED</b>				<b>URBAN AREA</b>		
	<u>Sediment</u> <i>(lbs/yr)</i>	<u>TN</u> <i>(lbs/yr)</i>	<u>TP</u> <i>(lbs/yr)</i>		<u>Sediment</u> <i>(lbs/yr)</i>	<u>TN</u> <i>(lbs/yr)</i>	<u>TP</u> <i>(lbs/yr)</i>
Initial MMW Load	207,373	5,579	495		207,374	1,727	467
Loads Removed w/ Existing Urban BMP's	-	-	-		-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-		-	-	-
Loads Removed w/ Existing Agricultural BMP's	29,303	542	108		29,303	542	108
Loads Removed w/ Proposed Agricultural BMP's	80,429	763	161		80,429	763	161
<b>TOTAL Loads Removed</b>	109,733	1,305	269		109,733	1,305	269
<b>New Reduced Load</b>	97,641	4,275	226		97,461	422	197
<b>Percent Reduction</b>	<b>53%</b>	<b>23%</b>	<b>54%</b>		<b>53%</b>	<b>76%</b>	<b>58%</b>
<b>TOTAL Baseline Load</b>	178,070	5,037	387		178,070	1,185	358
<b>TOTAL Loads Removed from Baseline</b>	80,429	763	161		80,429	763	161
<b>Percent Reduction from Baseline Load</b>	<b>45%</b>	<b>15%</b>	<b>42%</b>		<b>45%</b>	<b>64%</b>	<b>45%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 4C-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation

efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

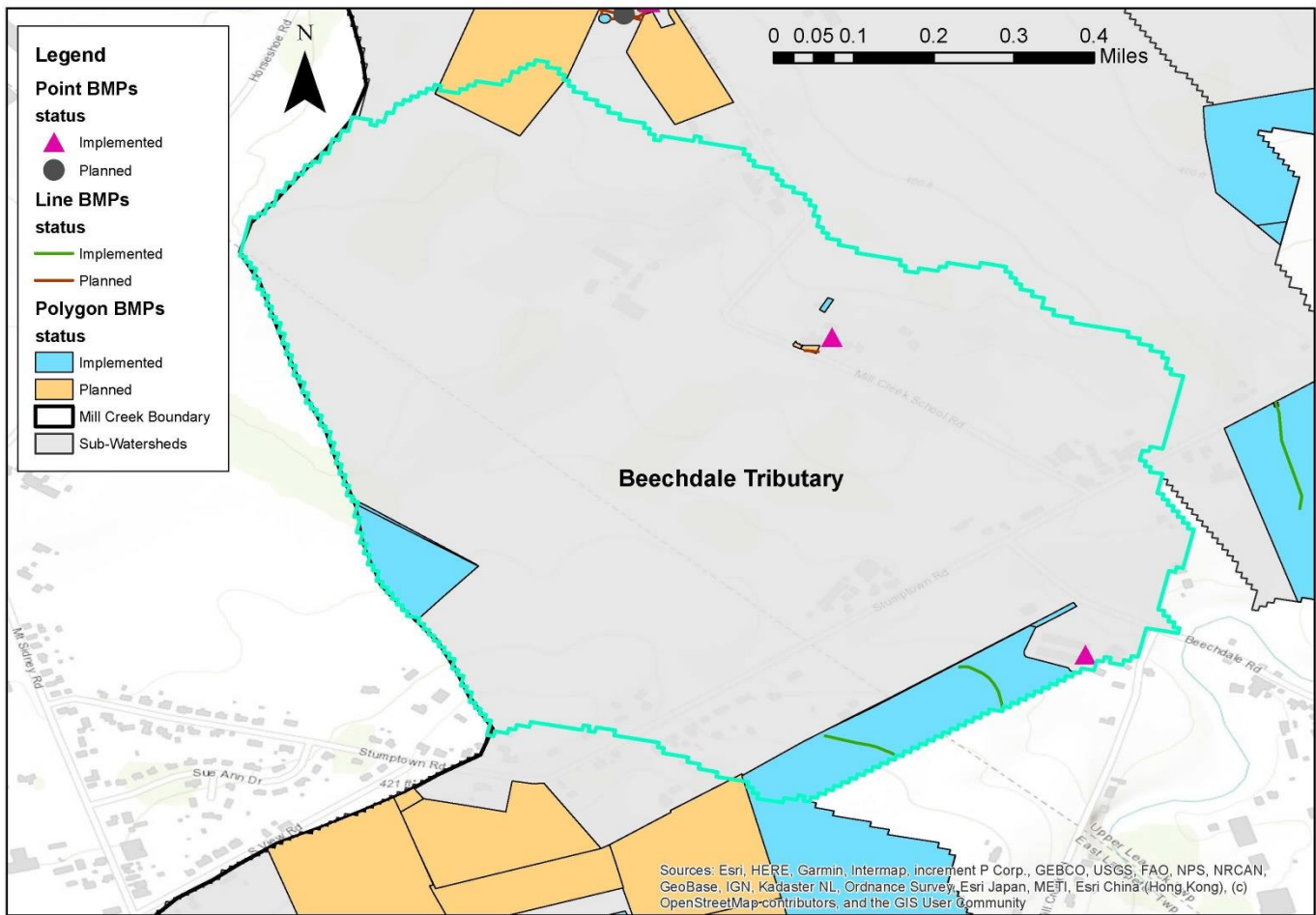
Table 4C-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	2.3 ac	\$2,500	\$5,750
Nutrient Management Plan	62 ac	\$8	\$496
Cover Crop	62 ac	\$20	\$1,240
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$7,486</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.

# Beechdale Tributary BMPs



Map4C-2: Completed & planned BMP's in the Sub-Watershed 4C according PracticeKeeper (2022)

## Sub-Watershed 4D “Stumptown” Tributary

### Priority Level 2

Sub-Watershed 4D, the “Stumptown” Tributary, is a 0.43 square mile watershed located northwest of Stumptown Rd. toward W. Eby and Horseshoe Roads. The stream is not a NAHD named stream and predominately is an intermittent stream. The majority of the tributary is agriculture with a small mix of residential as well. About 1/3 of the farms in the watershed have conservation and nutrient management plans. The remaining ones will need to be created in the future or verify that a plan exists for the operation.



Map 4D-1: Stream Stat Map of Sub-Watershed 4D

Table 4D-1: Stream Stats Table for Sub-Watershed 4D

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0543
Longitude of confluence	-76.1916
Mean basin slope in degrees	2.64°
Percent of basin with urban development	0.00%
Mean basin elevation	400 ft
Percent of area covered by forest	0.09%
Maximum basin elevation	449 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	10.09%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	2.09%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 4D-2: Wiki Watershed Facts for Sub-Watershed 4D

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	158.30	80.95
<i>Pasture/Hay</i>	16.41	8.39
<i>Developed, Open Space</i>	11.31	5.78
<i>Developed, Low Intensity</i>	7.76	3.97
<i>Developed, Medium Intensity</i>	1.55	0.79
<i>Developed, High Intensity</i>	0.22	0.11
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	162.74	83.22
<i>Slow Infiltration</i>	32.81	16.78
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	392 ft	
<i>Minimum</i>	331 ft	
<i>Maximum</i>	426 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	3,134	0
<i>Pigs/hogs/swine</i>	114	0
<i>Turkeys</i>	68	0
<i>Cows, dairy</i>	35	0
<i>Horses</i>	5	0
<i>Sheep</i>	3	0
<i>Chicken, layers</i>	1	81,500
<i>Cows, beef</i>	0	0

\*Only 1 farm's numbers, missing about 2/3 of data



Photos of Sub-Watershed 4D "Stumptown" Tributary



Table 4D-3: Wiki Watershed Loads Calculations for Sub-Watershed 4D

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	362,444	7,076	676
<i>Loading rates (lbs/ac)</i>	1,847	36	3
<i>Mean Annual Concentration (ppm)</i>	510	10	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	1.42	12	4
<i>Cropland</i>	180.05	1,285	376
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.05	2	0
<i>Medium-Density Mixed</i>	0.03	1	0
<i>High-Density Mixed</i>	0.01	0	0
<i>Low-Density Open Space</i>	0.06	3	0
<i>Farm Animals</i>	0	1,036	260
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	4,749	37
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	4	0
<b>TOTAL</b>	<b>182</b>	<b>7,092</b>	<b>678</b>

Sub-Watershed 4D is once again all agricultural in land use so no urban BMP's were proposed for the watershed. For this reason, we proposed exclusively ag BMP's for this sub-watershed both now and in the future.

Urban BMP Scenario:

No urban BMP's were proposed or modeled for this watershed.

Agricultural BMP Scenario:

According to Conservation District data, only about 1/3 of the farm operations within this sub-watershed have conservation plans, nutrient management plans, or any type of conservation practices on the ground currently. Until this can be verified, we are assuming that the remaining 2/3 of the farms need these practices and plans thus most of the work in this sub-watershed is proposed for future efforts. For example, currently only approx. 47 acres of ag lands have conservation plans, nutrient management plans, and any type of conservation practices on the ground. This leaves over 110 acres to still have these plans and practices completed on them in the future. Also, because most of the stream miles of this sub-watershed are along cropland with a swale, only 0.5 acres of riparian buffer were proposed and no streambank fencing or streambank stabilization work was proposed. Finally, because the model lacked any forest land use in this watershed, 0.01 acres of scrub/shrub lands were added to force the model to calculate this land use.

Table 4D-4: Wiki Watershed Load Reductions for Sub-Watershed 4D

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	363,138	7,089	677	363,136	2,336	641
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	55,118	457	118	55,118	457	118
Loads Removed w/ Proposed Agricultural BMP's	130,666	1,082	280	130,666	1,082	280
<b>TOTAL Loads Removed</b>	185,784	1,539	399	185,784	1,539	399
<b>New Reduced Load</b>	177,354	5,550	279	177,352	797	242
<b>Percent Reduction</b>	<b>51%</b>	<b>22%</b>	<b>59%</b>	<b>51%</b>	<b>66%</b>	<b>62%</b>
<b>TOTAL Baseline Load</b>	308,020	6,632	559	308,018	1,879	522
<b>TOTAL Loads Removed from Baseline</b>	130,666	1,082	280	130,666	1,082	280
<b>Percent Reduction from Baseline Load</b>	<b>42%</b>	<b>16%</b>	<b>50%</b>	<b>42%</b>	<b>58%</b>	<b>54%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 4D-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

Table 4D-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			

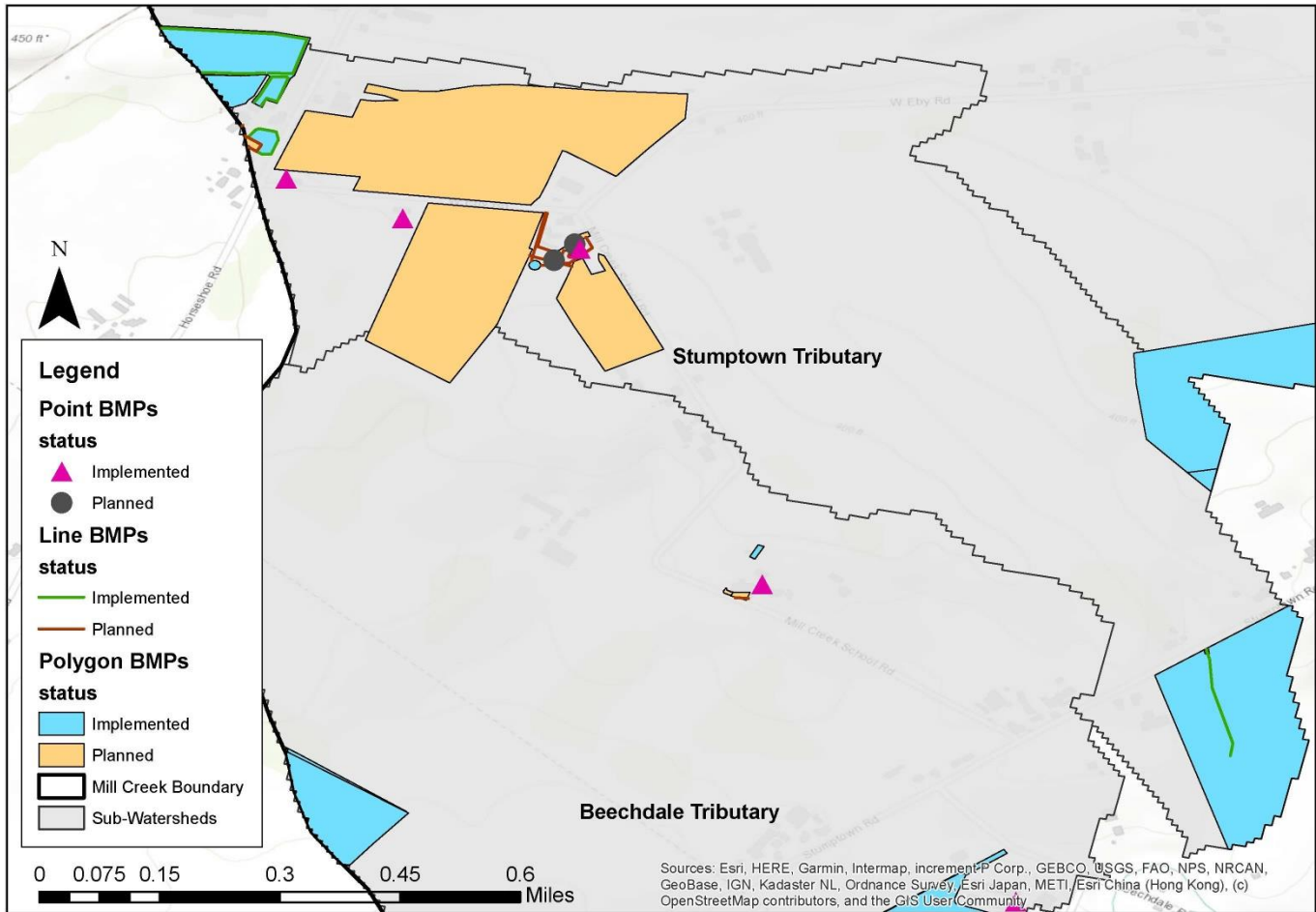
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	0.5 ac	\$2,500	\$1,250
Nutrient Management Plan	110 ac	\$8	\$880
Cover Crop	111 ac	\$20	\$2,220
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$4,350</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.



## Stumptown Tributary BMPs



Map4D-2: Completed & planned BMP's in the Sub-Watershed 4D according PracticeKeeper (2022)

## Sub-Watershed 5 “Reeser’s Run” Tributary

### Priority Level 1

Sub-Watershed 5, the “Reeser’s Run” Tributary, is a 4.70 square mile watershed located directly south of Route 23 and Leola and entering Mill Cr. around the intersection of Stumptown and Gibbons Roads. The stream is a NAHD named stream with five Warm Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL Date</u>
57463277	2050306001319	1.04	Agriculture	Nutrients	10/8/2004
Reach Location: Mouth to West tributary confluence			Agriculture	Siltation	10/8/2004
57463145	2050306001321	1.00	Crop production	Nutrients	10/8/2004
Reach Location: West Tributary (Creek Hill/Horseshoe)			Grazing in riparian zone	Siltation	10/8/2004
57463143	2050306001320	0.11	Agriculture	Nutrients	10/8/2004
Reach Location: Segment between West and Central Tributarys			Agriculture	Siltation	10/8/2004
57463125	2050306004636	0.89	Industrial point source	Salinity/TDS/ Chlorides/ Sulfates	4/9/1999
Reach Location: Central Tributary (Newport to Maple Ave.)			Agriculture	turbidity	10/8/2004
57463123	2050306001320	2.02	Agriculture	Nutrients	10/8/2004
Reach Location: East Tributary (Newport to Farmland/Hess)			Agriculture	Siltation	10/8/2004

The tributary is mostly agriculture with a spattering of industrial and residential mixed in. About 50-60% of the farms in the sub-watershed have conservation and nutrient management plans with about 50% of these plans implemented and the rest just planned at this point. The majority of the streams in this tributary have streambank fencing, but only with minor setbacks averaging about 10-15ft. in most places. This sub-watershed also has a point source discharge on it from Dart Container Company but no Point Source NPDES # is listed for this point source with PA DEP.

### Unnamed Tributary Stream (UNT) to Mill Creek TMDL

The UNT Mill Creek TMDL was developed to address impairments caused by nutrients and sediment. Pennsylvania’s 1996 303(d) list identified 0.2 miles of an UNT to Mill Creek as impaired by nutrients and siltation/suspended solids emanating from agricultural activities in the basin. The miles impaired were then increased on Pennsylvania’s 1998 303(d). The 1996 and 1998 listings were based on data collected before 1996 through PA DEP’s Surface Water Monitoring Program. PA DEP assessments in 2000 increased the number of miles listed as impaired and added nutrients as an additional pollutant of concern. The three stream segments this TMDL applies to drain approximately 3.4 square miles. (information from the 2006 WIP)

Table 5-1: The major components of the UNT Mill Creek TMDL are summarized below:

Pollutant	Current Loading (lbs/yr)	Load Reduction (lbs/yr)	% Reduction	TMDL Load Allocation
Phosphorous	1,776.65	917.77	52	858.88
Sediment	1,243,807.40	786,991.26	63	456,816.14

(Table from the 2006 WIP)

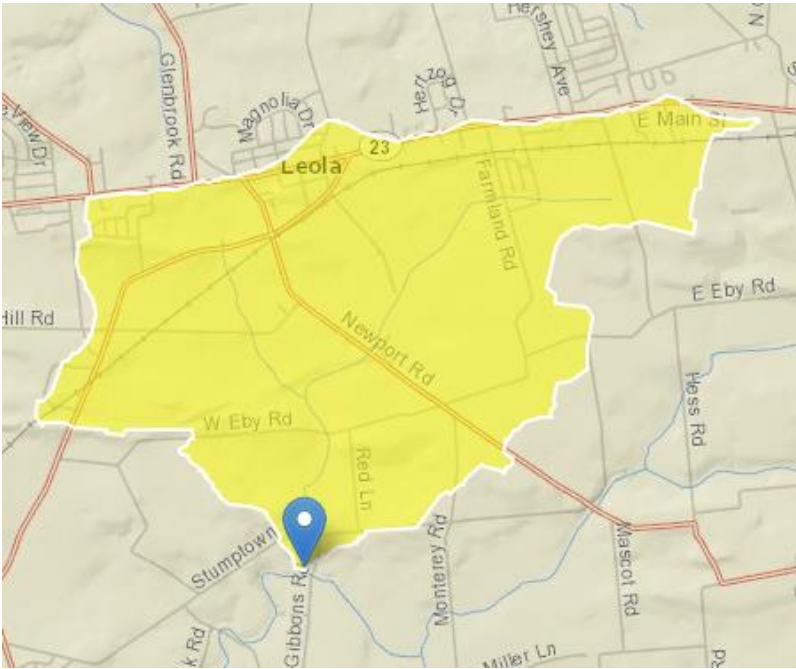
Table 5-2: Load allocations for UNT Mill Creek by land use/source:

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/yr)		Pollutant Loading (lbs/yr)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
<i>PHOSPHOROUS</i>						
Hay/Pasture	365.70	0.45	0.37	166.37	133.89	20
Cropland	976.10	1.18	0.71	1,152.74	691.20	40
Developed	217.60	0.17	0.14	37.05	29.81	20
Stream banks	0.00			4.95	3.98	20
<i>SEDIMENT</i>						
Hay/Pasture	365.70	195.09	113.47	71,343.44	41,494.62	42
Cropland	976.10	758.07	272.08	739,949.13	265,576.12	64
Developed	217.60	148.49	86.37	32,312.25	18,793.38	42
Stream banks	0.00			224,807.40	130,752.01	42

(Table from the 2006 WIP)

It should be noted that although this sub-watershed is given a Priority Level 1 classification, mostly due to the existence of a TMDL in three small tributaries in the headwaters of this watershed, this is an extremely difficult watershed to show progress in for 2 reasons. 1.) The sheer size of the watershed is 4.7 square miles which is much larger than some of the other priority sub-watersheds and thus much harder to see significant water quality improvements over a short amount of time. 2.) And the land use of this sub-watershed is quite diverse with lots of development in the headwaters of most of the tributaries that eventually travel into agricultural areas. Meaning stormwater impacts from these developed areas will not be lessened in the future but only expanding and trying to mitigate these changes in the agricultural areas downstream can be quite difficult because of the changing land use.





Map 5-1: Stream Stat Map of Sub-Watershed 5

Table 5-3: Stream Stats Table for Sub-Watershed 5

<b>Stream STATS Facts</b>	
Latitude of confluence	40.0584
Longitude of confluence	-76.1844
Mean basin slope in degrees	2.57°
Percent of basin with urban development	12.55%
Mean basin elevation	417 ft
Percent of area covered by forest	0.66%
Maximum basin elevation	479 ft.
Percentage of impervious area determined from NLCD 2001 impervious dataset	11.80%
Percentage of land-use from NLCD 2001 classes 21-24	25.58%
Percentage of developed (urban) land from NLCD 2011 classes 21-24	31.42%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	14.45%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 5-4: Wiki Watershed Facts for Sub-Watershed 5

<b>ENTIRE REESER'S RUN Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	1,539.46	52.42
<i>Pasture/Hay</i>	350.89	11.97
<i>Developed, Low Intensity</i>	303.94	10.35
<i>Developed, High Intensity</i>	271.82	9.27
<i>Developed, Medium Intensity</i>	254.52	8.68
<i>Developed, Open Space</i>	207.57	7.03
<i>Shrub/Scrub</i>	4.94	0.14
<i>Barren Land (Rock/Sand/Clay)</i>	2.47	0.08
<i>Emergent Herbaceous Wetlands</i>	2.47	0.06

<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	2,619.31	89.19
<i>Slow Infiltration</i>	168.03	5.72
<i>Medium/Very Slow Infiltration</i>	148.26	5.08
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	403 ft	
<i>Minimum</i>	334 ft	
<i>Maximum</i>	474 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	46,990	
<i>Pigs/hogs/swine</i>	1,713	
<i>Turkeys</i>	1,019	
<i>Cows, dairy</i>	528	
<i>Horses</i>	75	
<i>Sheep</i>	51	
<i>Chicken, layers</i>	23	
<i>Cows, beef</i>	0	



*Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary*



*Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary*





*Photos of middle section of Sub-Watershed 5 the "Reeser's Run" Tributary*



*Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary*



*Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary*





Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary



Photos of upper section of Sub-Watershed 5 the "Reeser's Run" Tributary

Table 5-5: Wiki Watershed Loads Calculations for Sub-Watershed 5

<b>ENTIRE REESER'S RUN Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	3,366,954	78,842	7,803
<i>Loading rates (lbs/ac)</i>	1,146	27	3
<i>Mean Annual Concentration (ppm)</i>	337	8	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	51,683	231	79
<i>Cropland</i>	3,068,457	11,249	3,254
<i>Wooded Areas</i>	12	0	0
<i>Wetlands</i>	3	0	0

<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	4	1	0
<i>Low-Density Mixed</i>	3,868	108	11
<i>Medium-Density Mixed</i>	14,307	368	38
<i>High-Density Mixed</i>	15,276	393	41
<i>Low-Density Open Space</i>	2,629	73	8
<i>Farm Animals</i>	0	15,618	3,921
<i>Stream Bank Erosion</i>	210,716	150	51
<i>Subsurface Flow</i>	0	49,853	401
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	799	0

Sub-Watershed 5 has seen a lot of conservation focus over the last 20 years from NRCS and the District through our Pequea-Mill Cr. Smoketown Office. This has resulted in extensive streambank fencing with minimal setbacks, some buffer areas in this fenced-in area, and lots of outreach on planning efforts and conservation practices. Unfortunately, not all of the work in this high-profile watershed has been accomplished to date. Some development pressure can be seen in the headwaters of the area from commercial development and also some residential areas. For this reason, we proposed some Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 40 acres of Low-Density development, and 20 acres of Medium-Density development.

Agricultural BMP Scenario:

Since only 50% of the ag producers in this watershed have conservation and nutrient management plans, additional effort is needed to complete those plans in the future. Those with conservation plans only have about 50% of their conservation practices implemented, so this is where the majority of the BMP work in this watershed should focus. Only a small amount of riparian buffer has been planted to date in the watershed, about 5 acres so this would need to be significantly increased to approx. 68.9 acres in the future. As stated earlier, lots of streambank fencing has been implemented in this watershed – approx. 15,000 ft. but an additional 7,000 ft. is proposed to fence the entire stream corridor. Along with the fencing and buffer work, we are also proposing 3,900 ft. of streambank stabilization on top of these BMP's where needed.

Table 5-6: Wiki Watershed Load Reductions for Sub-Watershed 5

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	3,371,972	78,948	7,813	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	3,367	9	2	-	-	-
Loads Removed w/ Existing Agricultural BMP's	608,967	16,527	3,635	-	-	-



Loads Removed w/ Proposed Agricultural BMP's	1,343,842	9,495	2,361		-	-	-
<i><b>TOTAL Loads Removed</b></i>	1,956,176	26,031	5,997		-	-	-
<i><b>New Reduced Load</b></i>	1,415,796	52,918	1,815		-	-	-
<i><b>Percent Reduction</b></i>	<b>58%</b>	<b>33%</b>	<b>77%</b>		-	-	-
<i><b>TOTAL Baseline Load</b></i>	2,763,005	62,421	4,178		-	-	-
<i><b>TOTAL Loads Removed from Baseline</b></i>	1,347,209	9,504	2,362		-	-	-
<i><b>Percent Reduction from Baseline Load</b></i>	<b>49%</b>	<b>15%</b>	<b>57%</b>		-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 5-6 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 67 (Medium Priority)** – lat. 40.0858; long. -76.1648 (Upper Leacock Twp.)
- **Site # 145 (Medium Priority)** – lat. 40.0849; long. -76.1804 (Upper Leacock Twp.)
- **Site # 144 (Medium-Low Priority)** – lat. 40.0820; long. -76.1797 (Upper Leacock Twp.)
- **\*Site # 151 (Medium Priority)** – lat. 40.0759; long. -76.1749 (Upper Leacock Twp.)
- **Site # 150 (Medium Priority)** – lat. 40.0769; long. -76.1818 (Upper Leacock Twp.)
- **Site # 152 (Medium-Low Priority)** – lat. 40.0747; long. -76.1780 (Upper Leacock Twp.)
- **Site # 146 (High-Medium Priority)** – lat. 40.0851; long. -76.1887 (Upper Leacock Twp.)
- **Site # 147 (High Priority)** – lat. 40.0825; long. -76.1924 (Upper Leacock Twp.)
- **Site # 148 (High-Medium Priority)** – lat. 40.0813; long. -76.1922 (Upper Leacock Twp.)
- **\*Site # 134 (Medium Priority)** – lat. 40.0753; long. -76.1893 (Upper Leacock Twp.)
- **Site # 131 (Medium Priority)** – lat. 40.0692; long. -76.1829 (Upper Leacock Twp.)
- **Site # 129 (High Priority)** – lat. 40.0672; long. -76.1823 (Upper Leacock Twp.)
- **\*\*Site # 157 (Medium Priority)** – lat. 40.0611; long. -76.1834 (Upper Leacock Twp.)
- **\*\*Site # 142 (Medium Priority)** – lat. 40.0645; long. -76.1806 (Upper Leacock Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 5-7: Existing, Proposed, and New BMP's Estimated Cost

<b>Combined BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Nutrient management plan	155.3 ac	\$8	\$1,242
Barnyard Runoff controls	1	\$22,000	\$22,000
Waste storage system	1	\$80,000	\$80,000
Streambank Fencing	1,000'	\$8	\$8,000
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$111,242</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Filtering practices	1 ac	Varies	Varies
Impervious surface reduction	5 ac	Varies	Varies
Barnyard runoff controls	3	\$22,000	\$66,000
Waste storage system	1	\$80,000	\$80,000
Riparian buffer	7.3 ac	\$2,500	\$18,250
Streambank Fencing	3,900'	\$8	\$31,200
Erosion & sedimentation controls	1 ac	Varies	Varies
Stream bank Stabilization	3,900'	\$130	\$507,000
Conservation crop rotation	73.8 ac	\$11	\$812
Cover crop	73.8 ac	\$20	\$1,476
Prescribed grazing	14.7 ac	\$50	\$735
Grassed waterway	1.5 ac	\$4,500	\$6,750
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	71.6 ac	\$2,500	\$179,000
Green Infrastructure	60 ac	Varies	Varies
Cover Crop	1,026.2 ac	\$20	\$20,524
Streambank Fencing	3,100'	\$8	\$24,800
Nutrient Management Plan	770 ac	\$8	\$6,160
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$942,707</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.

Below is additional WikiWatershed data for tributaries within Reeser's Run. Models were not run on these tributaries but data is provided as background information on them.

<b>WEST TRIBUTARY REESER'S RUN Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	410.19	45.66
<i>Pasture/Hay</i>	138.38	15.33
<i>Developed, Low Intensity</i>	116.14	12.80
<i>Developed, Medium Intensity</i>	88.96	9.92
<i>Developed, Open Space</i>	81.54	9.11

<i>Developed, High Intensity</i>	61.78	6.82
<i>Shrub/Scrub</i>	2.47	0.15
<i>Emergent Herbaceous Wetlands</i>	2.47	0.20
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	778.38	86.54
<i>Slow Infiltration</i>	81.54	9.18
<i>Medium/Very Slow Infiltration</i>	39.54	4.28
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	398 ft	
<i>Minimum</i>	355 ft	
<i>Maximum</i>	464 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	14,417	
<i>Pigs/hogs/swine</i>	525	
<i>Turkeys</i>	312	
<i>Cows, dairy</i>	162	
<i>Horses</i>	23	
<i>Sheep</i>	15	
<i>Chicken, layers</i>	7	
<i>Cows, beef</i>	0	

<b><u>WEST TRIBUTARY RESER'S RUN Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	935,441	22,340	2,293
<i>Loading rates (lbs/ac)</i>	1,038	25	3
<i>Mean Annual Concentration (ppm)</i>	315	8	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	20,955	93	31
<i>Cropland</i>	869,302	3,146	909
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	3	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	1,462	40	4
<i>Medium-Density Mixed</i>	5,284	124	13
<i>High-Density Mixed</i>	3,624	85	9
<i>Low-Density Open Space</i>	1,040	29	3
<i>Farm Animals</i>	0	4,790	1,202
<i>Stream Bank Erosion</i>	33,770	24	9

<i>Subsurface Flow</i>	0	13,728	113
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	280	0

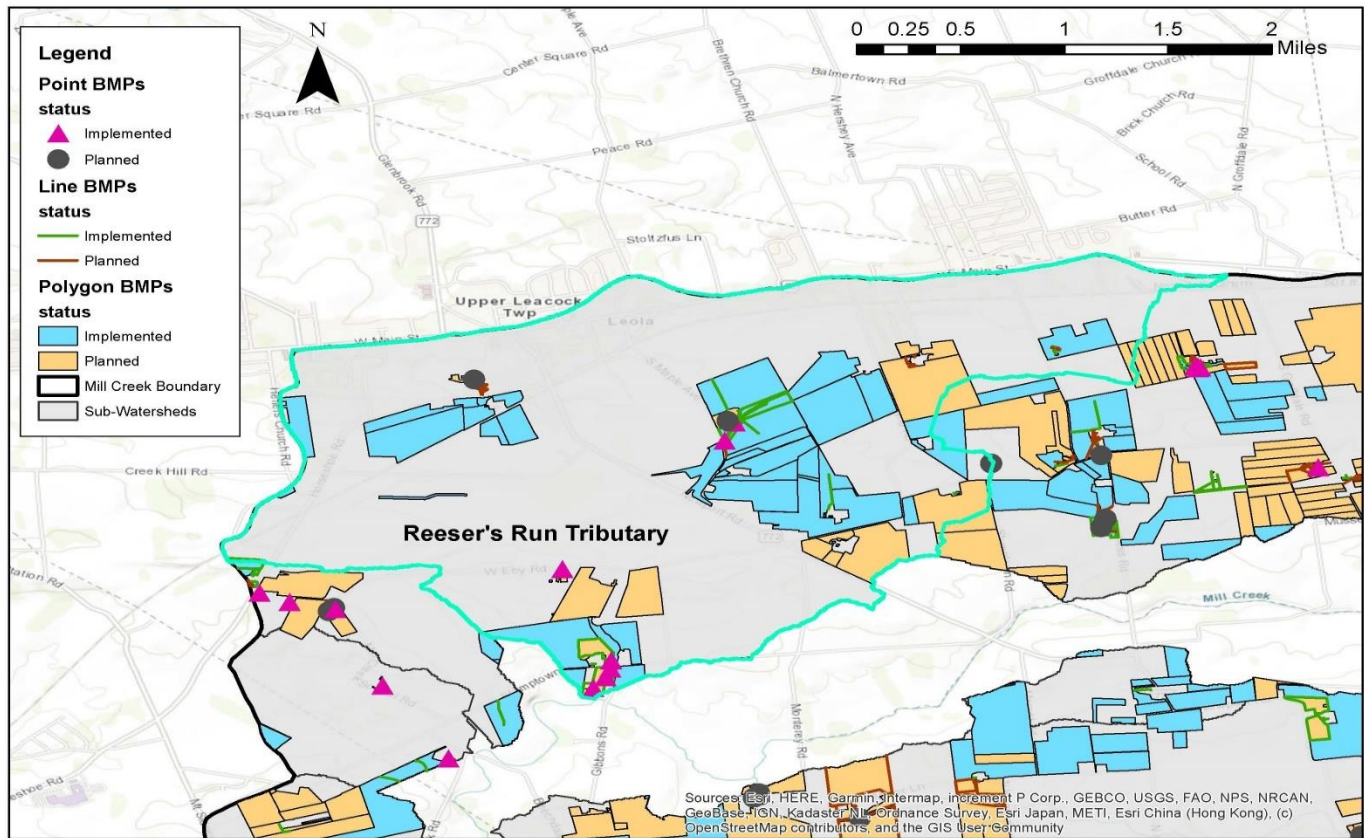
<b><u>EAST TRIBUTARY REESER'S RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	694.37	48.69
<i>Developed, High Intensity</i>	205.10	14.45
<i>Developed, Medium Intensity</i>	155.68	10.94
<i>Developed, Low Intensity</i>	153.21	10.70
<i>Pasture/Hay</i>	128.49	8.93
<i>Developed, Open Space</i>	84.02	5.93
<i>Barren Land (Rock/Sand/Clay)</i>	2.47	0.17
<i>Shrub/Scrub</i>	2.47	0.19
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,336.84	93.74
<i>Medium/Very Slow Infiltration</i>	64.25	4.47
<i>Slow Infiltration</i>	24.71	1.79
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	414 ft	
<i>Minimum</i>	355 ft	
<i>Maximum</i>	474 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	22,843	
<i>Pigs/hogs/swine</i>	833	
<i>Turkeys</i>	495	
<i>Cows, dairy</i>	256	
<i>Horses</i>	36	
<i>Sheep</i>	25	
<i>Chicken, layers</i>	11	
<i>Cows, beef</i>	0	

<b><u>EAST TRIBUTARY REESER'S RUN Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	1,542,706	36,834	3,710
<i>Loading rates (lbs/ac)</i>	1,080	26	3
<i>Mean Annual Concentration (ppm)</i>	310	7	1

<b>Load Sources</b>			
<b>SOURCES</b>	<b>SEDIMENT (lbs)</b>	<b>TOTAL NITROGEN (lbs)</b>	<b>TOTAL PHOSPHORUS (lbs)</b>
Hay/Pasture	19,633	86	29
Cropland	1,421,593	5,182	1,509
Wooded Areas	6	0	0
Wetlands	0	0	0
Open Land	0	0	0
Barren Areas	4	1	0
Low-Density Mixed	1,993	56	6
Medium-Density Mixed	8,525	229	24
High-Density Mixed	11,255	302	31
Low-Density Open Space	1,106	31	3
Farm Animals	0	7,575	1,902
Stream Bank Erosion	78,591	55	20
Subsurface Flow	0	22,828	185
Point Sources	0	0	0
Septic Systems	0	487	0



## Reeser's Run Tributary BMPs



Map5-2: Completed & planned BMP's in the Sub-Watershed 5 according PracticeKeeper (2022)

**Sub-Watershed 6 “Lantz” Tributary**

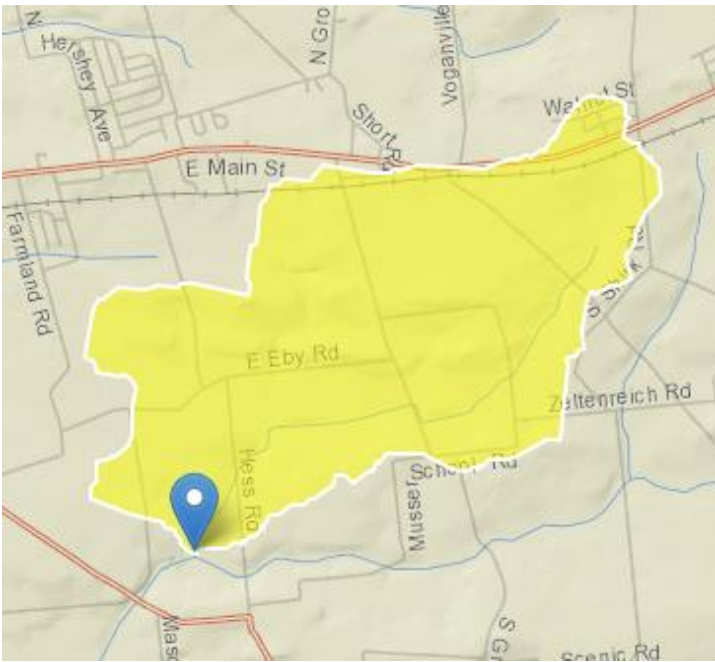
**Priority Level 2**

Sub-Watershed 6, the “Lantz” Tributary, is a 3.08 square mile watershed located south of Route 23 and east of Newport Rd. and entering Mill Cr. northeast of the village of Mascot and above the Ressler Mill dam. The stream is a NAHD named stream with four Warm Water Fishery COMID reach numbers.

<b><u>COMID #</u></b>	<b><u>NHD Reach Codes</u></b>	<b><u>Length (mi)</u></b>	<b><u>Impairment Source</u></b>	<b><u>Impairment Cause</u></b>	<b><u>TMDL priority</u></b>
57463147	2050306001318	0.75	Crop production	Nutrients	Medium
Reach Location: Mouth to East & West tributary confluences			Grazing in riparian zone	Siltation	High
57463047	2050306004631	0.89	Crop production	Nutrients	Medium
Reach Location: West Tributary (E. Eby Rd.)			Grazing in riparian zone	Siltation	High
57463045	2050306001318	2.04	Crop production	Nutrients	Medium
Reach Location: Est Tributary (S. Groffdale, Musser School, Peters Rds.)			Grazing in riparian zone	Siltation	High
57463103	2050306004635	0.17	Agriculture	Siltation	High
Reach Location: Mouth between Musser School & S. Groffdale Rds.			Agriculture	Nutrients	Medium

The tributary is a mix of residential and agricultural land uses. Roughly 90-95% of the agricultural operations in this sub-watershed have conservation and nutrient management plans according to the Conservation District. Of this number, about 50% have been inspected to verify their plans and about 50% have implemented most of the BMP’s needed within their plans. A lot of conservation efforts have taken place over the years in this watershed through District and NRCS efforts from the Pequea/Mill Cr. Smoketown office that was in the area and has paid huge dividends for conservation efforts in this area.





Map 6-1: Stream Stat Map of Sub-Watershed 6

Table 6-1: Stream Stats Table for Sub-Watershed 6

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0660
Longitude of confluence	-76.1516
Mean basin slope in degrees	2.32°
Percent of basin with urban development	6.03%
Mean basin elevation	437 ft
Percent of area covered by forest	0.51%
Maximum basin elevation	525 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	14.53%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	4.96%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 6-2: Wiki Watershed Facts for Sub-Watershed 6

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	1,329.42	69.14
<i>Pasture/Hay</i>	172.97	8.96
<i>Developed, Low Intensity</i>	138.38	7.24
<i>Developed, Open Space</i>	123.55	6.46
<i>Developed, Medium Intensity</i>	91.43	4.79
<i>Developed, High Intensity</i>	61.78	3.20
<i>Mixed Forest</i>	2.47	0.10
<i>Grassland/Herbaceous</i>	2.47	0.08
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,712.44	89.03
<i>Slow Infiltration</i>	210.04	10.97

<u>ELEVATION</u>	<u>FEET</u>	
<i>Average</i>	429 ft	
<i>Minimum</i>	350 ft	
<i>Maximum</i>	524 ft	
<u>ANIMALS</u>	<u>NUMBERS</u>	<u>*Numbers According to PK</u>
<i>Chicken, broilers</i>	30,802	17,500
<i>Pigs/hogs/swine</i>	1,123	10
<i>Turkeys</i>	668	6,500
<i>Cows, dairy</i>	346	607
<i>Horses</i>	49	94
<i>Sheep</i>	33	16
<i>Chicken, layers</i>	15	52,736
<i>Cows, beef</i>	0	172

*\*All but 3 farms animal numbers here*



*Photos of lower section of Sub-Watershed 6 "Lantz" Tributary*



*Photos of middle section of Sub-Watershed 6 "Lantz" Tributary*





Photos of upper section of Sub-Watershed 6 “Lantz” Tributary



Photos of upper section of Sub-Watershed 6 “Lantz” Tributary

Table 6-3: Wiki Watershed Loads Calculations for Sub-Watershed 6

<u>SOURCES</u>	<u>Loads</u>		
	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
Total loads (lbs)	2,807,386	60,162	5,892
Loading rates (lbs/ac)	1,458	31	3
Mean Annual Concentration (ppm)	424	9	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b> <b><u>(tons)</u></b>	<b><u>TOTAL NITROGEN</u></b> <b><u>(lbs)</u></b>	<b><u>TOTAL</u></b> <b><u>PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	12.86	113	40
<i>Cropland</i>	1,347.46	9,738	2,928
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	1	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.87	47	5
<i>Medium-Density Mixed</i>	2.74	129	13
<i>High-Density Mixed</i>	1.83	86	9
<i>Low-Density Open Space</i>	0.78	42	4
<i>Farm Animals</i>	0	10,257	2,575
<i>Stream Bank Erosion</i>	40.33	57	20
<i>Subsurface Flow</i>	0	39,540	312
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	288	0
<b>TOTAL</b>	<b>1,407</b>	<b>60,299</b>	<b>5,906</b>

Sub-Watershed 6 is all agricultural land use with no urbanized area. For this reason, only ag BMP's were proposed for this model scenario.

Urban BMP Scenario:

No urban BMP's were proposed or implemented in this ag watershed.

Agricultural BMP Scenario:

Since the majority of farms in this watershed have a conservation plan and other on-the-ground conservation practices, most of the work for this model run involves future work proposed in this ag-dominated watershed. For example, 1,200 acres of ag lands have plans, for both conservation and nutrient management, along with conservation practices. That leaves only 128 acres proposed for these BMP's in the future. That being stated an additional 328 acres of nutrient management planning would need to take place in the watershed. About half of the watershed has had riparian buffers implemented on them which leaves the remaining half or 23 acres, yet to implement buffers. Finally, with those buffers, about 5,000 ft. have streambank fencing with them so the remaining 18,000 ft. need to continue the fencing. This would also include 3,000 ft. of streambank stabilization to assist in this effort.

Table 6-4: Wiki Watershed Load Reductions for Sub-Watershed 6

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	2,812,211	60,256	5,901	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	1,363,911	15,062	3,627	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	264,705	3,114	621	-	-	-
<b>TOTAL Loads Removed</b>	1,628,616	18,176	4,248	-	-	-
<b>New Reduced Load</b>	1,183,595	42,081	1,654	-	-	-
<b>Percent Reduction</b>	<b>58%</b>	<b>30%</b>	<b>72%</b>	-	-	-
<b>TOTAL Baseline Load</b>	1,448,300	45,195	2,274	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	264,705	3,114	621	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>18%</b>	<b>7%</b>	<b>27%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 6-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 156 (Medium-Low Priority)** – lat. 40.0839; long. -76.1191 (Upper Leacock Twp.)
- **Site # 155 (Medium Priority)** – lat. 40.0788; long. -76.1232 (Upper Leacock Twp.)
- **\*Site # 154 (Medium Priority)** – lat. 40.0775; long. -76.1247 (Upper Leacock Twp.)
- **\*Site # 128 (Medium Priority)** – lat. 40.0753; long. -76.1324 (Upper Leacock Twp.)
- **\*\*Site # 137 (Medium-Low Priority)** – lat. 40.0756; long. -76.1348 (Upper Leacock Twp.)
- **\*\*Site # 135 (Medium Priority)** – lat. 40.0726; long. -76.1299 (Upper Leacock Twp.)
- **Site # 163 (Medium Priority)** – lat. 40.0783; long. -76.1443 (Upper Leacock Twp.)
- **\*Site # 162 (Medium Priority)** – lat. 40.0727; long. -76.1457 (Upper Leacock Twp.)
- **Site # 140 (Medium Priority)** – lat. 40.0711; long. -76.1480 (Upper Leacock Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 6-5: Existing, Proposed, and New BMP's Estimated Cost

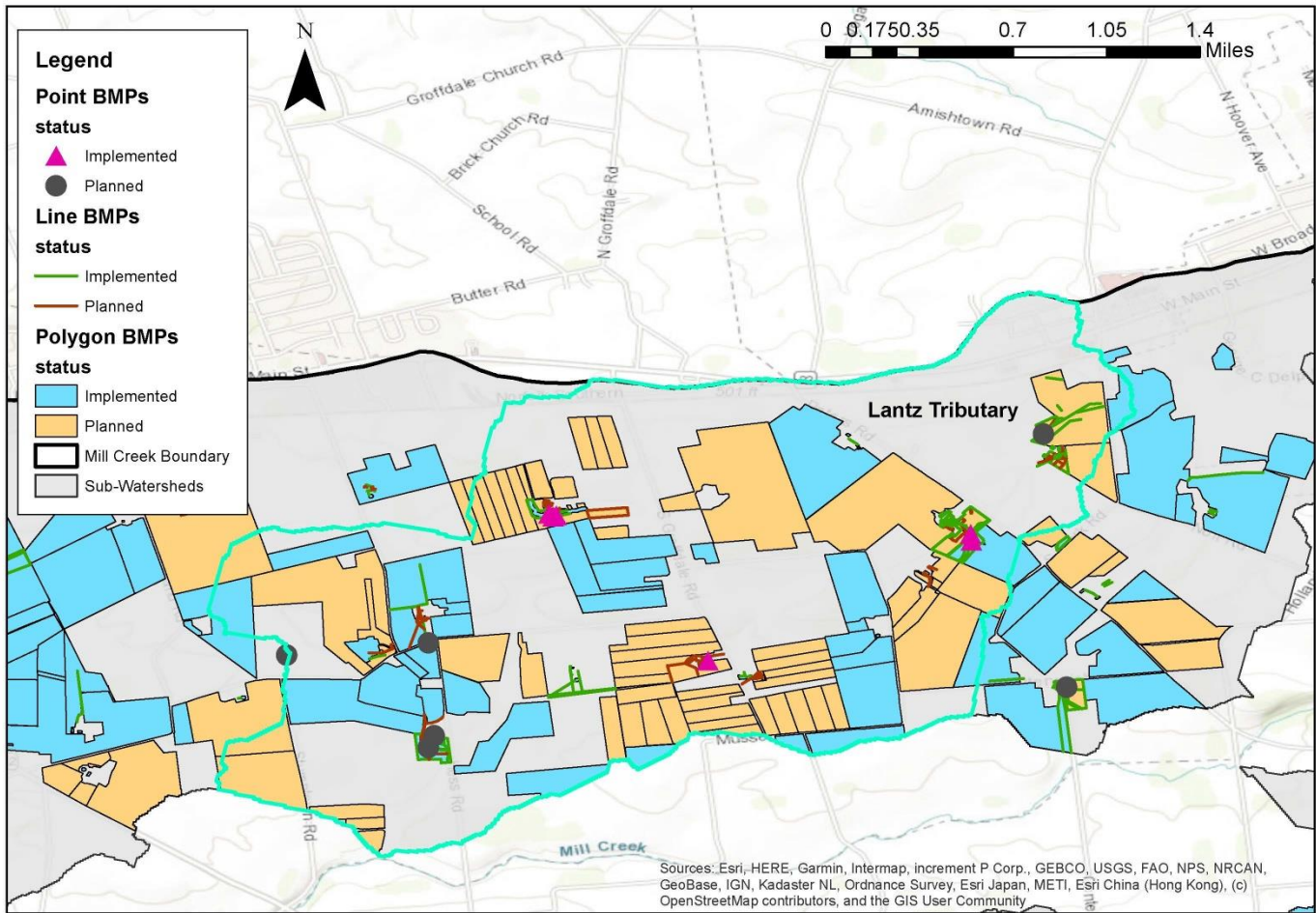
<b><u>Combined BMP's Installed Since the 2006 WIP (Existing)</u></b>	<b><u>Units Installed</u></b>	<b><u>Estimated Cost/Unit</u></b>	<b><u>Cost</u></b>
Nutrient management plan	157 ac	\$8	\$1,256
Barnyard Runoff controls	2	\$22,000	\$44,000
Waste storage system	2	\$80,000	\$160,000
Streambank Fencing	5,000'	\$8	\$40,000
Prescribed grazing	20 ac	\$50	\$1,000
Conservation crop rotation	89 ac	\$11	\$979
Cover crop	86.1 ac	\$20	\$1,722
Residue management, no-till	7.2 ac	\$19	\$137
Stripcropping, contour	16 ac	\$2	\$32
Contour farming	30 ac	\$8	\$240
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$249,366</b>
<b><u>Combined BMP's to be Installed From the 2006 WIP (Proposed)</u></b>			
Barnyard runoff controls	1	\$22,000	\$22,000
Riparian buffer	19.7 ac	\$2,500	\$49,250
Streambank Fencing	18,000'	\$8	\$144,000
Stream bank Stabilization	2,200'	\$130	\$286,000
<b><u>Additional Future Proposed BMP's (NEW)</u></b>			
Riparian buffer	3.3 ac	\$2,500	\$8,250
Stream bank Stabilization	800'	\$130	\$104,000
Cover Crop	128 ac	\$20	\$2,560
Nutrient Management Plan	328 ac	\$8	\$2,624
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$618,684</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



# Lantz Tributary BMPs



Map6-2: Completed & planned BMP's in the Sub-Watershed 6 according PracticeKeeper (2022)

## Sub-Watershed 7 “CHNA” Tributary

### Priority Level 3

Sub-Watershed 7, the “CHNA” Tributary, is a 1.22 square mile watershed located north of Centerville Rd. all the way North to Route 23. The stream is a Warm Water Fishery NAHD named stream 1.62 miles long.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57463009	2050306001317	1.62	Crop production	Nutrients	Medium
			Agriculture	Siltation	High
			Agriculture	Nutrients	Medium

The tributary is a mix of residential, industrial, and agricultural land uses. It appears that all of the farm operations within this tributary have conservation and nutrient management plans. Of that, about 2/3 of the ag operations in the tributary have implemented conservation plans, so more work needs to happen. The headwaters of this tributary are owned by the CHNA corporation with leased farmland. Numerous riparian buffers have been implemented in these areas over the last several years by various partners. Additional work is needed to further this effort.



Map 7-1: Stream Stat Map of Sub-Watershed 7

Table 7-1: Stream Stats Table for Sub-Watershed 7

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0712
Longitude of confluence	-76.1137
Mean basin slope in degrees	1.52°
Percent of basin with urban development	20.21%
Mean basin elevation	450 ft
Percent of area covered by forest	0.53%
Maximum basin elevation	524 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	39.10%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	18.12%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 7-2: Wiki Watershed Facts for Sub-Watershed 7

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	387.95	48.93
<i>Developed, High Intensity</i>	88.96	11.35
<i>Developed, Low Intensity</i>	86.49	11.07
<i>Pasture/Hay</i>	79.07	9.95
<i>Developed, Medium Intensity</i>	76.60	9.70
<i>Developed, Open Space</i>	71.66	8.97
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	689.42	87.05
<i>Slow Infiltration</i>	101.31	12.95
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	450 ft	
<i>Minimum</i>	376 ft	
<i>Maximum</i>	523 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	12,662	0
<i>Pigs/hogs/swine</i>	461	0
<i>Turkeys</i>	274	0
<i>Cows, dairy</i>	142	181
<i>Horses</i>	20	45
<i>Sheep</i>	13	0
<i>Chicken, layers</i>	6	9,000
<i>Cows, beef</i>	0	250

\*Factors in all but 1 farm





*Photos of upper section of Sub-Watershed 7 "CHNA" Tributary*



*Photos of middle section of Sub-Watershed 7 "CHNA" Tributary*



*Photos of middle section of Sub-Watershed 7 "CHNA" Tributary*

Table 7-3: Wiki Watershed Loads Calculations for Sub-Watershed 7

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	824,199	20,270	2,072
<i>Loading rates (lbs/ac)</i>	1,041	26	3
<i>Mean Annual Concentration (ppm)</i>	306	8	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	5.78	50	19
<i>Cropland</i>	384.21	2,723	859
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.54	30	3
<i>Medium-Density Mixed</i>	2.14	113	12
<i>High-Density Mixed</i>	2.52	132	14
<i>Low-Density Open Space</i>	0.44	24	3
<i>Farm Animals</i>	0	4,208	1,056
<i>Stream Bank Erosion</i>	17.40	24	9
<i>Subsurface Flow</i>	0	12,770	103
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	242	0
<b>TOTAL</b>	<b>413</b>	<b>20,316</b>	<b>2,077</b>

Sub-Watershed 7 is mostly all agricultural land use with some commercial areas toward the headwater of the watershed. For this reason, the majority of the BMP's are focused on ag BMP's.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers that CHNA has installed over the last 2-3 years on 10 acres in the developed areas, Green Infrastructure approaches on 35 acres of Low-Density development, and 25 acres on Medium-Density development.

Agricultural BMP Scenario:

Since the majority of farms in this watershed have a conservation plan, nutrient management plan, and other on-the-ground conservation practices, most of the work for this model run involves future work proposed in this ag-dominated watershed. For example, all 387 acres of ag lands have plans, for both conservation and nutrient management, along with conservation practices. About half the watershed has had riparian buffers implemented on them which leaves the remaining half or 19.3 acres yet to implement buffers. Finally, with those buffers about 4,200 ft. have streambank fencing with them, so the remaining 4,200 ft. need to continue the fencing. This would also include 2,500 ft. of streambank stabilization to assist in this effort.

Table 7-4: Wiki Watershed Load Reductions for Sub-Watershed 7

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	825,192	20,292	2,074	-	-	-
Loads Removed w/ Existing Urban BMP's	417	1	0	-	-	-
Loads Removed w/ Proposed Urban BMP's	3,993	31	4	-	-	-
Loads Removed w/ Existing Agricultural BMP's	482,000	6,794	1,622	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	100,493	449	94	-	-	-
<b>TOTAL Loads Removed</b>	586,903	7,275	1,721	-	-	-
<b>New Reduced Load</b>	238,289	13,017	353	-	-	-
<b>Percent Reduction</b>	<b>71%</b>	<b>36%</b>	<b>83%</b>	-	-	-
<b>TOTAL Baseline Load</b>	342,775	13,496	452	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	104,486	479	98	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>31%</b>	<b>4%</b>	<b>22%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 7-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 16 (Medium Priority)** – lat. 40.0837; long. -76.1085 (Earl Twp.)
- **Site # 6 (High-Medium Priority)** – lat. 40.0794; long. -76.1126 (Earl Twp.)

Table 7-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>



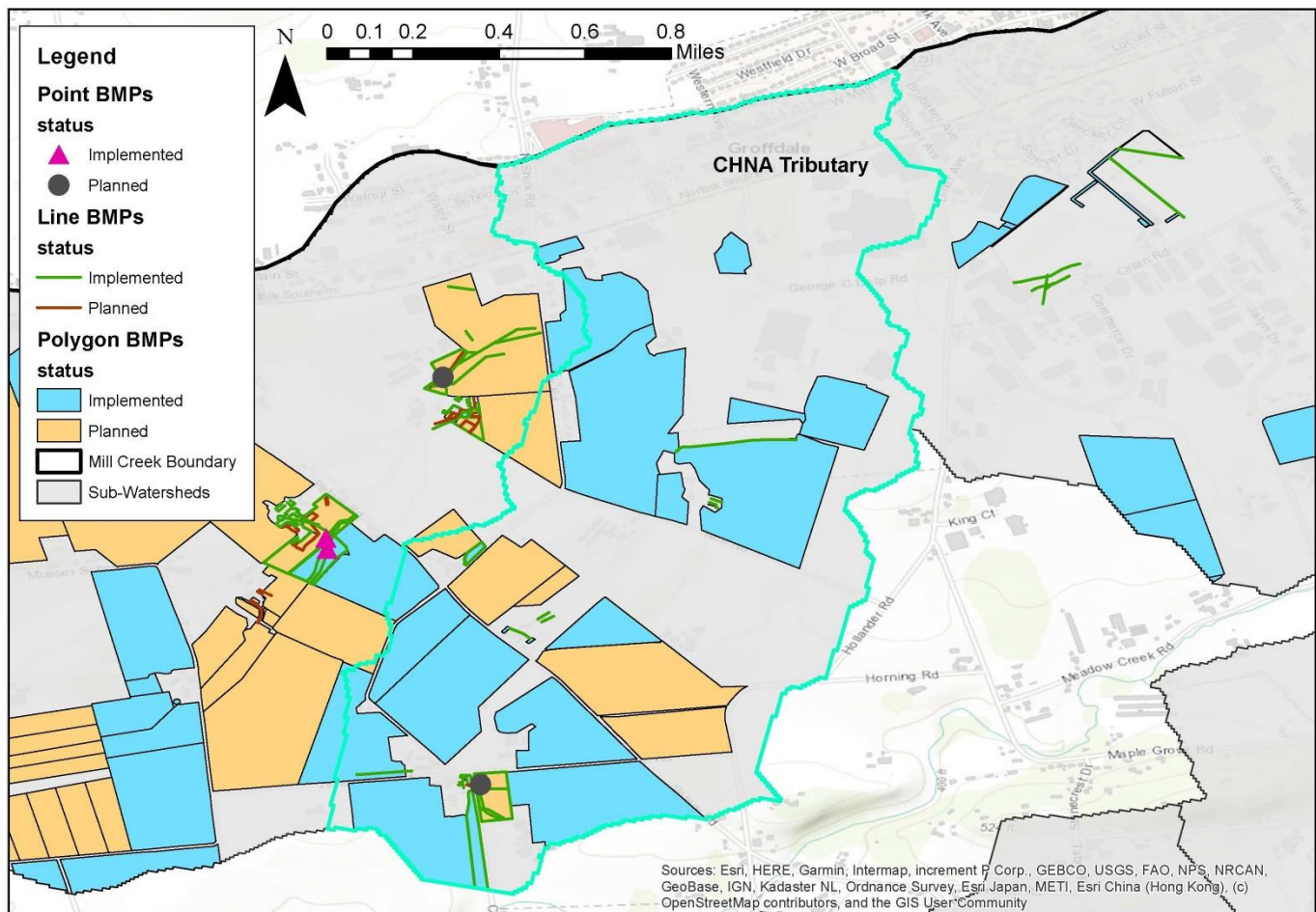
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	2.9 ac	\$2,500	\$7,250
Streambank Fencing	3,600'	\$8	\$28,800
<b>Additional Future Proposed BMP's (NEW)</b>			
Green Infrastructure	60 ac	Varies	Varies
Riparian buffer	16.4 ac	\$2,500	\$41,000
Stream bank Stabilization	2,500'	\$130	\$325,000
Streambank Fencing	600'	\$8	\$4,800
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$406,850</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.



## CHNA Tributary BMPs



Map7-2: Completed & planned BMP's in the Sub-Watershed 7 according PracticeKeeper (2022)

### Sub-Watershed 8 “Shultz” Tributary

#### Priority Level 3

Sub-Watershed 8, the “Shultz” Tributary, is a 2.03 square mile watershed located directly south of Route 23 and New Holland and entering Mill Cr. west of New Holland Rd. The stream is a NAHD named stream with three Warm Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57462847	2050306001315	0.78	Grazing in riparian zone	Nutrients	Medium
Reach Location: Mouth to East & West tributary confluences			Grazing in riparian zone	Siltation	High
57462747	2050306004607	0.72	Grazing in riparian zone	Nutrients	Medium
Reach Location: West Tributary (Orlan Rd.)			Grazing in riparian zone	Siltation	High
57462745	2050306001315	0.88	Grazing in riparian zone	Nutrients	Medium
Reach Location: Est Tributary (New Holland Rd./Garden Spot Village)			Grazing in riparian zone	Siltation	High

The tributary is a true mix of agriculture at the mouth, commercial and industrial in the mid reaches, and medium and high-density residential at the headwaters. The majority of the farms in the sub-watershed have conservation and nutrient management plans with most of the planned BMP’s implemented as well. Some stream and riparian improvements have taken place in the mid reaches of the watershed along with the headwaters with some recent development in this area as well. This sub-watershed also has a point source discharge on it from Tyson Foods Company; Point Source NPDES # PA0021890. This point source is permitted to discharge 120,282 cubic ft./day or 900,000 gal/day. The Total Nitrogen Load from this discharge is 12,141 lbs/yr and the Total Phosphorus is 1,830 lbs/yr.



Map 8-1: Stream Stat Map of Sub-Watershed 8

Table 8-1: Stream Stats Table for Sub-Watershed 8

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0815
Longitude of confluence	-76.0878
Mean basin slope in degrees	1.26°
Percent of basin with urban development	27.58%
Mean basin elevation	470 ft
Percent of area covered by forest	0.79%
Maximum basin elevation	559 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	56.69%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	27.96%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 8-2: Wiki Watershed Facts for Sub-Watershed 8

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	360.77	28.97
<i>Developed, Medium Intensity</i>	237.22	18.95
<i>Developed, Low Intensity</i>	210.04	16.84
<i>Developed, High Intensity</i>	202.63	16.27
<i>Developed, Open Space</i>	143.32	11.40
<i>Pasture/Hay</i>	93.90	7.46

<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,124.33	90.02
<i>Slow Infiltration</i>	123.55	9.98
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	470 ft	
<i>Minimum</i>	417 ft	
<i>Maximum</i>	562 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	19,983	112,000
<i>Pigs/hogs/swine</i>	728	500
<i>Turkeys</i>	433	0
<i>Cows, dairy</i>	224	0
<i>Horses</i>	32	8
<i>Sheep</i>	22	12
<i>Chicken, layers</i>	10	80,000
<i>Cows, beef</i>	0	22



*Photos of lower reaches of Sub-Watershed 8 the "Schultz" Tributary*





Photos of lower reaches of Sub-Watershed 8 the "Schultz" Tributary



Photos of upper reaches of Sub-Watershed 8 the "Schultz" Tributary

Table 8-3: Wiki Watershed Loads Calculations for Sub-Watershed 8

<u>SOURCES</u>	<u>Loads</u>		
	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
Total loads (lbs)	864,087	38,267	4,532
Loading rates (lbs/ac)	692	31	4
Mean Annual Concentration (ppm)	122	5	1



<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	6.17	54	21
<i>Cropland</i>	340.00	2,357	776
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	1.34	75	8
<i>Medium-Density Mixed</i>	6.82	336	35
<i>High-Density Mixed</i>	5.85	288	30
<i>Low-Density Open Space</i>	0.91	51	5
<i>Farm Animals</i>	0	6,649	1,670
<i>Stream Bank Erosion</i>	71.93	93	38
<i>Subsurface Flow</i>	0	15,568	130
<i>Point Sources</i>	0	12,143	1,830
<i>Septic Systems</i>	0	741	0
<b>TOTAL</b>	<b>433</b>	<b>38,354</b>	<b>4,542</b>

Sub-Watershed 8 is a mix of land uses so both Ag and Urban BMP's will be explored. The lower reaches of the watershed are dominated by agriculture, while the mid reaches have a mix of commercial and industrial land uses, and the upper reaches have mostly residential development and a retirement community. For these reasons, we proposed both ag and urban BMP's within this watershed.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 15 acres in the developed areas, Green Infrastructure approaches on 40 acres of Low-Density development, and 20 acres on Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 1,000 ft. of the developed retirement community as they expand their development.

Agricultural BMP Scenario:

Since most of the ag operations in this watershed have conservation plans, nutrient management plans and conservation practices, 300 acres are in ag plans, nutrient plans, and conservation practices and 60 will be proposed in the future. 1.5 acres of buffers have been implemented in the watershed but an additional 20.7 acres could be added. 1,000 ft. of streambank stabilization has taken place in the watershed and 4,000 additional ft. could be added along with adding 3,000 ft. of fencing to add to the existing 3,000 ft. of fence.

Table 8-4: Wiki Watershed Load Reductions for Sub-Watershed 8

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	864,232	38,304	4,537	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	123,402	222	179	-	-	-
Loads Removed w/ Existing Agricultural BMP's	325,807	4,318	965	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	181,042	1,075	236	-	-	-
<b>TOTAL Loads Removed</b>	630,251	5,615	1,380	-	-	-
<b>New Reduced Load</b>	233,981	32,689	3,156	-	-	-
<b>Percent Reduction</b>	<b>73%</b>	<b>15%</b>	<b>30%</b>	-	-	-
<b>TOTAL Baseline Load</b>	538,425	33,985	3,572	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	304,444	1,297	415	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>57%</b>	<b>4%</b>	<b>12%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 8-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 15 (Medium Priority)** – lat. 40.0952; long. -76.0791 (Earl Twp.)
- **\*\*Site # 14 (Medium Priority)** – lat. 40.0945; long. -76.0806 (Earl Twp.)
- **Site # 13 (Medium-Low Priority)** – lat. 40.0847; long. -76.0869 (Earl Twp.)
- **\*Site # 12 (Medium Priority)** – lat. 40.0833; long. -76.0871 (Earl Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

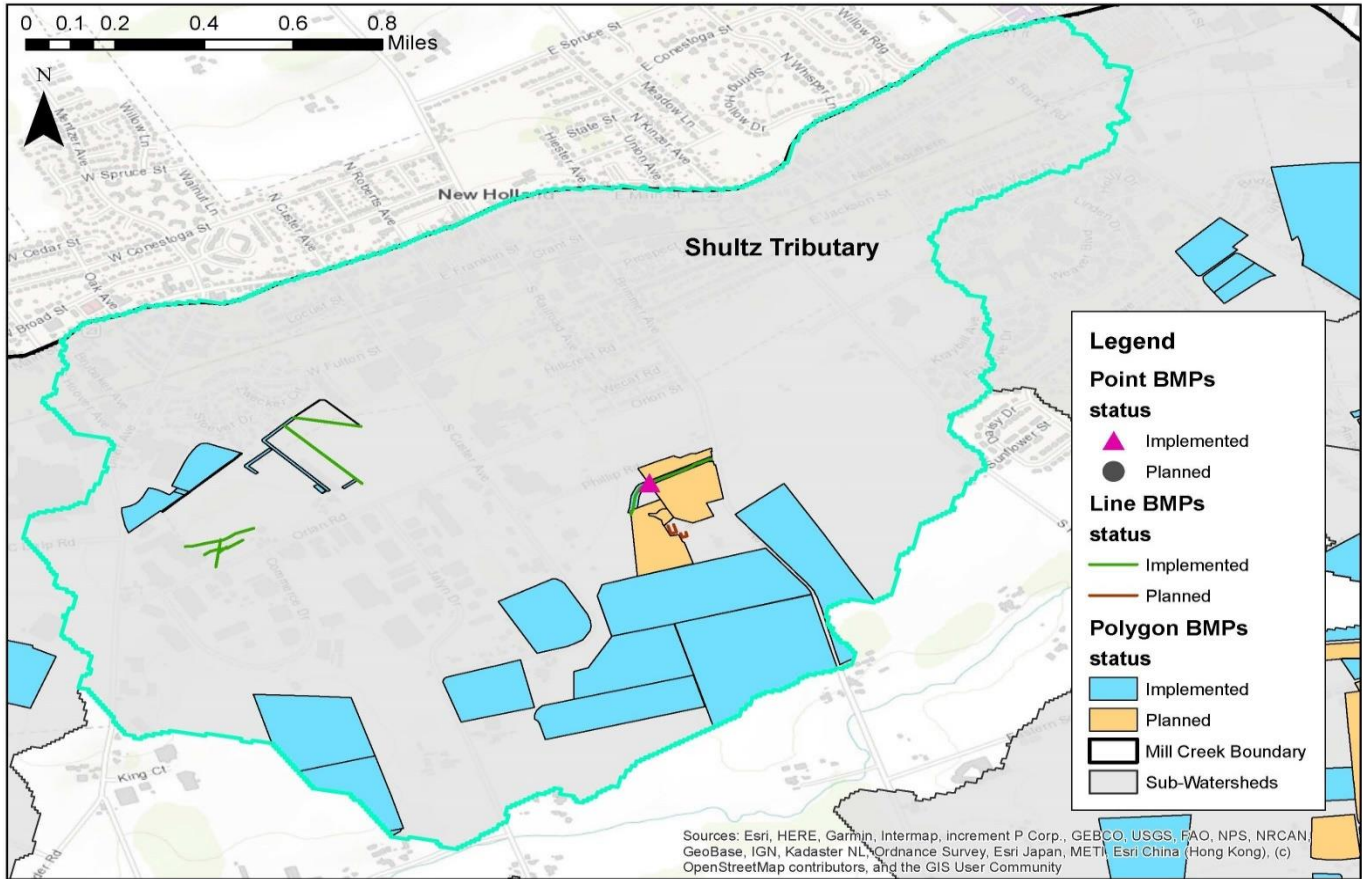
Table 8-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Riparian buffer	1.5 ac	\$2,500	\$3,750
Nutrient management plan	40	\$8	\$320
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$4,070</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	5.6 ac	\$2,500	\$14,000
Streambank Fencing	2,000'	\$8	\$16,000
Barnyard runoff controls	2	\$22,000	\$44,000
Small dam removal		Varies	Varies
Waste storage system	1	\$80,000	\$80,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Green Infrastructure	60 ac	Varies	Varies
Riparian buffer	30.1 ac	\$2,500	\$72,250
Stream bank Stabilization	4,000'	\$130	\$520,000
Streambank Fencing	1,000'	\$8	\$8,000
Cover Crop	60 ac	\$20	\$1,200
Nutrient Management Plan	60 ac	\$8	\$480
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$755,930</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

# Shultz Tributary BMPs



Map 8-2: Completed & planned BMP's in the Sub-Watershed 8 according PracticeKeeper (2022)

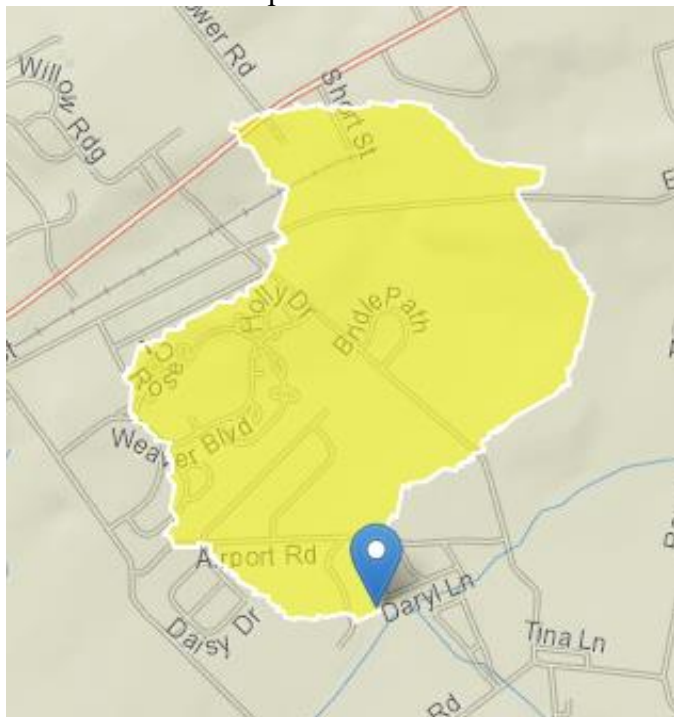
**Sub-Watershed 9 “Petra” Tributary**

**Priority Level 3**

Sub-Watershed 9, the “Petra” Tributary, is a 0.65 square mile watershed located directly southeast of Route 23 and New Holland and entering Mill Cr. south of Airport Rd. The stream is a NAHD named stream with four Cold Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57462657	2050306004599	0.02	Agriculture	Nutrients	Medium
Reach Location: Segment 1 (mouth)			Agriculture	Siltation	High
57462645	2050306004599	0.10	Agriculture	Nutrients	Medium
Reach Location: Segment 2 (mouth middle)			Agriculture	Siltation	High
57462633	2050306004599	0.02	Agriculture	Nutrients	Medium
Reach Location: Segment 3 (head middle)			Agriculture	Siltation	High
57462631	2050306004599	0.02	Agriculture	Nutrients	Medium
Reach Location: Segment 4 (headwaters)			Agriculture	Siltation	High

The tributary is mostly residential with one farm and one commercial business at the headwaters. The farm does have a conservation plan and several BMP’s as well but no animals.



Map 9-1: Stream Stat Map of Sub-Watershed 9



Table 9-1: Stream Stats Table for Sub-Watershed 9

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0955
Longitude of confluence	-76.0623
Mean basin slope in degrees	1.03°
Percent of basin with urban development	17.32%
Mean basin elevation	492 ft
Percent of area covered by forest	0.51%
Maximum basin elevation	558 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	66.22%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	31.08%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 9-2: Wiki Watershed Facts for Sub-Watershed 9

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	66.51	30.46
<i>Developed, Low Intensity</i>	36.80	16.85
<i>Developed, Open Space</i>	36.14	16.55
<i>Developed, High Intensity</i>	35.47	16.24
<i>Developed, Medium Intensity</i>	33.03	15.13
<i>Pasture/Hay</i>	10.42	4.77
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	196.44	89.95
<i>Slow Infiltration</i>	21.51	9.85
<i>Medium/Very Slow Infiltration</i>	0.44	0.2
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	484 ft	
<i>Minimum</i>	456 ft	
<i>Maximum</i>	526 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	3,494	0
<i>Pigs/hogs/swine</i>	127	0
<i>Turkeys</i>	75	0
<i>Cows, dairy</i>	39	90
<i>Horses</i>	5	0
<i>Sheep</i>	3	0
<i>Chicken, layers</i>	1	300
<i>Cows, beef</i>	0	0



Photos of Sub-Watershed 9 the "Petra" Tributary



Photos of Sub-Watershed 9 the "Petra" Tributary

Table 9-3: Wiki Watershed Loads Calculations for Sub-Watershed 9

<u>SOURCES</u>	<u>Loads</u>		
	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
Total loads (lbs)	146,404	4,970	487
Loading rates (lbs/ac)	670	23	2
Mean Annual Concentration (ppm)	195	7	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u> <u>(tons)</u></b>	<b><u>TOTAL NITROGEN</u> <u>(lbs)</u></b>	<b><u>TOTAL</u> <u>PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.78	6	2
<i>Cropland</i>	69.17	454	159
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.22	12	1
<i>Medium-Density Mixed</i>	0.95	49	5
<i>High-Density Mixed</i>	1.02	53	6
<i>Low-Density Open Space</i>	0.22	12	1
<i>Farm Animals</i>	0	1,148	288
<i>Stream Bank Erosion</i>	1.00	2	0
<i>Subsurface Flow</i>	0	3,144	25
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	102	0
<b>TOTAL</b>	<b>73</b>	<b>4,982</b>	<b>488</b>

Sub-Watershed 9 is under development pressure and could be developed in the next 10 years with residential or commercial development. Looking at the surrounding watershed, all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 15 acres in the developed areas, Green Infrastructure approaches on 35 acres of Low-Density development, and 15 acres on Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 1,000 ft. of the lower reaches of the watershed where a nearby development exists.

Agricultural BMP Scenario:

Since the one farm in this watershed has a conservation plan, conservation practices, and a fully implemented nutrient management plan, all 66 acres of cropland were considered in conservation protection measures. If by chance the farm would stay in agriculture in the future, we proposed about 4.6 acres of additional riparian buffer from what is already there. In addition, for this model run, we had to add 0.01 acres of scrub/shrub forest to have the model run this scenario.

Table 9-4: Wiki Watershed Load Reductions for Sub-Watershed 9

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	146,299	4,970	487	146,293	1,724	461
Loads Removed w/ Existing Urban BMP's						
Loads Removed w/ Proposed Urban BMP's	116,471	213	177	116,471	213	177
Loads Removed w/ Existing Agricultural BMP's	70,218	1,602	376	70,218	1,602	376
Loads Removed w/ Proposed Agricultural BMP's	19,879	83	20	19,879	83	20
<b>TOTAL Loads Removed</b>	206,568	1,898	572	206,568	1,898	572
<b>New Reduced Load</b>	(60,269)	3,072	(85)	(60,275)	(174)	(110)
<b>Percent Reduction</b>	<b>141%</b>	<b>38%</b>	<b>118%</b>	<b>141%</b>	<b>110%</b>	<b>124%</b>
<b>TOTAL Baseline Load</b>	76,081	3,368	111	76,074	122	86
<b>TOTAL Loads Removed from Baseline</b>	136,350	296	196	136,350	296	196
<b>Percent Reduction from Baseline Load</b>	<b>179%</b>	<b>9%</b>	<b>177%</b>	<b>179%</b>	<b>242%</b>	<b>229%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 9-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 35 (Low Priority)** – lat. 40.0988; long. -76.0655 (Earl Twp.)

Table 9-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Constructed wetlands	10 ac	\$12,000	\$120,000

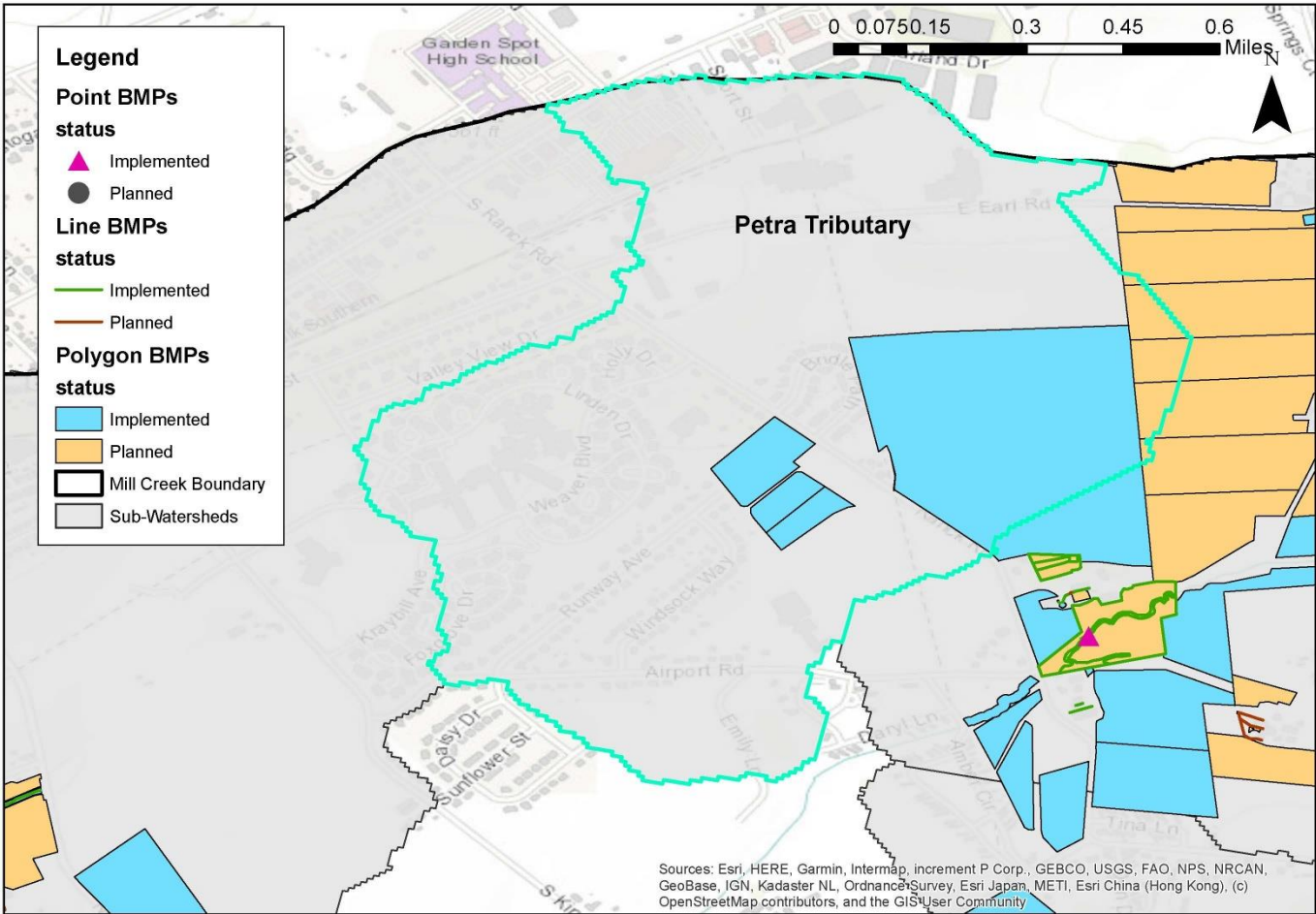
<b>Additional Future Proposed BMP's (NEW)</b>			
Green Infrastructure	50 ac	Varies	Varies
Riparian buffer	19.6 ac	\$2,500	\$49,000
Stream bank Stabilization	1,000'	\$130	\$130,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$299,000</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



## Petra Tributary BMPs



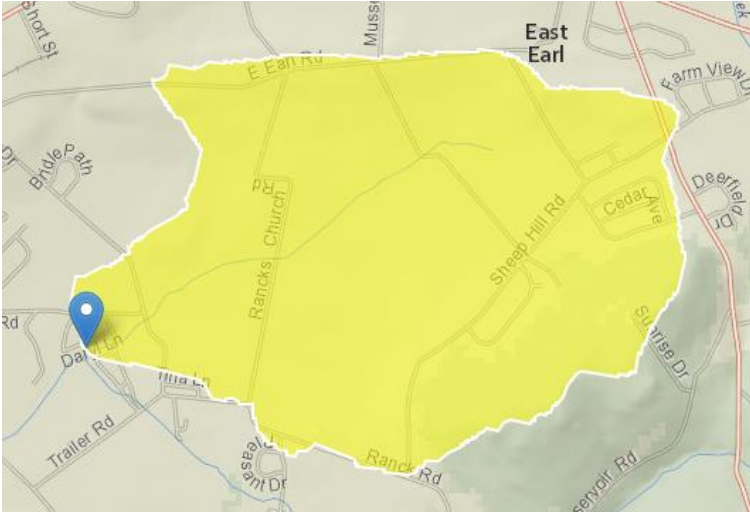
Map9-2: Completed & planned BMP's in the Sub-Watershed 9 according PracticeKeeper (2022)



## Sub-Watershed 10 “Ranck” Tributary

### Priority Level 1

Sub-Watershed 10, the “Ranck” Tributary, is a 1.9 square mile watershed located northeast of Ranck Rd. toward the headwaters of Mill Creek. The stream, 1.55 miles in length, is not a NAHD named stream but does not appear to be an intermittent stream and appears to run all year long. The majority of the tributary is agriculture with a small mix of residential as well. Recently conservation planning and nutrient management/manure management plans have been created for the majority of the operations in this tributary. About half of these conservation and nutrient management plans are implemented and half are just planned at this point and will need to be implemented in the future.



Map 10-1: Stream Stat Map of Sub-Watershed 10

Table 10-1: Stream Stats Table for Sub-Watershed 10

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0959
Longitude of confluence	-76.0606
Mean basin slope in degrees	3.07°
Percent of basin with urban development	1.68%
Mean basin elevation	543 ft
Percent of area covered by forest	19.39%
Maximum basin elevation	929 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	16.27%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	3.44%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 10-2: Wiki Watershed Facts for Sub-Watershed 10

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	731.43	51.00
<i>Deciduous Forest</i>	155.68	10.82
<i>Developed, Low Intensity</i>	140.85	9.89
<i>Developed, Open Space</i>	138.38	9.69
<i>Pasture/Hay</i>	101.31	7.10
<i>Developed, High Intensity</i>	76.60	5.40
<i>Developed, Medium Intensity</i>	64.25	4.47
<i>Mixed Forest</i>	14.83	0.96
<i>Emergent Herbaceous Wetlands</i>	7.41	0.48
<i>Shrub/Scrub</i>	2.47	0.20
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,069.96	74.67
<i>Slow Infiltration</i>	311.35	21.77
<i>Medium/Very Slow Infiltration</i>	51.89	3.56
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	536 ft	
<i>Minimum</i>	456 ft	
<i>Maximum</i>	921 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	22,942	0
<i>Pigs/hogs/swine</i>	836	250
<i>Turkeys</i>	497	0
<i>Cows, dairy</i>	258	755
<i>Horses</i>	36	12
<i>Sheep</i>	25	0
<i>Chicken, layers</i>	11	300
<i>Cows, beef</i>	0	0



Photos of Sub-Watershed 10 the “Ranck” Tributary



Photos of Sub-Watershed 10 the “Ranck” Tributary

Table 10-3: Wiki Watershed Loads Calculations for Sub-Watershed 10

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
Total loads (lbs)	1,604,757	41,422	4,000
Loading rates (lbs/ac)	1,119	29	3
Mean Annual Concentration (ppm)	284	7	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
Hay/Pasture	7.28	61	25
Cropland	770.77	5,043	1,791
Wooded Areas	0.42	8	1
Wetlands	0.01	1	0

<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.87	47	5
<i>Medium-Density Mixed</i>	1.78	94	10
<i>High-Density Mixed</i>	2.15	114	12
<i>Low-Density Open Space</i>	0.85	46	5
<i>Farm Animals</i>	0	7,639	1,917
<i>Stream Bank Erosion</i>	20.07	24	11
<i>Subsurface Flow</i>	0	28,240	234
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	200	0
<b>TOTAL</b>	<b>804</b>	<b>41,516</b>	<b>4,009</b>

Sub-Watershed 10 is all agricultural in land use with the majority of farms having conservation and nutrient management plans. Conservation practices are about 50% implemented and another 50% planned, so some additional work needs to take place in this headwater sub-watershed. Because this is a Priority Level 1 Watershed, the goal would be an 80% implementation rate with the BMP's proposed in this watershed to achieve documented load reductions.

Urban BMP Scenario:

No urban BMP's were called out with this scenario due to limited land use.

Agricultural BMP Scenario:

Since the majority of farms in this watershed have conservation and nutrient management plans, most of the proposed work is for field practices and other conservation BMP's. Roughly 500 acres of conservation work, like cover crops and no-till, have been done in the watershed with another 230 acres left to accomplish. Additional ag BMP's needed would include about 29.8 acres of riparian buffer because it is lacking right now in the watershed. We also proposed to add 9,200 ft. of streambank fencing to the current 4,000 ft. of fencing already in place. Finally, we would propose about 4,000 ft. of streambank stabilization measures to enhance habitat and streambanks in the watershed.

Table 10-4: Wiki Watershed Load Reductions for Sub-Watershed 10

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	1,606,707	41,471	4,005	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	615,543	12,738	3,041	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	335,354	1,102	439	-	-	-
<b>TOTAL Loads Removed</b>	950,897	13,840	3,480	-	-	-
<b>New Reduced Load</b>	655,810	27,631	525	-	-	-
<b>Percent Reduction</b>	<b>59%</b>	<b>33%</b>	<b>87%</b>	-	-	-

<b>TOTAL Baseline Load</b>	991,165	28,733	963		-	-	-
<b>TOTAL Loads Removed from Baseline</b>	335,354	1,102	439		-	-	-
<b>Percent Reduction from Baseline Load</b>	<b><u>34%</u></b>	<b><u>4%</u></b>	<b><u>46%</u></b>		-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 10-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 41 (Medium-Low Priority)** – lat. 40.1066; long. -76.0336 (E. Earl Twp.)
- **Site # 40 (Medium-Low Priority)** – lat. 40.1052; long. -76.0398 (E. Earl Twp.)
- **Site # 39 (Medium-Low Priority)** – lat. 40.1006; long. -76.0485 (E. Earl Twp.)
- **Site # 38 (Medium-Low Priority)** – lat. 40.1001; long. -76.0507 (E. Earl Twp.)

*Table 10-5: Existing, Proposed, and New BMP's Estimated Cost*

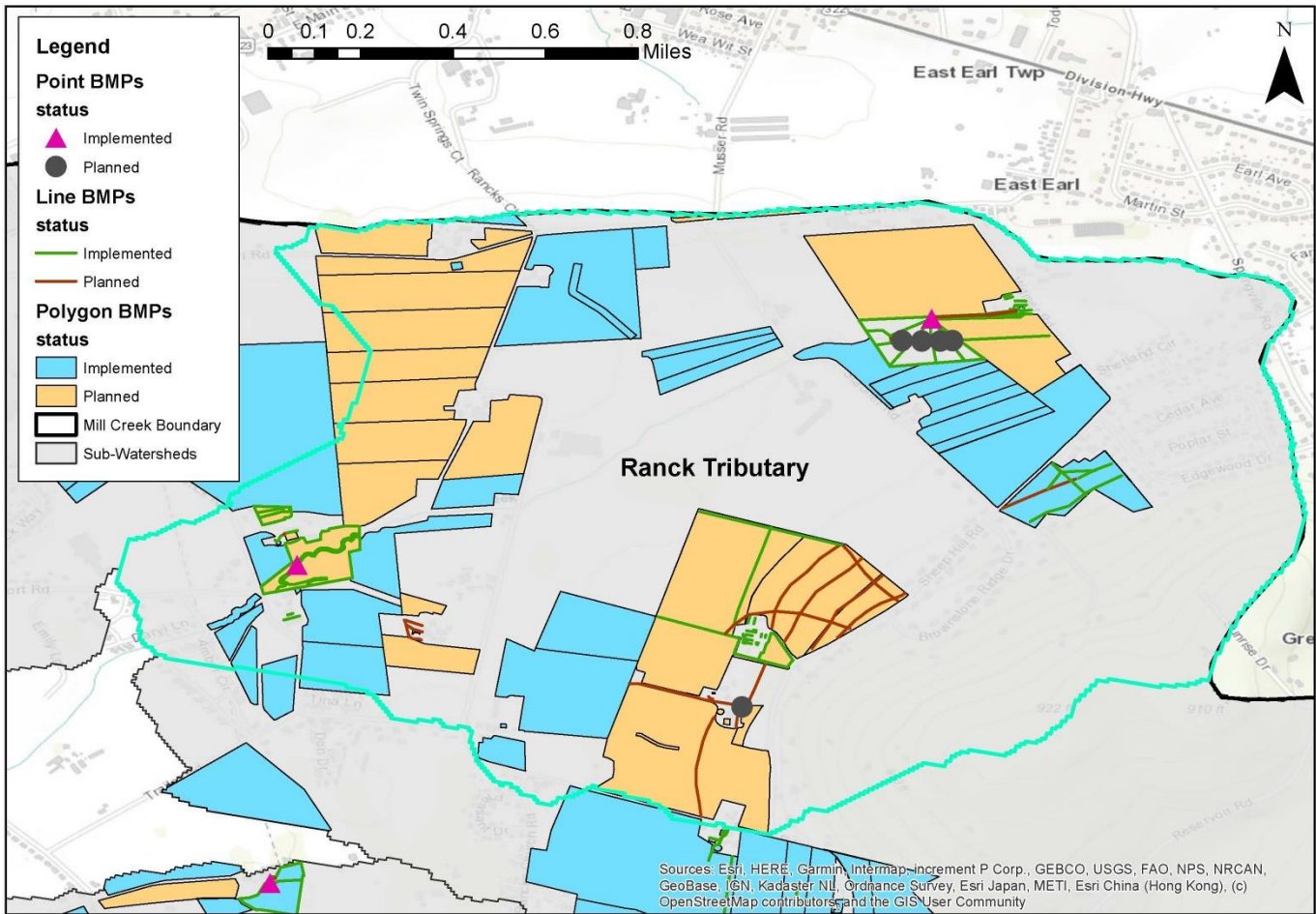
<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Barnyard runoff controls	1	\$22,000	\$22,000
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$22,000</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Streambank Fencing	9,200'	\$8	\$73,600
Riparian Buffer	7.4 ac	\$2,500	\$18,500
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	22.4 ac	\$2,500	\$56,000
Stream bank Stabilization	4,000'	\$130	\$520,000
Cover Crop	230 ac	\$20	\$4,600
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$672,700</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



# Ranck Tributary BMPs



Map10-2: Completed & planned BMP's in the Sub-Watershed 10 according PracticeKeeper (2022)

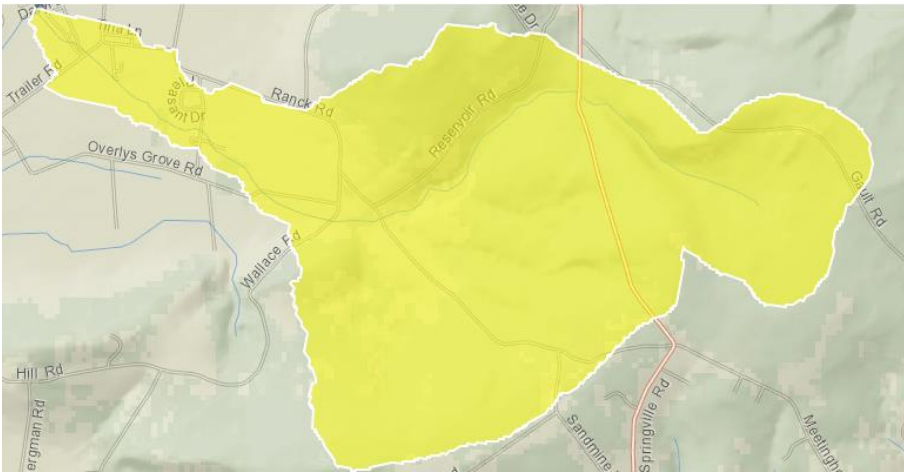
**Sub-Watershed 11 “Welsh Mtn.” Tributary**

**No Priority Level – NOT IMPAIRED**

Sub-Watershed 11, the “Welsh Mtn.” Tributary, is a 2.78 square mile watershed located on the Welsh Mountain off Reservoir Rd. and entering Mill Cr. North of Trailer Rd. The stream is a NAHD named stream with eleven Cold Water Fishery COMID reach numbers. Also, it should be noted that this sub-watershed is not an impaired watershed.

<b><u>COMID #</u></b>	<b><u>NHD Reach Codes</u></b>	<b><u>Length (mi)</u></b>	<b><u>Designated Use</u></b>	<b><u>Segment Location</u></b>
57462743	2050306001314	1.60	CWF	Mouth to West Tributary confluence
57462777	2050306004614	0.26	CWF	West Trib. Segment 1 (Mouth)(West of Ranck Rd.)
57462779	2050306004614	0.02	CWF	West Trib. Segment 2 (West of Ranck Rd.)
57462785	2050306004614	0.10	CWF	West Trib. Segment 3 (West of Ranck Rd.)
57462791	2050306004614	0.04	CWF	West Trib. Segment 4 (West of Ranck Rd.)
57462835	2050306004614	0.35	CWF	West Trib. Segment 5 (West of Ranck Rd.)
57462735	2050306001314	0.17	CWF	Segment between West & Central tribs.
57462749	2050306004608	0.88	CWF	Central Trib. (West of Ranck Rd.)
57462721	2050306001314	0.23	CWF	East Trib. Segment 1 (Mouth)(Mouth to Reservoir)
57462679	2050306001314	0.19	CWF	East Trib. Segment 2 (Reservoir)
57462671	2050306001314	1.46	HQ-CWF	East Trib. Segment 3 (above Reservoir to Welsh Mtn.)

The tributary is mostly residential, forest, and agriculture. Most if not all farm operations have conservation and nutrient management plans. The forested nature of this watershed is the reason why this sub-watershed is not currently impaired. Also, part of the forested area is owned by the Lancaster County Conservancy as part of their Welsh Mountain Preserve. The tributary through that section has a very healthy population of native brook trout within the stream's reach.



Map 11: Stream Stat Map of Sub-Watershed 11

Table 11-1: Stream Stats Table for Sub-Watershed 11

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0957
Longitude of confluence	-76.0601
Mean basin slope in degrees	5.01°
Percent of basin with urban development	1.41%
Mean basin elevation	808 ft
Percent of area covered by forest	79.59%
Maximum basin elevation	1,106 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.22%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.69%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 11-2: Wiki Watershed Facts for Sub-Watershed 11

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Deciduous Forest</i>	1,228.11	68.03
<i>Cultivated Crops</i>	143.32	7.89
<i>Pasture/Hay</i>	126.02	7.00
<i>Developed, Open Space</i>	118.61	6.59
<i>Mixed Forest</i>	79.07	4.43
<i>Developed, Low Intensity</i>	42.01	2.33
<i>Shrub/Scrub</i>	27.18	1.45
<i>Evergreen Forest</i>	12.36	0.75
<i>Developed, Medium Intensity</i>	9.88	0.52
<i>Grassland/Herbaceous</i>	9.88	0.50
<i>Open Water</i>	7.41	0.44
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,560.70	86.41
<i>Slow Infiltration</i>	190.27	10.47
<i>Medium/Very Slow Infiltration</i>	56.83	3.12



<u>ELEVATION</u>	<u>FEET</u>	
<i>Average</i>	802 ft	
<i>Minimum</i>	456 ft	
<i>Maximum</i>	1,103 ft	
<u>ANIMALS</u>	<u>NUMBERS</u>	<u>*Numbers According to PK</u>
<i>Chicken, broilers</i>	28,909	0
<i>Pigs/hogs/swine</i>	1,054	0
<i>Turkeys</i>	627	0
<i>Cows, dairy</i>	325	0
<i>Horses</i>	46	0
<i>Sheep</i>	31	0
<i>Chicken, layers</i>	14	0
<i>Cows, beef</i>	0	0

*\*still missing about 2-4 farms here*



*Photos of Sub-Watershed 11 the "Welsh Mtn." Tributary*



*Photos of Sub-Watershed 11 the "Welsh Mtn." Tributary*





*Photos of Sub-Watershed 11 the "Welsh Mtn." Tributary*



*Photos of Sub-Watershed 11 the "Welsh Mtn." Tributary*



Table 11-3: Wiki Watershed Loads Calculations for Sub-Watershed 11

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	435,601	29,744	3,100
<i>Loading rates (lbs/ac)</i>	242	17	2
<i>Mean Annual Concentration (ppm)</i>	64	4	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	5.86	60	24
<i>Cropland</i>	177.20	1,132	410
<i>Wooded Areas</i>	2.16	59	7
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0.30	6	1
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.23	11	1
<i>Medium-Density Mixed</i>	0.32	12	1
<i>High-Density Mixed</i>	0.03	1	0
<i>Low-Density Open Space</i>	0.66	32	4
<i>Farm Animals</i>	0	9,730	2,443
<i>Stream Bank Erosion</i>	31.54	40	18
<i>Subsurface Flow</i>	0	18,701	199
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	28	0
<b>TOTAL</b>	<b>218</b>	<b>29,811</b>	<b>3,107</b>

Sub-Watershed 11 is another headwater area of the Mill Cr. and one that is for the most part forested thus why this watershed is not impaired. There is some residential and agriculture in the watershed but all of this is minimal compared to the forested area.

Urban BMP Scenario:

No urban BMP's called for in this very rural watershed.

Agricultural BMP Scenario:

About 50% of the farms in the watershed have conservation plans and nutrient management plans thus 50% have conservation practices implemented as well. The majority of the watershed is forested at least within the Welsh Mtn. but the lowlands of the watershed still need about 23 acres of additional riparian buffer from what is already there which is about 23 acres. Also, only about 3,000 ft. of streambank fencing is in place so an additional 2,500 ft will need to be added along with about 2,000 ft. of streambank stabilization measures to enhance all of this work.

Table 11-4: Wiki Watershed Load Reductions for Sub-Watershed 11

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	435,273	29,780	3,104	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	332,182	10,034	2,298	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	217,333	2,251	347	-	-	-
<b>TOTAL Loads Removed</b>	549,514	12,284	2,644	-	-	-
<b>New Reduced Load</b>	(114,242)	17,495	459	-	-	-
<b>Percent Reduction</b>	<b>126%</b>	<b>41%</b>	<b>85%</b>	-	-	-
<b>TOTAL Baseline Load</b>	103,091	19,746	806	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	217,333	2,251	347	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>211%</b>	<b>11%</b>	<b>43%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 11-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 34 (Medium Priority)** – lat. 40.0841; long. -76.0353 (E. Earl Twp.)
- **Site # 33 (Medium Priority)** – lat. 40.0847; long. -76.0371 (E. Earl Twp.)
- **Site # 27 (High Priority)** – lat. 40.0835; long. -76.0377 (E. Earl Twp.)
- **Site # 32 (High-Medium Priority)** – lat. 40.0838; long. -76.0390 (E. Earl Twp.)

Table 11-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>

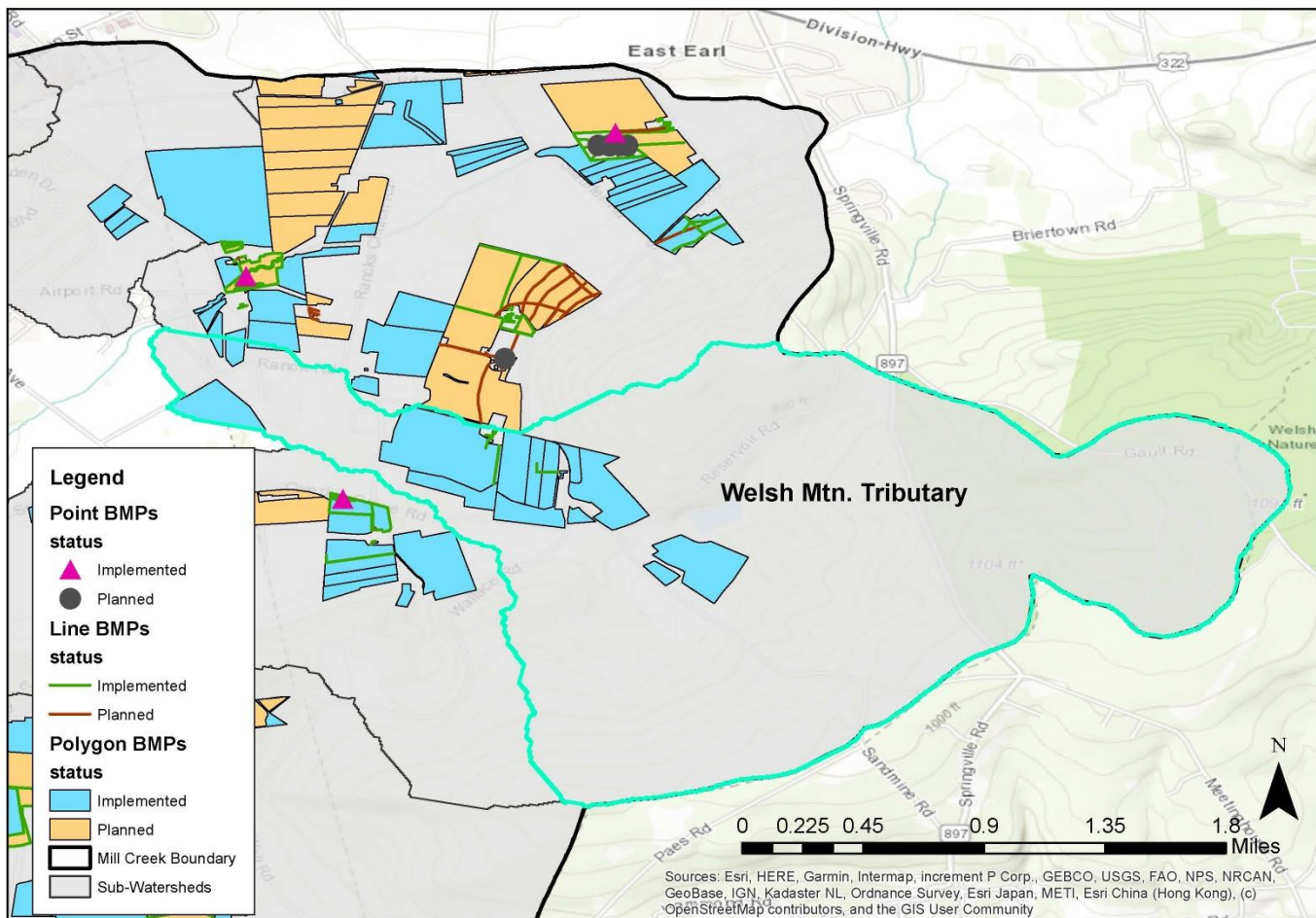
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian Buffer	3.7 ac	\$2,500	\$9,250
Conservation crop rotation	13.1 ac	\$11	\$144
Pasture/hayland planting	10.7 ac	\$300	\$3,210
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	19.3 ac	\$2,500	\$48,250
Stream bank Stabilization	2,000'	\$130	\$260,000
Cover Crop	70 ac	\$20	\$1,400
Streambank Fencing	2,500'	\$8	\$20,000
Nutrient Management Plan	70 ac	\$8	\$560
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$342,814</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



## Welsh Mtn. Tributary BMPs



Map11-2: Completed & planned BMP's in the Sub-Watershed 11 according PracticeKeeper (2022)

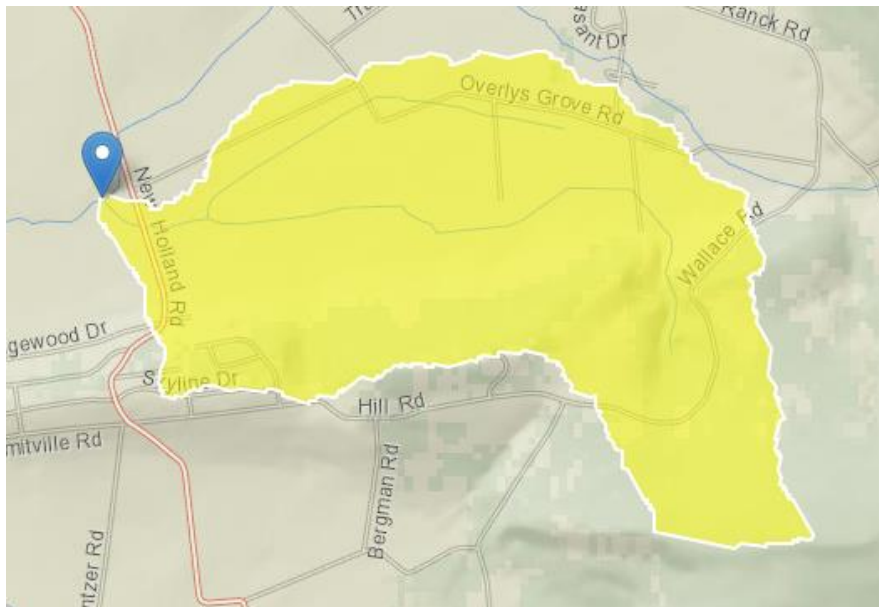
**Sub-Watershed 12 “New Holland Road” Tributary**

**No Priority Level – NOT IMPAIRED**

Sub-Watershed 12, the “New Holland Road” Tributary, is a 1.44 square mile watershed located on the west of Wallace Rd., South of Overlys Grove Rd., and East of New Holland Rd. and entering Mill Cr. West of New Holland Rd. The stream is a NAHD named stream with three COMID reach numbers. Also, should be noted that this sub-watershed is not an impaired watershed and is listed as a Warm Water Fishery. This sub-watershed could be reevaluated to have its designated use changed to Cold Water Fishery in the future.

<b><u>COMID #</u></b>	<b><u>NHD Reach Codes</u></b>	<b><u>Length (mi)</u></b>	<b><u>Designated Use</u></b>	<b><u>Segment Location</u></b>
57462809	2050306001311	0.33	WWF	Mouth to North & South Tributary confluence
57462801	2050306001313	1.15	WWF	North Trib. (S. Kinzer/Overlys Grove)
57462813	2050306001312	1.73	WWF	South Trib. (Wallace)

The tributary is mostly residential, forest, and agriculture. About 90% of all farm operations have conservation and nutrient management plans in the watershed and most of the plans have been implemented according to District records. The majority of the headwaters of this watershed is either forested or residential and then it travels down to more of the lowland Piedmont areas that are farmed.



Map 12-1: Stream Stat Map of Sub-Watershed 12

Table 12-1: Stream Stats Table for Sub-Watershed 12

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0834
Longitude of confluence	-76.0753
Mean basin slope in degrees	4.10°
Percent of basin with urban development	0.10%
Mean basin elevation	570 ft
Percent of area covered by forest	42.35%
Maximum basin elevation	978 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	6.57%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.54%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 12-2: Wiki Watershed Facts for Sub-Watershed 12

<b><u>ENTIRE 12 WATERSHED Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	400.31	44.82
<i>Deciduous Forest</i>	244.63	27.58
<i>Pasture/Hay</i>	64.25	7.27
<i>Developed, Open Space</i>	61.78	6.89
<i>Mixed Forest</i>	49.42	5.53
<i>Developed, Low Intensity</i>	37.07	4.03
<i>Developed, Medium Intensity</i>	14.83	1.72
<i>Grassland/Herbaceous</i>	7.41	0.75
<i>Developed, High Intensity</i>	4.94	0.60
<i>Shrub/Scrub</i>	4.94	0.60
<i>Evergreen Forest</i>	2.47	0.22
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	689.42	77.43
<i>Slow Infiltration</i>	200.16	22.57
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	572 ft	
<i>Minimum</i>	435 ft	
<i>Maximum</i>	982 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	14,258	27,400
<i>Pigs/hogs/swine</i>	519	0
<i>Turkeys</i>	309	0
<i>Cows, dairy</i>	160	39
<i>Horses</i>	22	29
<i>Sheep</i>	15	0
<i>Chicken, layers</i>	7	9,000
<i>Cows, beef</i>	0	55

\*2-3 farms missing data





Photos of Sub-Watershed 13 the “New Holland Road” Tributary

Table 12-3: Wiki Watershed Loads Calculations for Sub-Watershed 12

<b><u>ENITRE 12 WATERSHED Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	837,782	31,693	2,321
<i>Loading rates (lbs/ac)</i>	939	36	3
<i>Mean Annual Concentration (ppm)</i>	239	9	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	4.14	36	14
<i>Cropland</i>	397.19	2,637	916
<i>Wooded Areas</i>	0.65	17	2
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0.15	4	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.20	10	1
<i>Medium-Density Mixed</i>	0.50	21	2
<i>High-Density Mixed</i>	0.18	8	1
<i>Low-Density Open Space</i>	0.35	18	2
<i>Farm Animals</i>	0	5,333	1,189
<i>Stream Bank Erosion</i>	16.49	20	9
<i>Subsurface Flow</i>	0	24,208	189
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	49	0
<b>TOTAL</b>	<b>420</b>	<b>32,360</b>	<b>2,327</b>

Sub-Watershed 12 is another watershed not impaired and with ag land uses and farms with conservation and nutrient management plans already in place. This also includes conservation practices already in place as well.

Urban BMP Scenario:

No urban BMP's are needed in this watershed presently.

Agricultural BMP Scenario:

In this non-impaired watershed, about 75% of the farms have conservation and nutrient management plans along with conservation practices like no-till and cover crops. That leaves 25% to implement these farm practices. In addition to the 23 acres of buffers in the watershed, it is proposed to add 27.6 acres to this total. About 50% or 8,000 ft. of streambank fencing is in place presently, so this should be added to by another 8,000 ft. along with 6,400 ft. of streambank stabilization measures.

Table 12-4: Wiki Watershed Load Reductions for Sub-Watershed 12

	<b>ENTIRE WATERSHED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	838,989	32,342	2,325			
Loads Removed w/ Existing Urban BMP's						
Loads Removed w/ Proposed Urban BMP's						
Loads Removed w/ Existing Agricultural BMP's	513,706	6,382	1,208			
Loads Removed w/ Proposed Agricultural BMP's	239,246	1,963	385			
<b>TOTAL Loads Removed</b>	752,952	8,345	1,594			
<b>New Reduced Load</b>	86,037	23,997	731			
<b>Percent Reduction</b>	<b>90%</b>	<b>26%</b>	<b>69%</b>			
<b>TOTAL Baseline Load</b>	325,283	25,960	1,116			
<b>TOTAL Loads Removed from Baseline</b>	239,246	1,963	385			
<b>Percent Reduction from Baseline Load</b>	<b>74%</b>	<b>8%</b>	<b>35%</b>			

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 12-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 31 (High-Medium Priority)** – lat. 40.0841; long. -76.0409 (E. Earl Twp.)
- **Site # 30 (Medium Priority)** – lat. 40.0856; long. -76.0444 (E. Earl Twp.)
- **\*\*Site # 29 (High-Medium Priority)** – lat. 40.0864; long. -76.0507 (E. Earl Twp.)
- **Site # 28 (Medium Priority)** – lat. 40.0870; long. -76.0538 (E. Earl Twp.)
- **Site # 22 (High-Medium Priority)** – lat. 40.0875; long. -76.0605 (Earl Twp.)
- **\*Site # 5 (High-Medium Priority)** – lat. 40.0867; long. -76.0635 (Earl Twp.)
- **Site # 17 (Medium Priority)** – lat. 40.0876; long. -76.0614 (Earl Twp.)
- **\*Site # 18 (High-Medium Priority)** – lat. 40.0837; long. -76.0756 (Earl Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 12-5: Existing, Proposed, and New BMP's Estimated Cost

<b>Combined BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Nutrient management plan	167.3 ac	\$8	\$1,338
Conservation crop rotation	62.3 ac	\$11	\$685
Residue management, seasonal	48.7 ac	\$20	\$974
Residue management, no-till	13.6 ac	\$19	\$258
Cover crop	62.3 ac	\$20	\$1,246
Riparian buffer	1.1 ac	\$2,500	\$2,750
Streambank Fencing	800'	\$8	\$6,400
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$13,651</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian Buffer	9.3 ac	\$2,500	\$23,250
Stream bank Stabilization	6,400'	\$130	\$832,000
Streambank Fencing	6,200'	\$8	\$49,600
Grassed waterway	1 ac	\$4,500	\$4,500
Prescribed grazing	9.6 ac	\$50	\$480
Field borders	0.5 ac	\$150	\$75
Barnyard runoff controls	1	\$22,000	\$22,000
Waste storage system	1	\$80,000	\$80,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	18.3 ac	\$2,500	\$45,750
Cover Crop	100 ac	\$20	\$2,000
Streambank Fencing	1,800'	\$8	\$14,400
Nutrient Management Plan	100 ac	\$8	\$800
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$1,074,855</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

Below is additional Wiki Watershed data for tributaries within “New Holland Road” Tributary. Models were not run on these tributaries, but data is provided as background information on them.

<b><u>NORTH TRIB. WATERSHED (Overlys Grove) Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	115.29	63.49
<i>Developed, Low Intensity</i>	17.52	9.65
<i>Pasture/Hay</i>	16.63	9.16
<i>Developed, Open Space</i>	14.19	7.81
<i>Developed, Medium Intensity</i>	8.43	4.64
<i>Shrub/Scrub</i>	3.10	1.71
<i>Grassland/Herbaceous</i>	2.22	1.22
<i>Developed, High Intensity</i>	1.77	0.98
<i>Mixed Forest</i>	1.55	0.85
<i>Deciduous Forest</i>	0.44	0.24
<i>Evergreen Forest</i>	0.44	0.24
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Slow Infiltration</i>	102.43	56.41
<i>Moderate Infiltration</i>	79.15	43.59
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	469 ft	
<i>Minimum</i>	439 ft	
<i>Maximum</i>	521 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	2,906	
<i>Pigs/hogs/swine</i>	105	
<i>Turkeys</i>	63	
<i>Cows, dairy</i>	32	
<i>Horses</i>	4	
<i>Sheep</i>	3	
<i>Chicken, layers</i>	1	
<i>Cows, beef</i>	0	

<b><u>NORTH TRIB. WATERSHED (Overlys Grove) Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	271,514	7,137	584
<i>Loading rates (lbs/ac)</i>	1,492	39	3
<i>Mean Annual Concentration (ppm)</i>	424	11	1

<b>Load Sources</b>			
<b>SOURCES</b>	<b>SEDIMENT (lbs)</b>	<b>TOTAL NITROGEN (lbs)</b>	<b>TOTAL PHOSPHORUS (lbs)</b>
<i>Hay/Pasture</i>	2,847	11	4
<i>Cropland</i>	261,189	840	298
<i>Wooded Areas</i>	18	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	2	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	217	6	1
<i>Medium-Density Mixed</i>	560	11	1
<i>High-Density Mixed</i>	115	2	0
<i>Low-Density Open Space</i>	177	5	0
<i>Farm Animals</i>	0	944	237
<i>Stream Bank Erosion</i>	6,391	4	2
<i>Subsurface Flow</i>	0	5,283	39
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	28	0

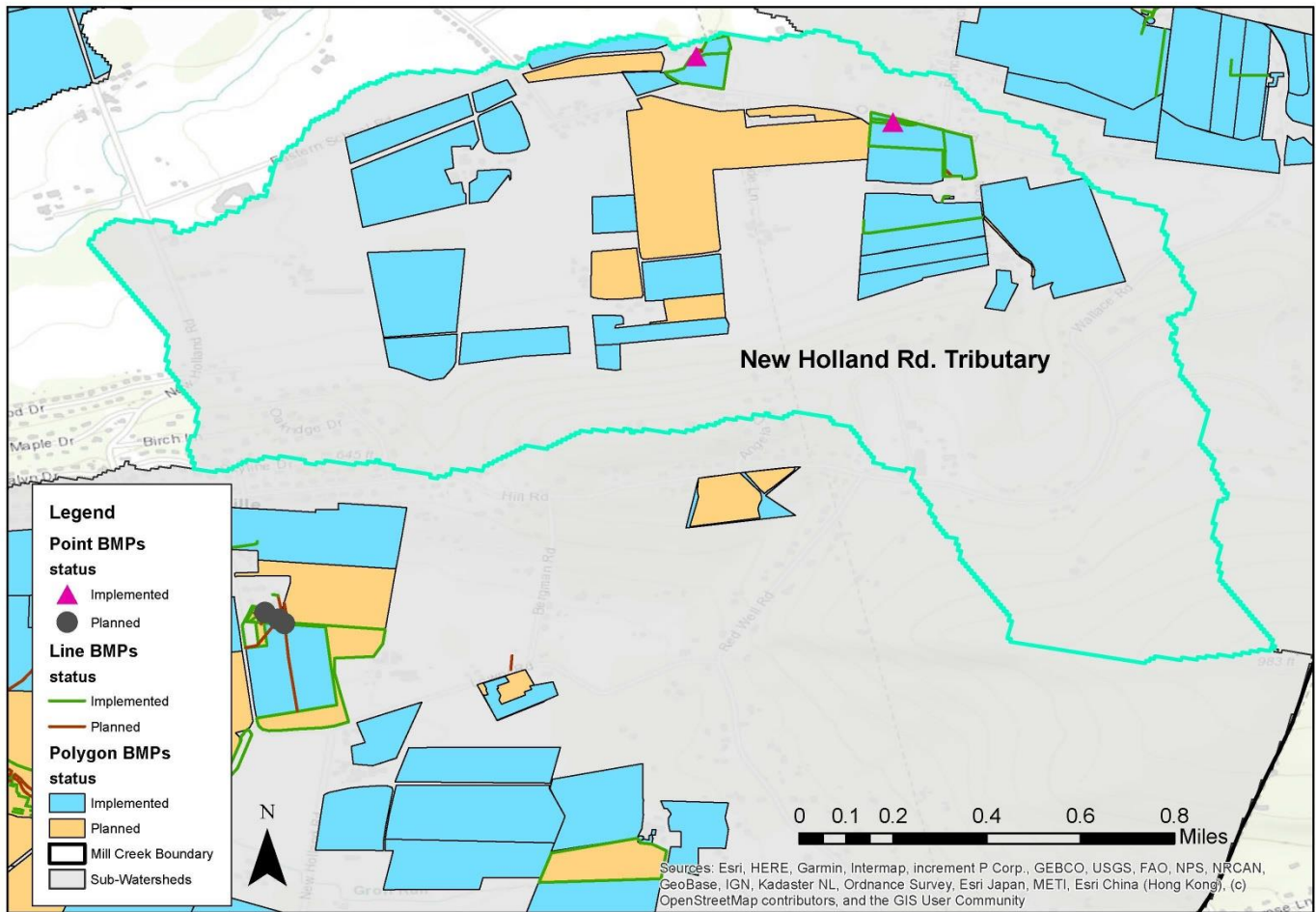
<b>SOUTH TRIB. WATERSHED (Wallace) Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	249.58	40.10
<i>Deciduous Forest</i>	242.16	38.88
<i>Mixed Forest</i>	37.07	6.08
<i>Developed, Open Space</i>	32.12	5.33
<i>Pasture/Hay</i>	32.12	5.11
<i>Developed, Low Intensity</i>	12.36	1.82
<i>Developed, Medium Intensity</i>	4.94	0.89
<i>Grassland/Herbaceous</i>	4.94	0.71
<i>Developed, High Intensity</i>	2.47	0.57
<i>Evergreen Forest</i>	2.47	0.25
<i>Shrub/Scrub</i>	2.47	0.25
<b>SOILS</b>	<b>ACRES</b>	<b>%</b>
<i>Moderate Infiltration</i>	551.04	88.81
<i>Slow Infiltration</i>	69.19	11.19
<b>ELEVATION</b>	<b>FEET</b>	
<i>Average</i>	612 ft	
<i>Minimum</i>	439 ft	
<i>Maximum</i>	982 ft	



<u>ANIMALS</u>	<u>NUMBERS</u>	
<i>Chicken, broilers</i>	9,928	
<i>Pigs/hogs/swine</i>	362	
<i>Turkeys</i>	215	
<i>Cows, dairy</i>	111	
<i>Horses</i>	15	
<i>Sheep</i>	10	
<i>Chicken, layers</i>	5	
<i>Cows, beef</i>	0	

<u>SOUTH TRIB. WATERSHED (Wallace) Loads</u>			
<u>SOURCES</u>	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
<i>Total loads (lbs)</i>	443,373	20,046	1,497
<i>Loading rates (lbs/ac)</i>	714	32	2
<i>Mean Annual Concentration (ppm)</i>	180	8	1
<u>Load Sources</u>			
<u>SOURCES</u>	<u>SEDIMENT (lbs)</u>	<u>TOTAL NITROGEN (lbs)</u>	<u>TOTAL PHOSPHORUS (lbs)</u>
<i>Hay/Pasture</i>	3,872	17	7
<i>Cropland</i>	425,613	1,761	539
<i>Wooded Areas</i>	1,635	17	2
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	239	3	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	123	3	0
<i>Medium-Density Mixed</i>	386	9	1
<i>High-Density Mixed</i>	246	6	1
<i>Low-Density Open Space</i>	358	9	1
<i>Farm Animals</i>	0	3,282	825
<i>Stream Bank Erosion</i>	10,901	7	2
<i>Subsurface Flow</i>	0	14,915	119
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	18	0

# New Holland Rd. Tributary BMPs



Map12-2: Completed & planned BMP's in the Sub-Watershed 12 according PracticeKeeper (2022)

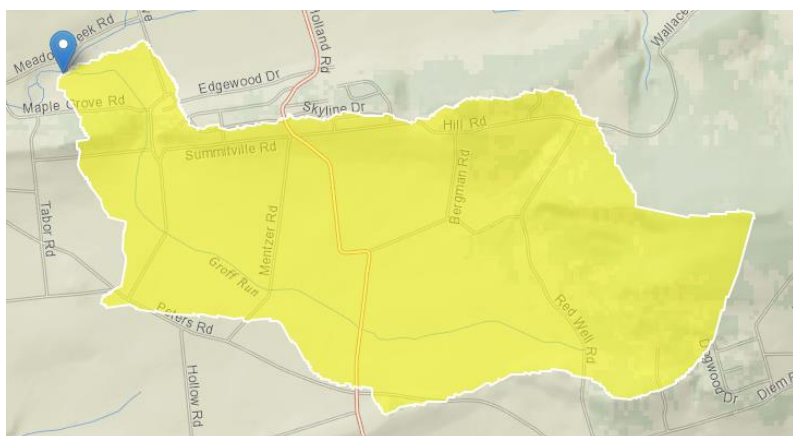
## Sub-Watershed 13 Groff Run Tributary

### Priority Level 1

Sub-Watershed 13, the Groff Run Tributary, is a 2.65 square mile watershed located directly east of Red Well Rd., North of Peters Rd., and south of Summitville Rd. and entering Mill Cr. south of Meadow Creek Rd. The stream is a NAHD named stream with four Warm Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL Priority</u>
57463007	2050306001310	1.90	Grazing in riparian zone	Nutrients	Medium
Reach Location: Mouth to North and South tributary confluence			Grazing in riparian zone	Siltation	High
57462999	2050306004629	0.95	Grazing in riparian zone	Nutrients	Medium
Reach Location: North Tributary Segment 1 (Mouth) (Lowery)			Grazing in riparian zone	Siltation	High
57462909	2050306004629	0.08	Grazing in riparian zone	Nutrients	Medium
Reach Location: North Tributary Segment 3 (Lowery)			Grazing in riparian zone	Siltation	High
57463031	2050306001310	1.26	Grazing in riparian zone	Nutrients	Medium
Reach Location: South Tributary (Redwell)			Grazing in riparian zone	Siltation	High

The tributary is mostly agriculture with a spattering of residential mixed in. About 75% of the farms in the sub-watershed have conservation and nutrient management plans, with about 50% of these plans implemented and the rest just planned at this point. Where outreach efforts need to be focused would be in the headwaters and mouth of the watershed where plans and conservation work currently lack according to District records.



Map 13-1: Stream Stat Map of Sub-Watershed 13

Table 13-1: Stream Stats Table for Sub-Watershed 13

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0784
Longitude of confluence	-76.0921
Mean basin slope in degrees	3.56°
Percent of basin with urban development	2.54%
Mean basin elevation	557 ft
Percent of area covered by forest	34.37%
Maximum basin elevation	983 ft.
Percentage of impervious area determined from NLCD 2001 impervious dataset	0.24%
Percentage of land-use from NLCD 2001 classes 21-24	1.44%
Percentage of developed (urban) land from NLCD 2011 classes 21-24	9.47%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.90%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 13-2: Wiki Watershed Facts for Sub-Watershed 13

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	637.53	43.20
<i>Pasture/Hay</i>	289.11	19.56
<i>Deciduous Forest</i>	212.51	14.37
<i>Developed, Open Space</i>	150.73	10.15
<i>Developed, Low Intensity</i>	86.49	5.88
<i>Mixed Forest</i>	51.89	3.47
<i>Developed, Medium Intensity</i>	17.30	1.17
<i>Shrub/Scrub</i>	14.83	0.96
<i>Developed, High Intensity</i>	49.94	0.35
<i>Evergreen Forest</i>	4.94	0.38
<i>Grassland/Herbaceous</i>	4.94	0.33
<i>Open Water</i>	2.47	0.17
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	939.00	63.73
<i>Slow Infiltration</i>	343.48	23.34
<i>Slow/Very Slow Infiltration</i>	138.38	9.44
<i>Very Slow Infiltration</i>	39.54	2.63
<i>Medium/Very Slow Infiltration</i>	12.36	0.86
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	516 ft	
<i>Minimum</i>	409 ft	
<i>Maximum</i>	771 ft	



<u>ANIMALS</u>	<u>NUMBERS</u>	
<i>Chicken, broilers</i>	23,585	
<i>Pigs/hogs/swine</i>	860	
<i>Turkeys</i>	511	
<i>Cows, dairy</i>	265	
<i>Horses</i>	37	
<i>Sheep</i>	25	
<i>Chicken, layers</i>	11	
<i>Cows, beef</i>	0	



*Photos of upper section of Sub-Watershed 13 the Groff Run Tributary*



*Photos of middle section of Sub-Watershed 13 the Groff Run Tributary*





Photos of lower section of Sub-Watershed 13 the Groff Run Tributary

Table 13-3: Wiki Watershed Loads Calculations for Sub-Watershed 13

<b><u>Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	1,462,891	38,947	3,820
<i>Loading rates (lbs/ac)</i>	993	26	3
<i>Mean Annual Concentration (ppm)</i>	274	7	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	37,972	171	64
<i>Cropland</i>	1,352,758	4,669	1,540
<i>Wooded Areas</i>	722	12	1
<i>Wetlands</i>	2	0	0
<i>Open Land</i>	0	2	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	993	25	3
<i>Medium-Density Mixed</i>	1,107	23	2
<i>High-Density Mixed</i>	332	7	1
<i>Low-Density Open Space</i>	1,713	44	5
<i>Farm Animals</i>	0	7,829	1,965
<i>Stream Bank Erosion</i>	67,291	44	18
<i>Subsurface Flow</i>	0	26,070	221
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	53	0

Sub-Watershed 13 is exclusively ag land use. Half of those farms have plans and the other half do not according to District records. Of the half that have plans, only about 50% have conservation practices on the ground called out in those plans. This watershed has potential if conservation practices are carried out and buffers are installed in the future. Because this is a Priority Level 1 Watershed, the goal would be an 80% implementation rate with the BMP's proposed in this watershed to achieve documented load reductions.

Urban BMP Scenario:

No urban BMP's are proposed for this watershed.

Agricultural BMP Scenario:

We are estimating that only about 200 acres of conservation practices like no-till, cover crop, and tillage practices have taken place within this watershed. That would still leave over 400 acres to be implemented in the future. Conservation planning and nutrient management planning are about 50% in the watershed presently, so this would need to increase by another 50% in the future. Minimal riparian buffer exists in the watershed, so about 20.5 acres are proposed and an additional 48.4 acres of buffer be added moving forward. With the proposed buffer increase the streambank fencing numbers would also need to be increased from about 5,000 ft. now to nearly 15,000 ft. in the future. Throw in about 17,200 ft. of streambank stabilization as well in some of the lower reaches of the watershed to assist in large-scale sediment loss.

Table 13-4: Wiki Watershed Load Reductions for Sub-Watershed 13

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> <i>(lbs/yr)</i>	<u>TN</u> <i>(lbs/yr)</i>	<u>TP</u> <i>(lbs/yr)</i>	<u>Sediment</u> <i>(lbs/yr)</i>	<u>TN</u> <i>(lbs/yr)</i>	<u>TP</u> <i>(lbs/yr)</i>
Initial MMW Load	1,464,499	38,993	3,824	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	294,395	5,543	1,476	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	779,872	2,671	953	-	-	-
<b>TOTAL Loads Removed</b>	1,074,267	8,214	2,429	-	-	-
<b>New Reduced Load</b>	390,232	30,779	1,395	-	-	-
<b>Percent Reduction</b>	<b>73%</b>	<b>21%</b>	<b>64%</b>	-	-	-
<b>TOTAL Baseline Load</b>	1,170,104	33,450	2,348	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	779,872	2,671	953	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>67%</b>	<b>8%</b>	<b>41%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 13-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this

model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 1 (High Priority)** – lat. 40.0628; long. -76.0518 (Earl Twp.)
- **Site # 25 (Medium-Low Priority)** – lat. 40.0630; long. -76.0682 (Earl Twp.)
- **Site # 26 (Medium Priority)** – lat. 40.0660; long. -76.0680 (Earl Twp.)
- **Site # 24 (High-Medium Priority)** – lat. 40.0654; long. -76.0754 (Earl Twp.)
- **Site # 23 (Medium Priority)** – lat. 40.0653; long. -76.0763 (Earl Twp.)
- **\*\*Site # 2 (Medium Priority)** – lat. 40.0735; long. -76.0730 (Earl Twp.)
- **Site # 3 (High-Medium Priority)** – lat. 40.0735; long. -76.0863 (Earl Twp.)
- **Site # 4 (High-Medium Priority)** – lat. 40.0786; long. -76.0884 (Earl Twp.)

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 13-5: Existing, Proposed, and New BMP's Estimated Cost

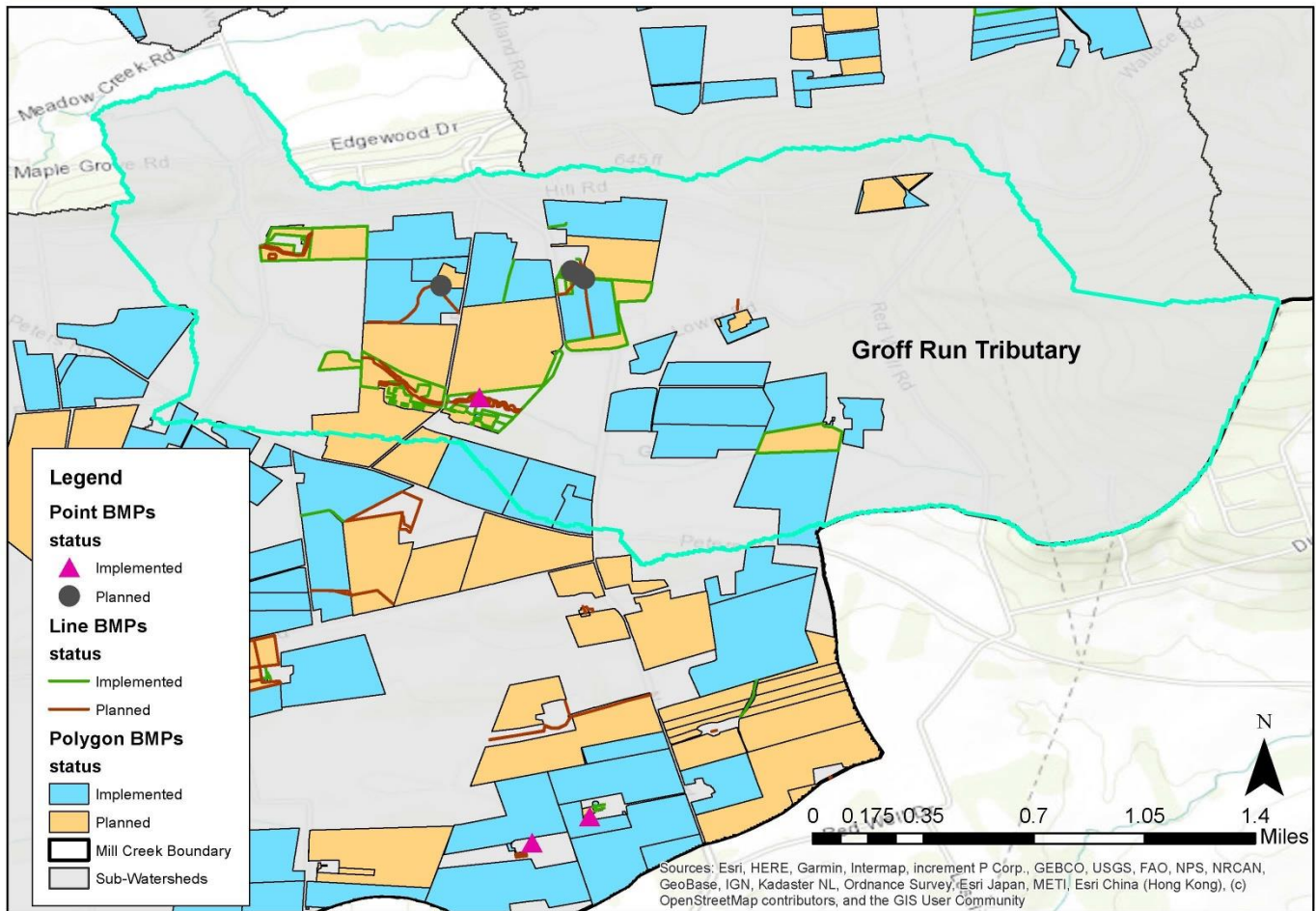
<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Conservation crop rotation	23.2 ac	\$11	\$255
Contour farming	23.1 ac	\$8	\$184
Cover crop	23.2 ac	\$20	\$464
Stripcropping, contour	23.1 ac	\$2	\$46
Nutrient management plan	27.1 ac	\$8	\$217
Pasture/hayland plantings	3.7 ac	\$300	\$1,110
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$2,276</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian Buffer	20.5 ac	\$2,500	\$51,250
Stream bank Stabilization	17,200'	\$130	\$2,236,000
Streambank Fencing	13,200'	\$8	\$105,000
Barnyard runoff controls	1	\$22,000	\$22,000
Waste storage system	1	\$80,000	\$80,000
Cover crop	68.2 ac	\$20	\$1,364
Nutrient management plan	68.2 ac	\$8	\$546
Stripcropping, contour	45 ac	\$2	\$90
Residue management, no-till	13.1 ac	\$19	\$249
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	48.4 ac	\$2,500	\$121,000
Cover Crop	361.8 ac	\$20	\$7,236
Streambank Fencing	1,800'	\$8	\$14,400
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$2,639,135</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



## Groff Run Tributary BMPs

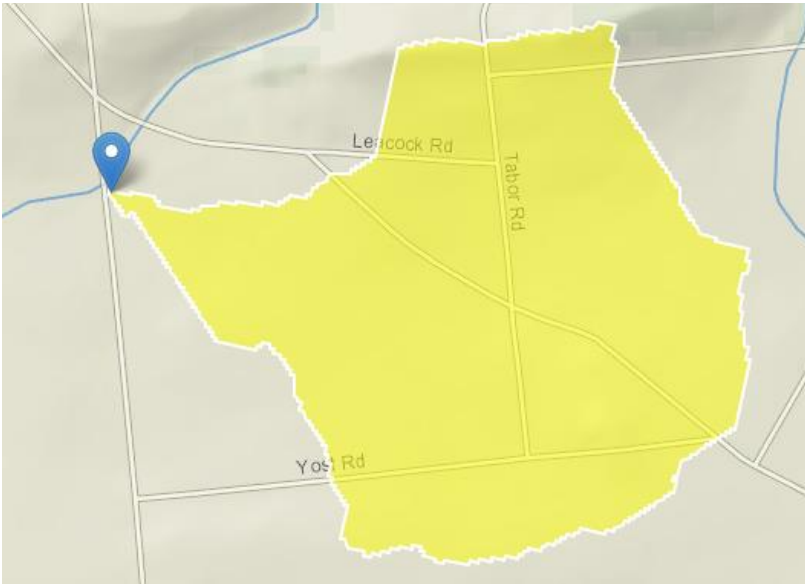


Map13-2: Completed & planned BMP's in the Sub-Watershed 13 according PracticeKeeper (2022)

## Sub-Watershed 14 “Tabor” Tributary

### Priority Level 2

Sub-Watershed 14, the “Tabor” Tributary, is a 0.44 square mile watershed located southeast of Hollander Rd. toward Tabor Rd. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential and agricultural land uses. Some of the farms have conservation plans and nutrient management plans but about half do not, or if they do have plans they have not been verified by the District to ensure those plans are in place and being implemented.



Map 14-1: Stream Stat Map of Sub-Watershed 14

Table 14-1: Stream Stats Table for Sub-Watershed 14

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0707
Longitude of confluence	-76.1051
Mean basin slope in degrees	1.89°
Percent of basin with urban development	0.00%
Mean basin elevation	445 ft
Percent of area covered by forest	0.67%
Maximum basin elevation	569 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	9.98%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	2.10%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity



Table 14-2: Wiki Watershed Facts for Sub-Watershed 14

<b>Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	170.72	82.09
<i>Pasture/Hay</i>	14.41	6.93
<i>Developed, Open Space</i>	14.19	6.82
<i>Developed, Low Intensity</i>	4.66	2.24
<i>Developed, Medium Intensity</i>	3.55	1.71
<i>Developed, High Intensity</i>	0.44	0.21
<b>SOILS</b>		
	<b>ACRES</b>	<b>%</b>
<i>Moderate Infiltration</i>	169.17	81.34
<i>Slow Infiltration</i>	38.80	18.66
<b>ELEVATION</b>		
	<b>FEET</b>	
<i>Average</i>	425 ft	
<i>Minimum</i>	388 ft	
<i>Maximum</i>	454 ft	
<b>ANIMALS</b>		
	<b>NUMBERS</b>	<b>*Numbers According to PK</b>
<i>Chicken, broilers</i>	3,323	0
<i>Pigs/hogs/swine</i>	121	13
<i>Turkeys</i>	72	50
<i>Cows, dairy</i>	37	188
<i>Horses</i>	5	44
<i>Sheep</i>	3	0
<i>Chicken, layers</i>	1	9,075
<i>Cows, beef</i>	0	55

\*2-3 farms missing data



Photos of Sub-Watershed 14 the "Tabor" Tributary

Table 14-3: Wiki Watershed Loads Calculations for Sub-Watershed 14

<b>Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	389,810	6,993	746
<i>Loading rates (lbs/ac)</i>	1,875	34	4
<i>Mean Annual Concentration (ppm)</i>	528	10	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	1.22	10	4
<i>Cropland</i>	193.81	1,280	432
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.02	1	0
<i>Medium-Density Mixed</i>	0.18	7	1
<i>High-Density Mixed</i>	0.03	1	0
<i>Low-Density Open Space</i>	0.07	4	0
<i>Farm Animals</i>	0	1,093	274
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	4,603	36
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	11	0
<b>TOTAL</b>	<b>195</b>	<b>7,009</b>	<b>748</b>

Sub-Watershed 14 is currently all in agricultural land use. The area is dominated by low-gradient croplands and pasturelands. Half the ag operations have conservation and nutrient management plans while the rest still need plans and conservation practices to improve the watershed.

Urban BMP Scenario:

No urban BMP's are planned for this very rural watershed.

Agricultural BMP Scenario:

Since only 50% of the farms in this watershed have plans and conservation practices for their operations, implementing more plans and practices should be the area of focus for this watershed. In addition, only about 1 acre of riparian buffer has been implemented in this watershed, so 6.9 acres of new buffer should be added to this total. Also, only about 500 ft. of streambank fencing has been implemented in the watershed, an additional 1,000 ft. should be added along with 500 ft. of streambank stabilization measures as well. It should be noted that 0.01 acres of scrub/shrub land use was added to the model to make it function properly.

Table 14-4: Wiki Watershed Load Reductions for Sub-Watershed 14

	<b>ENTIRE WATERSHED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	390,574	7,006	747	390,545	2,393	710
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	104,834	1,434	371	104,834	1,434	371
Loads Removed w/ Proposed Agricultural BMP's	139,404	946	274	139,404	946	274
<b>TOTAL Loads Removed</b>	244,238	2,381	645	244,238	2,381	645
<b>New Reduced Load</b>	146,309	4,625	102	146,306	12	65
<b>Percent Reduction</b>	<b>63%</b>	<b>34%</b>	<b>86%</b>	<b>63%</b>	<b>100%</b>	<b>91%</b>
<b>TOTAL Baseline Load</b>	285,712	5,572	376	285,710	959	339
<b>TOTAL Loads Removed from Baseline</b>	139,404	946	274	139,404	946	274
<b>Percent Reduction from Baseline Load</b>	<b>49%</b>	<b>17%</b>	<b>73%</b>	<b>49%</b>	<b>99%</b>	<b>81%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 14-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 103 (Low Priority)** – lat. 40.0690; long. -76.0933 (Earl Twp.)

Table 14-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>

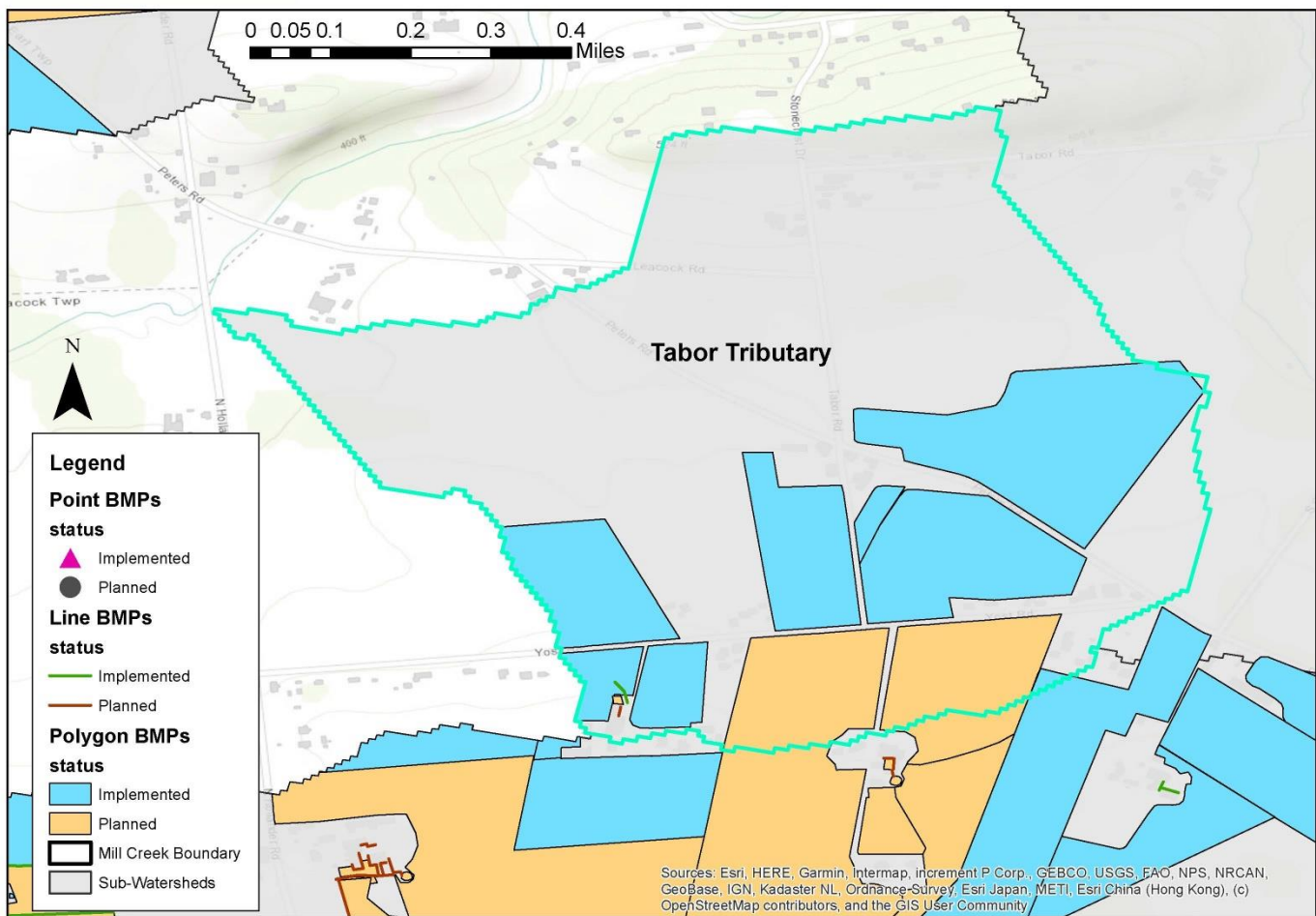
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Grassed waterway	1 ac	\$4,500	\$4,500
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	6.9 ac	\$2,500	\$17,250
Cover Crop	90 ac	\$20	\$1,800
Streambank Fencing	1,000'	\$8	\$8,000
Streambank Stabilization	500'	\$130	\$65,000
Nutrient Management Plan	90 ac	\$8	\$720
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$97,270</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



## Tabor Tributary BMPs

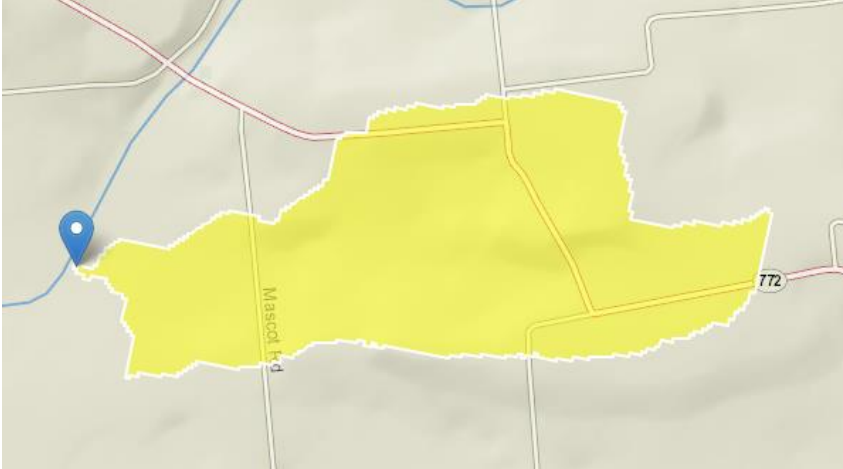


Map14-2: Completed & planned BMP's in the Sub-Watershed 14 according PracticeKeeper (2022)

## Sub-Watershed 15 “Mascot” Tributary

### Priority Level 2

Sub-Watershed 15, the “Mascot” Tributary, is a 0.30 square mile watershed located east of Mascot Rd. The stream is not a NAHD named stream and predominately is an interment stream. The tributary is a mix of residential and agricultural land uses. 90% of the farms in the watershed have a conservation and nutrient management plan. Most of these plans are fully implemented as well.



Map 15-1: Stream Stat Map of Sub-Watershed 15

Table 15-1: Stream Stats Table for Sub-Watershed 15

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0584
Longitude of confluence	-76.1597
Mean basin slope in degrees	2.28°
Percent of basin with urban development	0.00%
Mean basin elevation	411 ft
Percent of area covered by forest	0.38%
Maximum basin elevation	444 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	16.59%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	3.47%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 15-2: Wiki Watershed Facts for Sub-Watershed 15

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	80.04	79.34
<i>Pasture/Hay</i>	7.09	7.03
<i>Developed, Low Intensity</i>	5.54	5.49
<i>Developed, Open Space</i>	3.55	3.52
<i>Developed, Medium Intensity</i>	3.33	3.30
<i>Developed, High Intensity</i>	1.33	1.32



<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	74.27	73.63
<i>Slow Infiltration</i>	13.97	13.85
<i>Medium/Very Slow Infiltration</i>	12.64	12.53
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	384 ft	
<i>Minimum</i>	345 ft	
<i>Maximum</i>	440 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,597	0
<i>Pigs/hogs/swine</i>	58	6
<i>Turkeys</i>	34	0
<i>Cows, dairy</i>	17	0
<i>Horses</i>	2	10
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	45,000
<i>Cows, beef</i>	0	6

\*all but 1-2 farms



Photos of Sub-Watershed 15 the "Mascot" Tributary

Table 15-3: Wiki Watershed Loads Calculations for Sub-Watershed 15

<b><u>SOURCES</u></b>	<b><u>Loads</u></b>		
	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	185,494	3,497	344
<i>Loading rates (lbs/ac)</i>	1,862	35	3
<i>Mean Annual Concentration (ppm)</i>	527	10	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	0.60	5	2
<i>Cropland</i>	92.03	654	197
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.04	2	0
<i>Medium-Density Mixed</i>	0.18	8	1
<i>High-Density Mixed</i>	0.07	3	0
<i>Low-Density Open Space</i>	0.03	2	0
<i>Farm Animals</i>	0	503	127
<i>Stream Bank Erosion</i>	0.01	0	0
<i>Subsurface Flow</i>	0	2,318	18
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	11	0
<b>TOTAL</b>	<b>93</b>	<b>3,506</b>	<b>345</b>

Sub-Watershed 15 is a rural ag-dominated watershed. 90% of farms in the watershed are covered with conservation and nutrient management plans along with conservation practices. Buffers and fencing are all that is needed.

Urban BMP Scenario:

No urban BMP's are needed in this watershed.

Agricultural BMP Scenario:

Since 90% of the farms in this watershed have conservation plans, nutrient management plans, and conservation practices implemented only 10% need to be added to complete the improvements in this watershed. What is needed in this watershed is riparian buffer coverage. Presently, there has only been about 0.5 acres of buffer implemented, this would need to be increased to about 16 acres. Streambank fencing would also need to be doubled from 2,000 ft. implemented to an additional 2,800 ft. as well. Finally, we are proposing 2,800 ft. of streambank stabilization in this watershed to complement all of the above practices. It should be noted that 0.01 acres of scrub/shrub land use was added to this model run to make it function as it is supposed to.

Table 15-4: Wiki Watershed Load Reductions for Sub-Watershed 15

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	185,863	3,504	344	185,865	1,175	327
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	81,020	762	210	81,020	762	210
Loads Removed w/ Proposed Agricultural BMP's	105,313	576	129	105,313	576	129
<b>TOTAL Loads Removed</b>	186,344	1,338	339	186,334	1,338	339
<b>New Reduced Load</b>	(471)	2,166	6	(468)	(163)	(12)
<b>Percent Reduction</b>	<b>100%</b>	<b>38%</b>	<b>98%</b>	<b>100%</b>	<b>114%</b>	<b>104%</b>
<b>TOTAL Baseline Load</b>	104,843	2,742	135	104,845	412	117
<b>TOTAL Loads Removed from Baseline</b>	105,313	576	129	105,313	576	129
<b>Percent Reduction from Baseline Load</b>	<b>100%</b>	<b>21%</b>	<b>96%</b>	<b>100%</b>	<b>139%</b>	<b>110%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 15-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 123 (Medium Priority)** – lat. 40.0584; long. -76.1535 (Leacock Twp.)
- **\*Site # 122 (High-Medium Priority)** – lat. 40.0584; long. -76.1535 (Leacock Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

Table 15-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Barnyard runoff controls	1	\$22,000	\$22,000
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$22,000</b>

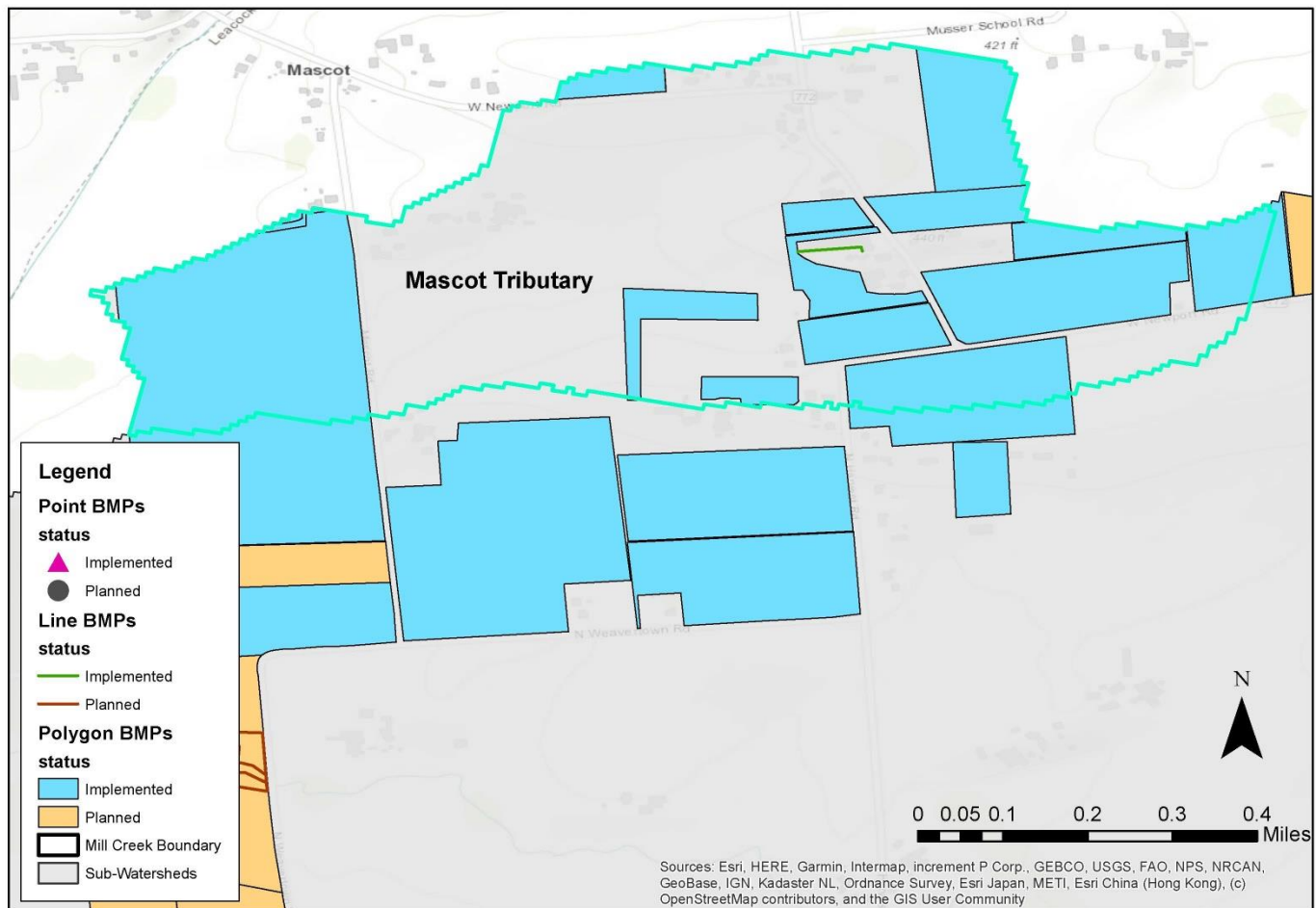
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Prescribed grazing	10 ac	\$50	\$500
Streambank Fencing	2,400'	\$8	\$19,200
Riparian buffer	2.0 ac	\$2,500	\$5,000
Stream bank Stabilization	2,400'	\$130	\$312,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	14.0 ac	\$2,500	\$35,000
Cover Crop	19.8 ac	\$20	\$396
Streambank Fencing	400'	\$8	\$3,200
Streambank Stabilization	400'	\$130	\$52,000
Nutrient Management Plan	19.9 ac	\$8	\$159
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$427,455</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.



## Mascot Tributary BMPs



Map15-2: Completed & planned BMP's in the Sub-Watershed 15 according PracticeKeeper (2022)

## Sub-Watershed 16 Muddy Run Tributary

### Priority Level 1

Sub-Watershed 16, the Muddy Run Tributary, is an 8.96 square mile watershed located north of Route 340, West of New Holland Rd., and south of Scenic Rd. and entering Mill Cr. west of Miller Lane. The stream is a NAHD named stream with eight Warm Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL Date</u>
57463365	2050306000469	2.19	Agriculture	Nutrients	4/9/2001
Reach Location: Mouth to Pond Rd. tributary confluence			Agriculture	TDS	4/9/2001
57463405	2050306004667	0.90	Agriculture	Nutrients	4/9/2001
Reach Location: Pond Rd. Tributary					
57463331	2050306000469	1.28	Agriculture	Nutrients	4/9/2001
Reach Location: Segment between Pond Rd. Trib. & 2 headwater tributaries			Agriculture	TDS	4/9/2001
57463271	2050306001309	1.99	Agriculture	Nutrients	4/9/2001
Reach Location: North Tributary (Centerville/Hollow)			Agriculture	Siltation	4/9/2001
57463287	2050306000470	0.23	Agriculture	Nutrients	4/9/2001
Reach Location: Segment between North Trib. & Beacon Hill Tributary			Agriculture	Siltation	4/9/2001
57463293	2050306000458	0.09	Agriculture	Nutrients	4/9/2001
Reach Location: Beacon Hill tributary Segment 1 (mouth)			Agriculture	Siltation	4/9/2001
57463297	2050306000458	0.02	Agriculture	Nutrients	4/9/2001
Reach Location: Beacon Hill tributary Segment 2 (headwaters)			Agriculture	Siltation	4/9/2001
57463305	2050306000470	1.96	Agriculture	Nutrients	4/9/2001
Reach Location: South tributary (N. Hollander/Colonial)			Agriculture	Siltation	4/9/2001

The tributary is almost exclusively agricultural with a spattering of commercial around the Village of Intercourse and residential mixed in. About 50-60% of the farms in the sub-watershed have conservation and nutrient management plans, with about 60% of these plans implemented and the rest just planned at this point. This is a significant sub-watershed for the Mill Cr. and one that has had a focused approach on in the past by the LCCD/NRCS Pequea/Mill Cr. Smoketown Office Initiative back in the late 90's and early 2000's. The area is also home to some of the most conservative Plain Sect farmers in the watershed, so outreach efforts have been challenging in this area. The good news is that the foundation has been laid in this watershed by previous efforts,



so building off of these efforts will only lead to positive implementation in the future. This sub-watershed also has a point source discharge on it; Point Source NPDES # PA0084212. This point source is permitted to discharge 26,736 cubic ft./day or 200,000 gal/day. The Total Nitrogen Load from this discharge is 3,225 lbs/yr and the Total Phosphorus is 218 lbs/yr.

Muddy Run TMDL

The PA DEP listed 5.4 miles of streams (including 1.2 and 2.0 miles of Muddy Run listed for nutrients and suspended solids, respectively) on the 1996 303(d)/305(b) list. The TMDL developed covers a total of 3.2 miles of stream segments in the approximately 9 square mile Muddy Run watershed. The Muddy Run watershed is primarily in agricultural land use, with 98% in pasture/hay or cropland (47.1% cropland and 49.7% hay/pastureland). The estimated population of Muddy Run watershed was 2,028 in 1995 and there were 583 households. 94% of the households use septic systems. Based on USGS water quality data estimated concentrations of nitrogen and phosphorous in groundwater in the watershed are 3.4mg/L and 0.024mg/L. In 1982 soil erosion rates in the Muddy Run watershed were over 10 tons per acre, almost double the state average. (information from the 2006 WIP)

Table 16-1: The major components of the Muddy Run TMDL are summarized below:

Pollutant	Current Loading (lbs/yr)	Load Reduction (lbs/yr)	% Reduction	TMDL Load Allocation
Phosphorous	17,147	11,910	69	5,237
Sediment	7,460,637	3,070,378	41	4,390,259

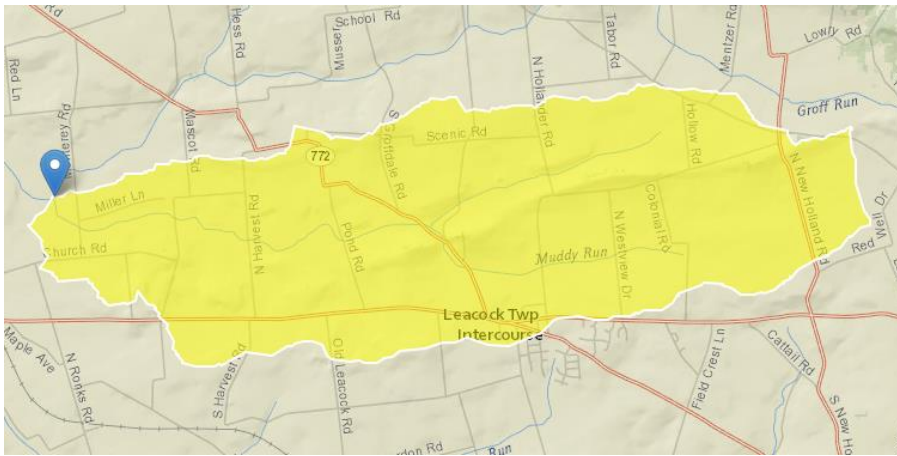
(Table from the 2006 WIP)

Table 16-2: Load allocations for Muddy Run by land use/source:

Source	Area (ac)	Unit Area Loading Rate (lbs/ac/yr)	Annual Average Load (lbs/yr)	Load Allocation (annual average) lbs/yr	% Reduction
<b>PHOSPHOROUS</b>					
Hay/Past	2,792	0.89	2,496	1,630	34.6%
Cropland	2,649	5.33	14,118	3,076	78.2%
Coniferous	30	0.01	0	0	0.0%
Mixed For	20	0.01	0	0	0.0%
Deciduous	25	0.02	0	0	0.0%
Lo Int Dev	42	0.10	4	4	0.0%
Hi Int Dev	62	1.26	78	78	0.0%
Groundwater			425	424	
Septic Systems			24	24	
<b>TOTAL</b>	<b>5,619</b>	<b>3.05</b>	<b>17,147</b>	<b>5,237</b>	<b>69%</b>
<b>SEDIMENT</b>					
Hay/Past	2,792	344.17	960,998	787,850	18.0%
Cropland	2,649	2,447.10	6,482,058	3,584,828	44.8%
Coniferous	30	5.97	177	177	0.0%
Mixed For	20	4.90	97	97	0.0%
Deciduous	25	5.08	126	126	0.0%
Lo Int Dev	42	246.47	10,354	10,354	0.0%
Hi Int Dev	62	110.53	6,828	6,828	0.0%
<b>TOTAL</b>	<b>5,619</b>	<b>1,327.76</b>	<b>7,460,637</b>	<b>4,390,259</b>	<b>41%</b>

(Table from the 2006WIP)

It should be noted that although this sub-watershed is given a Priority Level 1 classification, mostly due to the existence of a TMDL in this sub-watershed, this is an extremely difficult watershed to show progress in for 1 main reason. The sheer size of the watershed is 8.96 square miles which is much larger than some of the other priority sub-watersheds and thus much harder to see significant water quality improvements over a short amount of time. This sub-watershed is the second largest sub-watershed in this supplement meaning we may see other priority sub-watersheds improve before this one over the lifespan of this document. That doesn't mean we will not see improvements, just means it will be harder to document water quality improvements in such a large sub-watershed.



Map 16-1: Stream Stat Map of Sub-Watershed 16

Table 16-3: Stream Stats Table for Sub-Watershed 16

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0521
Longitude of confluence	-76.1731
Mean basin slope in degrees	2.26°
Percent of basin with urban development	2.21%
Mean basin elevation	417 ft
Percent of area covered by forest	1.28%
Maximum basin elevation	558 ft.
Percentage of impervious area determined from NLCD 2001 impervious dataset	1.94%
Percentage of land-use from NLCD 2001 classes 21-24	6.46%
Percentage of developed (urban) land from NLCD 2011 classes 21-24	10.30%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	2.73%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 16-4: Wiki Watershed Facts for Sub-Watershed 16

<b><u>ENTIRE MUDDY RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	3,914.14	69.39
<i>Pasture/Hay</i>	990.89	17.56
<i>Developed, Open Space</i>	276.76	4.90
<i>Developed, Low Intensity</i>	266.87	4.75

<i>Developed, Medium Intensity</i>	138.38	2.44
<i>Developed, High Intensity</i>	24.71	0.45
<i>Mixed Forest</i>	17.30	0.29
<i>Shrub/Scrub</i>	7.41	0.11
<i>Deciduous Forest</i>	4.94	0.09
<i>Emergent Herbaceous Wetlands</i>	2.47	0.02
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	4,996.46	88.57
<i>Slow Infiltration</i>	635.06	11.25
<i>Medium/Very Slow Infiltration</i>	9.88	0.16
<i>Slow/Very Slow Infiltration</i>	2.47	0.02
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	417 ft	
<i>Minimum</i>	339 ft	
<i>Maximum</i>	551 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	90,269	
<i>Pigs/hogs/swine</i>	3,291	
<i>Turkeys</i>	1,958	
<i>Cows, dairy</i>	1,015	
<i>Horses</i>	145	
<i>Sheep</i>	99	
<i>Chicken, layers</i>	45	
<i>Cows, beef</i>	0	



*Photos of middle reaches of Sub-Watershed 16 the Muddy Run Tributary*





*Aerial Photos of Sub-Watershed 16 the Muddy Run Tributary*



*Aerial Photos of Sub-Watershed 16 the Muddy Run Tributary*



*Aerial Photos of Sub-Watershed 16 the Muddy Run Tributary*





*Aerial Photos of Sub-Watershed 16 the Muddy Run Tributary*



*Photos of lower reaches of Sub-Watershed 16 the Muddy Run Tributary*



*Photos of Sub-Watershed 16 the Muddy Run Tributary*





Photos of upper section of Sub-Watershed 16 the Muddy Run Tributary

Table 16-5: Wiki Watershed Loads Calculations for Sub-Watershed 16

<b>ENTIRE MUDDY RUN Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	7,795,231	183,979	17,345
<i>Loading rates (lbs/ac)</i>	1,380	33	3
<i>Mean Annual Concentration (ppm)</i>	404	10	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	138,696	630	225
<i>Cropland</i>	7,401,736	27,399	8,313
<i>Wooded Areas</i>	76	1	0
<i>Wetlands</i>	3	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	1	0	0
<i>Low-Density Mixed</i>	3,254	87	9

<i>Medium-Density Mixed</i>	9,063	174	18
<i>High-Density Mixed</i>	1,670	32	3
<i>Low-Density Open Space</i>	3,359	90	9
<i>Farm Animals</i>	0	30,031	7,539
<i>Stream Bank Erosion</i>	237,373	167	59
<i>Subsurface Flow</i>	0	121,717	950
<i>Point Sources</i>	0	3,219	218
<i>Septic Systems</i>	0	431	0

Sub-Watershed 16 is predominantly ag land use with a smattering of residential and commercial around the Village of Intercourse. Once again, a tremendous amount of outreach has taken place within the watershed from NRCS and District staff over the last 25-plus years. Unfortunately, not all of that outreach has taken because only about 50% of the ag operations in the watershed have planning efforts on their farm and of that only 50% have implemented conservation BMP's to date. Add in the lack of buffers in the watershed and limited fencing and one can see why the stream is named Muddy Run.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 40 acres of Low-Density development, and 20 acres of Medium-Density development.

Agricultural BMP Scenario:

Roughly 2,000 acres of conservation planning and nutrient management planning have taken place within this watershed. The remaining 1,900 acres of ag lands in the watershed would need to have plans created on this moving forward. In addition, 1,500 acres of conservation practices have been put in the ground thus far. This would need to increase by about 62% in the future to 2,400 new acres with conservation work on them. The largest increase in the watershed would need to come from riparian buffer implementation. Presently there are only about 5.7 acres of buffers in the watershed. This would need to increase to about 124.8 acres in the future. Throw in an additional 25,000 ft. of streambank fencing onto of the 15,000 ft. already on the ground. Finally, we would propose an additional 7,560 ft. of streambank stabilization in the watershed as well.

Table 16-6: Wiki Watershed Load Reductions for Sub-Watershed 16

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	7,809,581	184,307	17,375	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	8,357	26	4	-	-	-
Loads Removed w/ Existing Agricultural BMP's	1,686,295	36,081	8,323	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	2,712,292	20,954	5,322	-	-	-

<b>TOTAL Loads Removed</b>	4,406,943	57,061	13,649	-	-	-
<b>New Reduced Load</b>	3,402,638	127,246	3,726	-	-	-
<b>Percent Reduction</b>	<b>56%</b>	<b>31%</b>	<b>79%</b>	-	-	-
<b>TOTAL Baseline Load</b>	6,123,286	148,226	9,052	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	2,720,649	20,980	5,326	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>44%</b>	<b>14%</b>	<b>59%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 16-6 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 118 (Low Priority)** – lat. 40.0490; long. -76.0845 (Leacock Twp.)
- **\*Site # 117 (Medium Priority)** – lat. 40.0484; long. -76.0864 (Leacock Twp.)
- **Site # 116 (High-Medium Priority)** – lat. 40.0457; long. -76.0936 (Leacock Twp.)
- **Site # 115 (High-Medium Priority)** – lat. 40.0450; long. -76.0973 (Leacock Twp.)
- **Site # 114 (Medium Priority)** – lat. 40.0450; long. -76.1011 (Leacock Twp.)
- **Site # 100 (High-Medium Priority)** – lat. 40.0442; long. -76.1041 (Leacock Twp.)
- **Site # 113 (Medium Priority)** – lat. 40.0428; long. -76.1058 (Leacock Twp.)
- **Site # 101 (Medium Priority)** – lat. 40.0436; long. -76.1082 (Leacock Twp.)
- **Site # 88 (Medium-Low Priority)** – lat. 40.0526; long. -76.1026 (Leacock Twp.)
- **\*\*Site # 90 (Medium Priority)** – lat. 40.0550; long. -76.0790 (Leacock Twp.)
- **\*\*Site # 99 (Medium-Low Priority)** – lat. 40.0572; long. -76.0833 (Leacock Twp.)
- **Site # 120 (Low Priority)** – lat. 40.0546; long. -76.1015 (Leacock Twp.)
- **Site # 119 (Medium-Low Priority)** – lat. 40.0517; long. -76.1145 (Leacock Twp.)
- **Site # 91 (Medium Priority)** – lat. 40.0506; long. -76.1164 (Leacock Twp.)
- **Site # 92 (High-Medium Priority)** – lat. 40.0445; long. -76.1133 (Leacock Twp.)
- **\*\*Site # 94 (High-Medium Priority)** – lat. 40.0444; long. -76.1150 (Leacock Twp.)
- **Site # 112 (High-Medium Priority)** – lat. 40.0452; long. -76.1158 (Leacock Twp.)
- **Site # 111 (High-Medium Priority)** – lat. 40.0470; long. -76.1172 (Leacock Twp.)
- **Site # 110 (Medium-Low Priority)** – lat. 40.0519; long. -76.1237 (Leacock Twp.)
- **\*\*Site # 89 (Medium Priority)** – lat. 40.0506; long. -76.1260 (Leacock Twp.)
- **\*Site # 109 (Medium Priority)** – lat. 40.0550; long. -76.1242 (Leacock Twp.)
- **Site # 85 (Medium-Low Priority)** – lat. 40.0408; long. -76.1303 (Leacock Twp.)
- **Site # 86 (Medium-Low Priority)** – lat. 40.0411; long. -76.1273 (Leacock Twp.)

- **Site # 82 (High-Medium Priority)** – lat. 40.0475; long. -76.1311 (Leacock Twp.)
- **\*\*Site # 81 (Medium-Low Priority)** – lat. 40.0456; long. -76.1371 (Leacock Twp.)
- **Site # 108 (Medium Priority)** – lat. 40.0482; long. -76.1329 (Leacock Twp.)
- **Site # 87 (Medium Priority)** – lat. 40.0439; long. -76.1441 (Leacock Twp.)
- **Site # 95 (Medium-Low Priority)** – lat. 40.0398; long. -76.1560 (Leacock Twp.)
- **Site # 98 (Medium Priority)** – lat. 40.0436; long. -76.1562 (Leacock Twp.)
- **\*Site # 97 (Medium Priority)** – lat. 40.0466; long. -76.1548 (Leacock Twp.)
- **Site # 107 (High Priority)** – lat. 40.0497; long. -76.1545 (Leacock Twp.)
- **\*Site # 106 (Medium Priority)** – lat. 40.0505; long. -76.1565 (Leacock Twp.)
- **Site # 96 (Medium Priority)** – lat. 40.0501; long. -76.1610 (Leacock Twp.)
- **Site # 80 (Medium Priority)** – lat. 40.0488; long. -76.1686 (Leacock Twp.)
- **Site # 105 & 158 (Medium-Low Priority)** – lat. 40.0497; long. -76.1711 (Leacock Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 16-7: Existing, Proposed, and New BMP's Estimated Cost

<b>Combined BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Prescribed grazing	28.5 ac	\$50	\$1,425
Barnyard runoff controls	4	\$22,000	\$88,000
Conservation crop rotation	160.6 ac	\$11	\$1,767
Cover crop	99 ac	\$20	\$1,980
Contour farming	61.6 ac	\$8	\$493
Waste storage system	1	\$80,000	\$80,000
Stripcropping, contour	100 ac	\$2	\$200
Nutrient management plan	59 ac	\$8	\$472
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$174,337</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Barnyard runoff controls	10	\$22,000	\$220,000
Prescribed grazing	172.5 ac	\$50	\$8,625
Riparian buffer	38.4 ac	\$2,500	\$96,000
Nutrient management plan	459 ac	\$8	\$3,672
Waste storage system	6	\$80,000	\$480,000
Streambank Fencing	11,900'	\$8	\$95,200
Conservation crop rotation	350.6 ac	\$11	\$3,857
Cover crop	262.9 ac	\$22	\$5,784
Grassed waterway	0.1 ac	\$4,500	\$450
Pasture/hayland plantings	2.2 ac	\$300	\$660
Small dam removal	2	Varies	Varies
Stripcropping, contour	22 ac	\$2	\$44
Contour farming	54 ac	\$8	\$432
Residue management, seasonal	104.8 ac	\$20	\$2,096
Stream bank Stabilization	7,560'	\$130	\$982,800

<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	86.4 ac	\$2,500	\$216,000
Cover Crop	2,137.1 ac	\$20	\$42,742
Streambank Fencing	13,100'	\$8	\$104,800
Nutrient Management Plan	1,441 ac	\$8	\$11,528
Green Infrastructure	60 ac	Varies	Varies
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$2,227,690</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage it was difficult to access and see every section of this tributary.

Below is additional WikiWatershed data for tributaries within Muddy Run. Models were not run on these tributaries but data is provided as background information on them.

<b><u>NORTH TRIBUTARY MUDDY RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	780.85	75.90
<i>Pasture/Hay</i>	138.38	13.50
<i>Developed, Open Space</i>	49.42	4.82
<i>Developed, Low Intensity</i>	42.01	3.98
<i>Developed, Medium Intensity</i>	9.88	0.90
<i>Mixed Forest</i>	7.41	0.75
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	906.88	88.18
<i>Slow Infiltration</i>	121.08	11.82
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	446 ft	
<i>Minimum</i>	371 ft	
<i>Maximum</i>	550 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	16,474	
<i>Pigs/hogs/swine</i>	600	
<i>Turkeys</i>	357	
<i>Cows, dairy</i>	185	
<i>Horses</i>	26	
<i>Sheep</i>	18	
<i>Chicken, layers</i>	8	
<i>Cows, beef</i>	0	



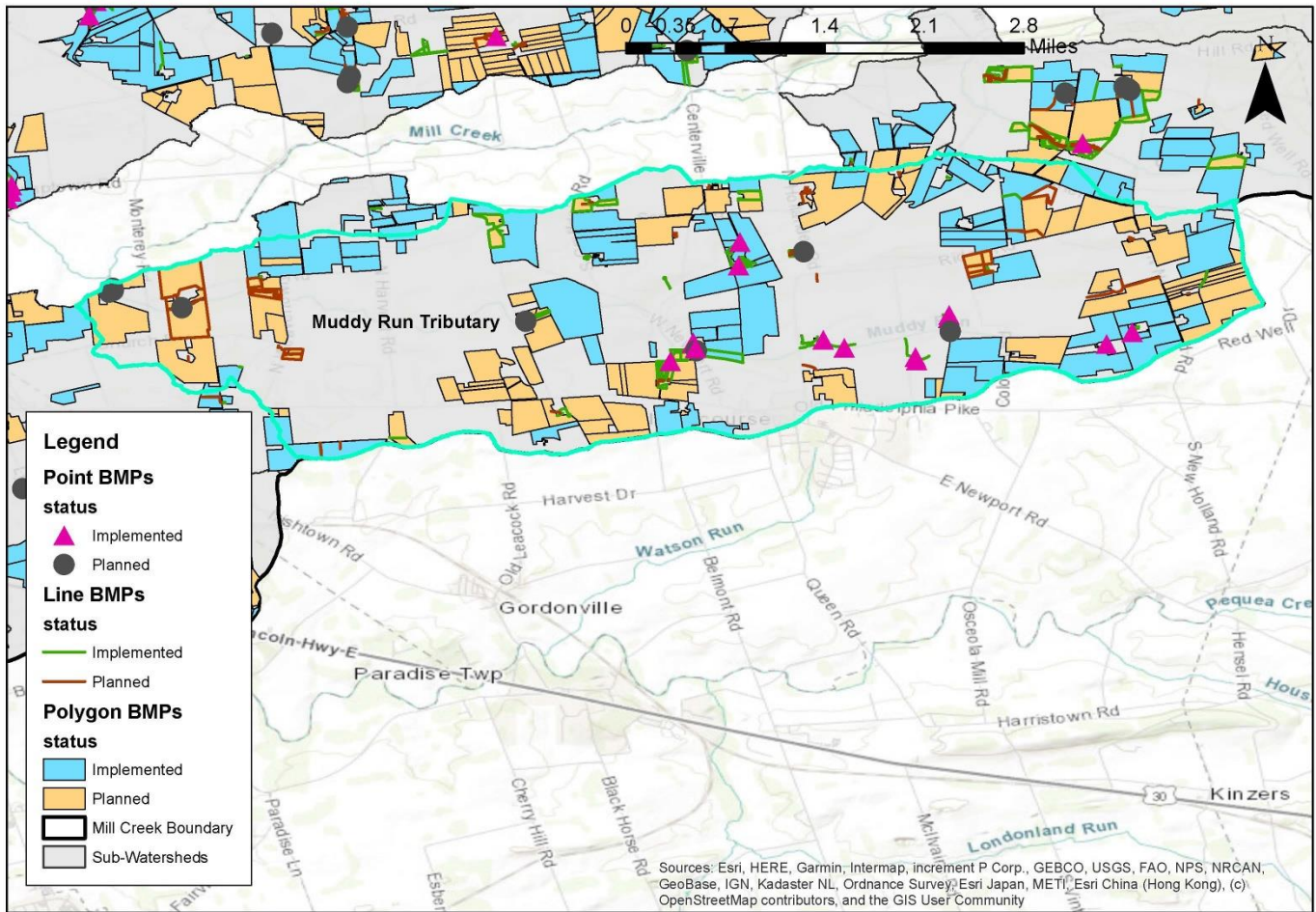
<b><u>NORTH TRIBUTARY MUDDY RUN Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	1,742,041	34,953	3,508
<i>Loading rates (lbs/ac)</i>	1,691	34	3
<i>Mean Annual Concentration (ppm)</i>	496	10	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	22,538	97	35
<i>Cropland</i>	1,703,651	6,071	1,910
<i>Wooded Areas</i>	23	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	485	13	1
<i>Medium-Density Mixed</i>	660	12	1
<i>High-Density Mixed</i>	70	1	0
<i>Low-Density Open Space</i>	590	16	2
<i>Farm Animals</i>	0	5,470	1,373
<i>Stream Bank Erosion</i>	14,025	9	4
<i>Subsurface Flow</i>	0	23,236	181
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	28	0

<b><u>SOUTH TRIBUTARY MUDDY RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	1,388.73	66.16
<i>Pasture/Hay</i>	380.54	18.16
<i>Developed, Low Intensity</i>	113.67	5.46
<i>Developed, Open Space</i>	103.78	4.92
<i>Developed, Medium Intensity</i>	84.02	3.98
<i>Developed, High Intensity</i>	19.77	0.90
<i>Deciduous Forest</i>	4.94	0.18
<i>Mixed Forest</i>	4.94	0.19
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,843.40	87.84
<i>Slow Infiltration</i>	254.52	12.09
<i>Medium/Very Slow Infiltration</i>	2.47	0.06

<u>ELEVATION</u>	<u>FEET</u>	
<i>Average</i>	436 ft	
<i>Minimum</i>	368 ft	
<i>Maximum</i>	551 ft	
<u>ANIMALS</u>	<u>NUMBERS</u>	
<i>Chicken, broilers</i>	33,586	
<i>Pigs/hogs/swine</i>	1,224	
<i>Turkeys</i>	728	
<i>Cows, dairy</i>	377	
<i>Horses</i>	53	
<i>Sheep</i>	36	
<i>Chicken, layers</i>	16	
<i>Cows, beef</i>	0	

<u>SOUTH TRIBUTARY MUDDY RUN Loads</u>			
<u>SOURCES</u>	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
<i>Total loads (lbs)</i>	3,028,680	69,296	6,777
<i>Loading rates (lbs/ac)</i>	1,441	33	3
<i>Mean Annual Concentration (ppm)</i>	398	9	1
<u>Load Sources</u>			
<u>SOURCES</u>	<u>SEDIMENT (lbs)</u>	<u>TOTAL NITROGEN (lbs)</u>	<u>TOTAL PHOSPHORUS (lbs)</u>
<i>Hay/Pasture</i>	59,917	262	94
<i>Cropland</i>	2,917,558	10,574	3,292
<i>Wooded Areas</i>	24	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	1,421	39	4
<i>Medium-Density Mixed</i>	5,363	106	11
<i>High-Density Mixed</i>	1,218	24	2
<i>Low-Density Open Space</i>	1,280	35	4
<i>Farm Animals</i>	0	11,146	2,798
<i>Stream Bank Erosion</i>	41,899	31	11
<i>Subsurface Flow</i>	0	43,599	343
<i>Point Sources</i>	0	3,219	218
<i>Septic Systems</i>	0	263	0

# Muddy Run Tributary BMPs



Map16-2: Completed & planned BMP's in the Sub-Watershed 16 according PracticeKeeper (2022)

## Sub-Watershed 17 “Bird-in-Hand” Tributary

### Priority Level 3

Sub-Watershed 17, the “Bird-in-Hand” Tributary, is a 1.42 square mile watershed located east of Bird-in-Hand and draining most of Bird-in-Hand. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is a mix of residential, commercial, and agricultural land uses. Roughly 50% of the farms in the watershed have a conservation and nutrient management plan. Half do not, or if they do have plans they are not provided to the Conservation District. The agricultural operations with conservation plans also have nutrient management plans and they have fully implemented their conservation plans.



Map 17-1: Stream Stat Map of Sub-Watershed 17

Table 17-1: Stream Stats Table for Sub-Watershed 17

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0477
Longitude of confluence	-76.1916
Mean basin slope in degrees	2.39°
Percent of basin with urban development	8.72%
Mean basin elevation	376 ft
Percent of area covered by forest	1.92%
Maximum basin elevation	450 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	21.97%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	7.22%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 17-2: Wiki Watershed Facts for Sub-Watershed 17

<b>Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	291.58	52.28
<i>Pasture/Hay</i>	111.20	19.84
<i>Developed, Low Intensity</i>	64.25	11.41
<i>Developed, Open Space</i>	39.54	6.97
<i>Developed, Medium Intensity</i>	39.54	7.25
<i>Developed, High Intensity</i>	9.88	1.86
<i>Shrub/Scrub</i>	2.47	0.36
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	476.91	85.03
<i>Medium/Very Slow Infiltration</i>	51.89	9.27
<i>Slow Infiltration</i>	32.12	5.70
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	360 ft	
<i>Minimum</i>	338 ft	
<i>Maximum</i>	402 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	8,952	0
<i>Pigs/hogs/swine</i>	326	0
<i>Turkeys</i>	194	0
<i>Cows, dairy</i>	100	192
<i>Horses</i>	14	54
<i>Sheep</i>	9	0
<i>Chicken, layers</i>	4	84,825
<i>Cows, beef</i>	0	20



Photos of upper reaches of Sub-Watershed 17 the "Bird-in-Hand" Tributary





Photos of upper reaches of Sub-Watershed 17 the "Bird-in-Hand" Tributary



Photos of middle reaches of Sub-Watershed 17 the "Bird-in-Hand" Tributary

Table 17-3: Wiki Watershed Loads Calculations for Sub-Watershed 17

<u>SOURCES</u>	<u>Loads</u>		
	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
Total loads (lbs)	634,219	16,479	1,521
Loading rates (lbs/ac)	1,133	29	3
Mean Annual Concentration (ppm)	347	9	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	8.69	76	26
<i>Cropland</i>	306.74	2,226	656
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.41	23	2
<i>Medium-Density Mixed</i>	1.36	54	6
<i>High-Density Mixed</i>	0.35	14	1
<i>Low-Density Open Space</i>	0.25	14	2
<i>Farm Animals</i>	0	2,964	745
<i>Stream Bank Erosion</i>	0.04	0	0
<i>Subsurface Flow</i>	0	11,019	86
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	126	0
<b>TOTAL</b>	<b>318</b>	<b>16,515</b>	<b>1,524</b>

Sub-Watershed 17 headwaters have development pressure and will more than likely be developed in the next 10 years with commercial development. The other parts of the watershed will more than likely stay in agriculture. The ag land areas require quite a bit of conservation work since only ½ of the ag lands have conservation plans and conservation practices. We proposed additional Green Infrastructure BMP's in the headwaters within this watershed for the future. Things like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 4 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 40 acres of Low-Density development, and 5 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 500 ft. of the farm that will be developed in the future.

Agricultural BMP Scenario:

50% of the farms in the watershed have conservation plans, nutrient management plans, and conservation practices in place, so an additional 50% of these ag BMP's need to be implemented in the future. In addition, there is little to no riparian buffer in the watershed so this scenario proposes about 4.8 acres of new buffer. Also, half or 1,500 ft. of streambank fencing is in place but an additional 3,000 ft. is needed along with about 2,500 ft. of streambank stabilization.

Table 17-4: Wiki Watershed Load Reductions for Sub-Watershed 17

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)	<u>Sediment</u> (lbs/yr)	<u>TN</u> (lbs/yr)	<u>TP</u> (lbs/yr)
Initial MMW Load	635,162	16,501	1,523	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	58,131	108	88	-	-	-
Loads Removed w/ Existing Agricultural BMP's	159,534	1,962	427	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	220,928	1,839	407	-	-	-
<b>TOTAL Loads Removed</b>	438,593	3,909	922	-	-	-
<b>New Reduced Load</b>	196,569	12,593	600	-	-	-
<b>Percent Reduction</b>	<b>69%</b>	<b>24%</b>	<b>61%</b>	-	-	-
<b>TOTAL Baseline Load</b>	475,628	14,539	1,096	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	279,059	1,947	496	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>59%</b>	<b>13%</b>	<b>45%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 17-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 76 (Low Priority)** – lat. 40.0372; long. -76.1721 (Leacock Twp.)
- **Site # 77 (Medium-Low Priority)** – lat. 40.0373; long. -76.1743 (Leacock Twp.)
- **Site # 78 (Medium-Low Priority)** – lat. 40.0414; long. -76.1825 (E. Lampeter Twp.)

Table 17-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>



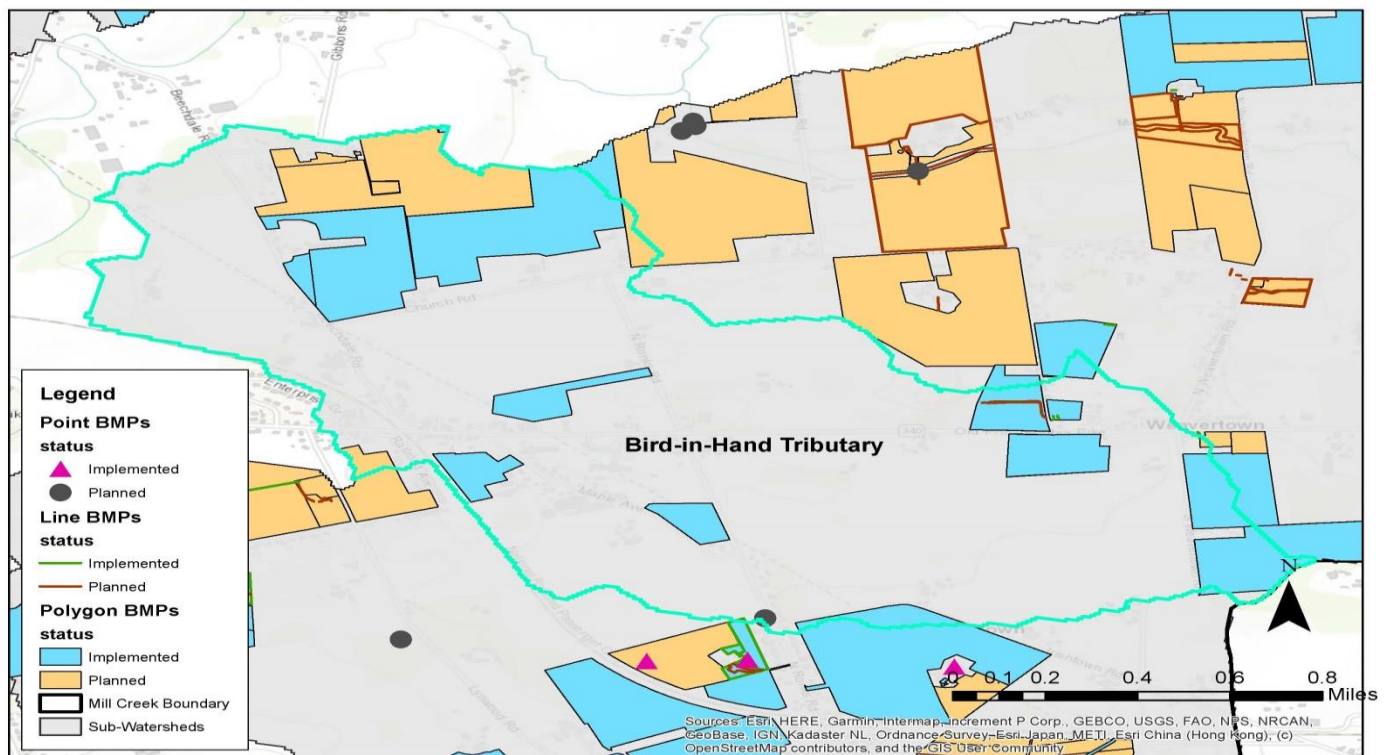
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Barnyard runoff controls	1	\$22,000	\$20,000
Riparian buffer	1.2 ac	\$2,500	\$3,000
Nutrient management plan	16 ac	\$8	\$128
Waste storage system	1	\$80,000	\$80,000
Streambank Fencing	1,500'	\$8	\$12,000
Grassed waterway	0.1 ac	\$4,500	\$450
Filtering practices	3 ac	Varies	Varies
Impervious surface reduction	3 ac	Varies	Varies
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	13.6 ac	\$2,500	\$34,000
Cover Crop	146 ac	\$20	\$2,920
Streambank Fencing	1,500'	\$8	\$12,000
Nutrient Management Plan	130 ac	\$8	\$1,040
Green Infrastructure	45 ac	Varies	Varies
Stream bank Stabilization	2,500'	\$130	\$325,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$490,538</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



### Bird-in-Hand Tributary BMPs



Map17-2: Completed & planned BMP's in the Sub-Watershed 17 according PracticeKeeper (2022)

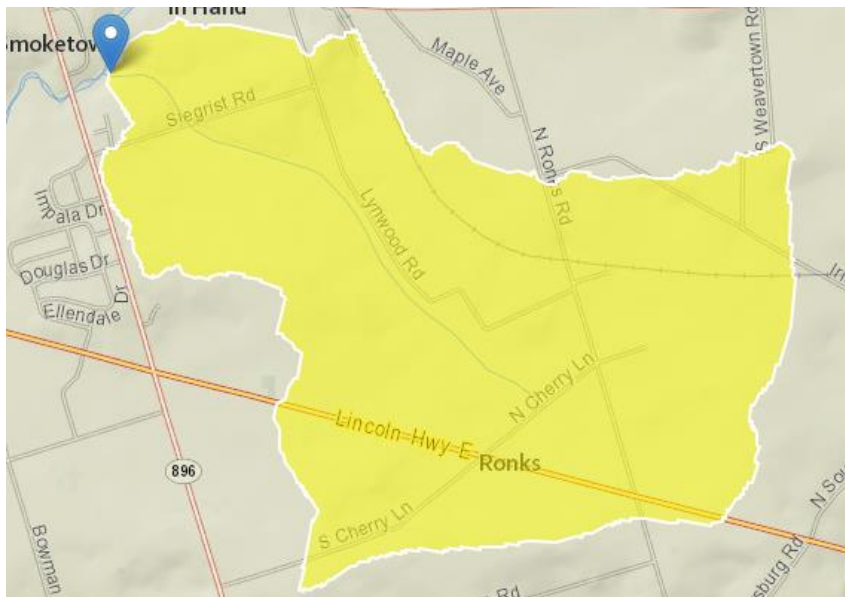
**Sub-Watershed 18 “Lynnwood” Tributary**

**Priority Level 2 – (Possible Reevaluation by PA DEP)**

Sub-Watershed 18, the “Lynnwood” Tributary, is a 2.2 square mile watershed located on the North of Route 30 and West of N. Ronks Rd. and entering Mill Cr. East of Route 896. The stream is a NAHD named Warm Water Fishery stream with an COMID reach number.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57463915	2050306001308	1.79	Agriculture	Nutrients	Medium
			Agriculture	Siltation	High

The tributary is mostly agriculture with limited residential. About 50% of all farm operations have conservation and nutrient management plans in the watershed. Of those with plans, about 50% have implemented their plans and the rest are just planning at this point. This watershed has also been a focus area for other conservation partners like the Stroud Water Research Center which has fenced out (and buffered) most livestock from this watershed presently. In addition, the Lancaster County Clean Water Partners has denoted this tributary as a priority-focused area for an NRCS RCPP ongoing project. There are many opportunities for water quality improvements in this sub-watershed.



Map 18-1: Stream Stat Map of Sub-Watershed 18



Table 18-1: Stream Stats Table for Sub-Watershed 18

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0356
Longitude of confluence	-76.1955
Mean basin slope in degrees	2.41°
Percent of basin with urban development	8.81%
Mean basin elevation	376 ft
Percent of area covered by forest	1.92%
Maximum basin elevation	442 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	22.39%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	6.51%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 18-2: Wiki Watershed Facts for Sub-Watershed 18

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	914.29	66.90
<i>Developed, Low Intensity</i>	140.85	10.24
<i>Pasture/Hay</i>	130.97	9.51
<i>Developed, Open Space</i>	96.37	7.09
<i>Developed, Medium Intensity</i>	64.25	4.62
<i>Developed, High Intensity</i>	14.83	1.04
<i>Shrub/Scrub</i>	2.47	0.18
<i>Grassland/Herbaceous</i>	2.47	0.13
<i>Emergent Herbaceous Wetland</i>	2.47	0.11
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	1,158.92	84.85
<i>Slow Infiltration</i>	138.38	10.17
<i>Medium/Very Slow Infiltration</i>	34.59	2.52
<i>Very Slow Infiltration</i>	34.59	2.47
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	376 ft	
<i>Minimum</i>	292 ft	
<i>Maximum</i>	442 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>*Numbers According to PK</u></b>
<i>Chicken, broilers</i>	21,853	0
<i>Pigs/hogs/swine</i>	796	6
<i>Turkeys</i>	474	0
<i>Cows, dairy</i>	245	458
<i>Horses</i>	35	66
<i>Sheep</i>	24	0
<i>Chicken, layers</i>	11	50
<i>Cows, beef</i>	0	0

\*Missing data on 4-6 farms



Photos of Sub-Watershed 18 the "Lynnwood" Tributary



Photos of Sub-Watershed 18 the "Lynnwood" Tributary

Table 18-3: Wiki Watershed Loads Calculations for Sub-Watershed 18

<b><u>WATERSHED Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
Total loads (lbs)	146,404	4,970	487
Loading rates (lbs/ac)	670	23	2
Mean Annual Concentration (ppm)	195	7	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	10.45	100	31
<i>Cropland</i>	997.63	8,090	2,141
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0.05	1	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.89	50	5
<i>Medium-Density Mixed</i>	2.03	80	8
<i>High-Density Mixed</i>	0.46	18	2
<i>Low-Density Open Space</i>	0.62	34	4
<i>Farm Animals</i>	0	7,273	1,826
<i>Stream Bank Erosion</i>	17.04	29	9
<i>Subsurface Flow</i>	0	36,331	274
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	197	0
<b>TOTAL</b>	<b>1,029</b>	<b>52,203</b>	<b>4,300</b>

Sub-Watershed 18 has a lot of potential from past streambank fencing and buffer work already implemented in it. If conservation plans, nutrient management plans, and other conservation BMP's can be implemented in this priority watershed good things are possible. Some of the headwaters could also use some Urban BMP's like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches to improve this section of the watershed.

Urban BMP Scenario:

The following scenario assumes 3 proposed Urban BMP's in the future. Riparian buffers on 5 acres in the developed areas, Green Infrastructure approaches on 40 acres of Low-Density development, and 10 acres of Medium-Density development.

Agricultural BMP Scenario:

Since only 50% of the ag operations in this watershed have conservation planning, nutrient management planning, and on-the-ground conservation practices in place now 50% need to be implemented in the future as well. This scenario also considers the nearly 17.2 acres of buffer already planted in this watershed and proposes an additional 14.2 acres of buffer on top of that. Also, this scenario considers the 10,130 ft. of streambank fencing implemented to date and adds to this an additional 3,600 ft. Finally, this model run proposes about 2,000 ft. of streambank stabilization to increase load reductions.

Table 18-4: Wiki Watershed Load Reductions for Sub-Watershed 18

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	2,057,120	52,168	4,297	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	2,736	16	2	-	-	-
Loads Removed w/ Existing Agricultural BMP's	676,621	11,598	2,650	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	565,918	5,566	1,182	-	-	-
<b>TOTAL Loads Removed</b>	1,245,275	17,180	3,834	-	-	-
<b>New Reduced Load</b>	811,844	34,988	463	-	-	-
<b>Percent Reduction</b>	<b>61%</b>	<b>33%</b>	<b>89%</b>	-	-	-
<b>TOTAL Baseline Load</b>	1,380,499	40,570	1,647	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	568,654	5,582	1,184	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>41%</b>	<b>14%</b>	<b>72%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 18-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **\*\*Site # 75 (Medium Priority)** – lat. 40.0220; long. -76.1725 (E. Lampeter Twp.)
- **\*\*Site # 74 (Medium Priority)** – lat. 40.0272; long. -76.1792 (E. Lampeter Twp.)
- **\*\*Site # 73 (Medium Priority)** – lat. 40.0266; long. -76.1778 (E. Lampeter Twp.)
- **Site # 43 (Medium Priority)** – lat. 40.0252; long. -76.1921 (E. Lampeter Twp.)
- **\*\*Site # 72 (High-Medium Priority)** – lat. 40.0318; long. -76.1847 (E. Lampeter Twp.)
- **\*\*Site # 71 (Medium Priority)** – lat. 40.0326; long. -76.1890 (E. Lampeter Twp.)
- **Site # 70 (High-Medium Priority)** – lat. 40.0353; long. -76.1920 (E. Lampeter Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 18-5: Existing, Proposed, and New BMP's Estimated Cost

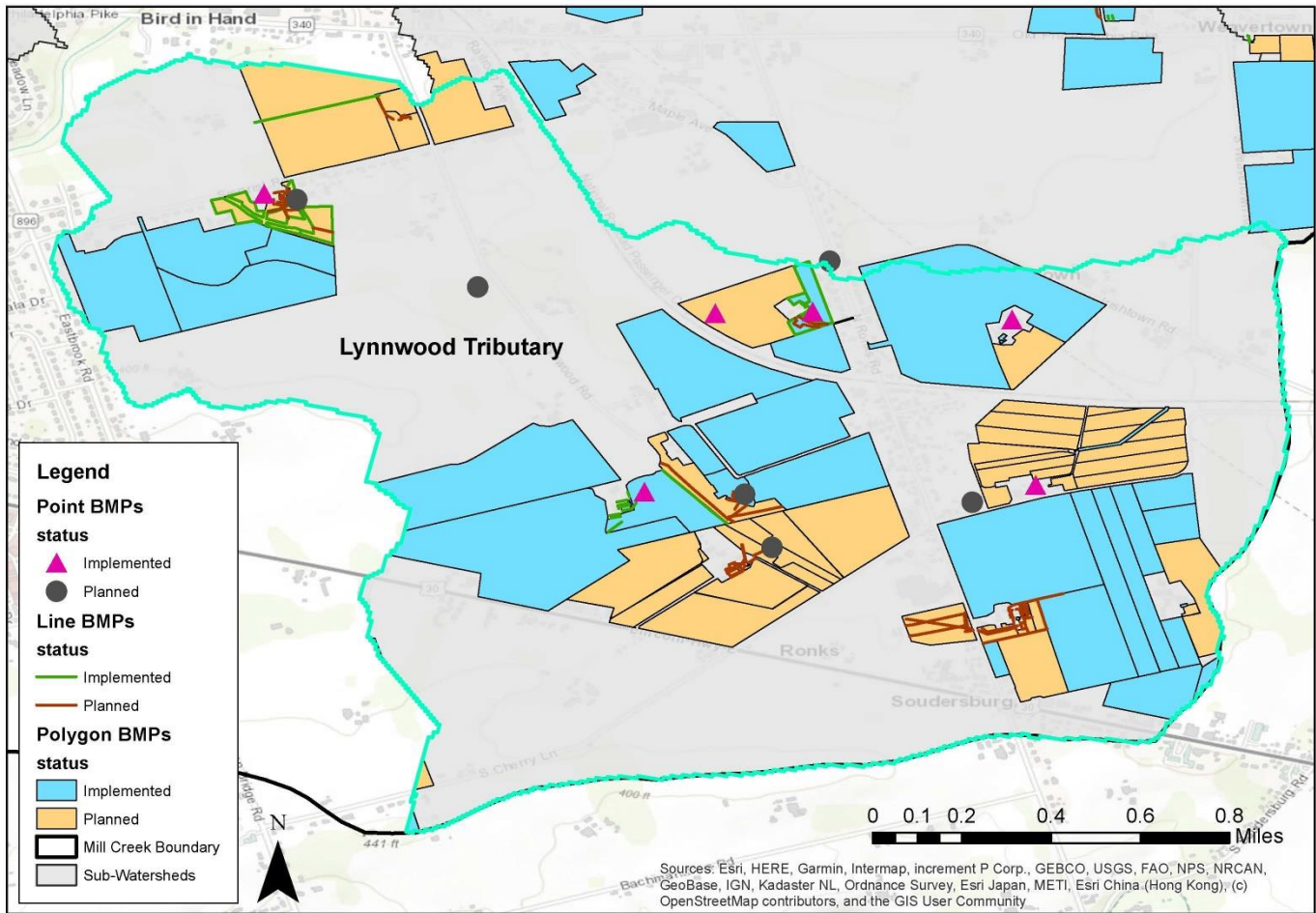
<b><u>Combined BMP's Installed Since the 2006 WIP (Existing)</u></b>	<b><u>Units Installed</u></b>	<b><u>Estimated Cost/Unit</u></b>	<b><u>Cost</u></b>
Riparian buffer	8.1 ac	\$2,500	\$20,250
Streambank Fencing	10,130'	\$8	\$81,040
Barnyard runoff controls	1	\$22,000	\$22,000
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$123,290</b>
<b><u>Combined BMP's to be Installed From the 2006 WIP (Proposed)</u></b>			
Riparian buffer	2.9 ac	\$2,500	\$7,250
Streambank Fencing	3,600'	\$8	\$28,800
Barnyard runoff controls	1	\$22,000	\$22,000
Waste storage system	1	\$80,000	\$80,000
Nutrient management plan	56 ac	\$8	\$448
Prescribed grazing	10 ac	\$50	\$500
Stripcropping, contour	15 ac	\$2	\$30
<b><u>Additional Future Proposed BMP's (NEW)</u></b>			
Riparian buffer	11.3 ac	\$2,500	\$28,250
Cover Crop	460 ac	\$20	\$9,200
Nutrient Management Plan	404 ac	\$8	\$3,232
Green Infrastructure	50 ac	Varies	Varies
Stream bank Stabilization	2,000'	\$130	\$260,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$439,710</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



# Lynnwood Tributary BMPs



Map18-2: Completed & planned BMP's in the Sub-Watershed 18 according PracticeKeeper (2022)

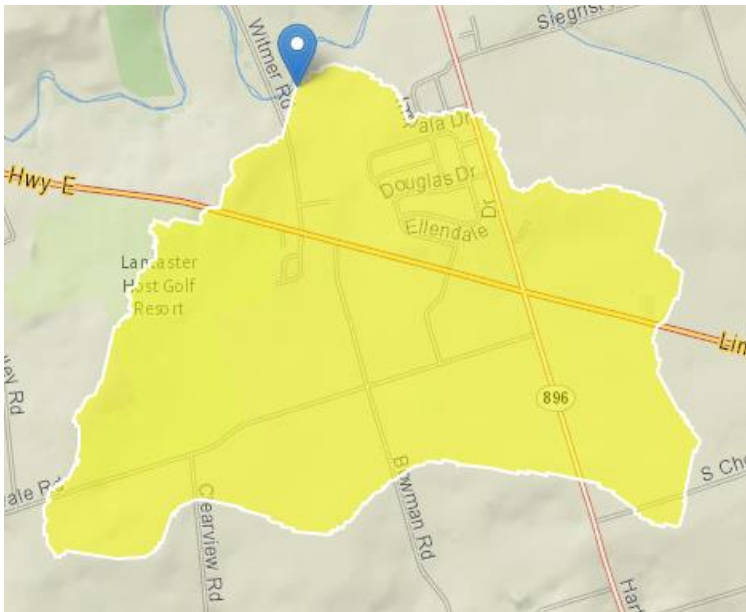
## Sub-Watershed 19 “Rockvale” Tributary

### Priority Level 3

Sub-Watershed 19, the “Rockvale” Tributary, is a 1.62 square mile watershed located on the West of Route 896 and South of Rockvale Rd. and entering Mill Cr. East of Witmer Rd. The stream is a NAHD named Warm Water Fishery stream with two COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57464045	2050306004746	0.83	Agriculture	Nutrients	Medium
Segment 1 (mouth)			Agriculture	Siltation	High
57464051	2050306004746	0.02	Agriculture	Siltation	High
Segment 2					

The tributary is divided into thirds with 1/3 being agriculture, 1/3 being residential, and 1/3 being commercial. All ag operations have conservation and nutrient management plans with most BMP’s implemented in those plans. The largest threat to the watershed is the substantial commercial footprint and stormwater related to this land use. This is the heart of the Route 30 tourism area with outlets, shopping, and tourist destinations within this tributary so this threat will continue to evolve in the future.



Map 19-1: Stream Stat Map of Sub-Watershed 19

Table 19-1: Stream Stats Table for Sub-Watershed 19

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0309
Longitude of confluence	-76.2051
Mean basin slope in degrees	2.69°
Percent of basin with urban development	15.33%
Mean basin elevation	375 ft
Percent of area covered by forest	4.13%
Maximum basin elevation	443 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	45.03%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	14.71%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 19-2: Wiki Watershed Facts for Sub-Watershed 19

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	496.68	53.94
<i>Developed, Open Space</i>	121.08	13.04
<i>Developed, Low Intensity</i>	116.14	12.52
<i>Developed, Medium Intensity</i>	76.60	8.42
<i>Developed, High Intensity</i>	66.72	7.12
<i>Pasture/Hay</i>	32.12	3.56
<i>Mixed Forest</i>	4.94	0.51
<i>Open Water</i>	2.47	0.29
<i>Deciduous Forest</i>	2.47	0.14
<i>Shrub/Scrub</i>	2.47	0.29
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	854.98	92.71
<i>Slow Infiltration</i>	49.42	5.34
<i>Medium/Very Slow Infiltration</i>	17.30	1.95
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	378 ft	
<i>Minimum</i>	314 ft	
<i>Maximum</i>	443 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	14,729	0
<i>Pigs/hogs/swine</i>	537	0
<i>Turkeys</i>	319	0
<i>Cows, dairy</i>	165	183
<i>Horses</i>	23	26
<i>Sheep</i>	16	2
<i>Chicken, layers</i>	7	0
<i>Cows, beef</i>	0	15

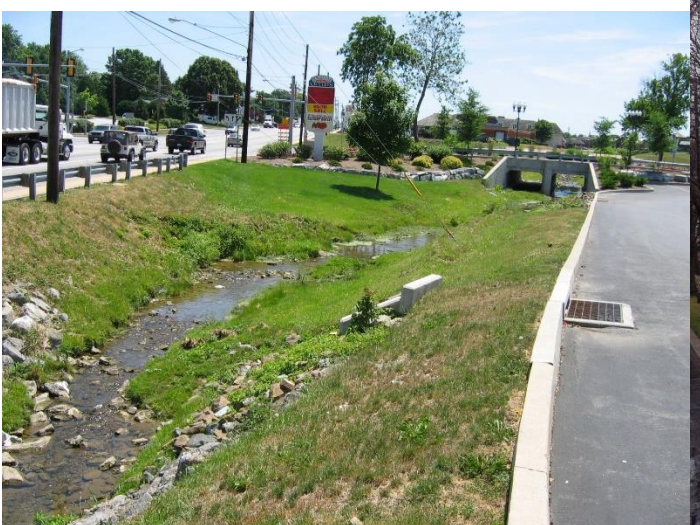




*Photos of Sub-Watershed 19 the "Rockvale" Tributary*



*Photos of Sub-Watershed 19 the "Rockvale" Tributary*



*Photos of Sub-Watershed 19 the "Rockvale" Tributary*

Table 19-3: Wiki Watershed Loads Calculations for Sub-Watershed 19

<b>WATERSHED Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	1,121,013	33,637	2,598
<i>Loading rates (lbs/ac)</i>	1,219	37	3
<i>Mean Annual Concentration (ppm)</i>	351	11	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	2.67	26	8
<i>Cropland</i>	544.32	4,598	1,158
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0.03	1	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.70	38	4
<i>Medium-Density Mixed</i>	2.20	108	11
<i>High-Density Mixed</i>	1.86	91	10
<i>Low-Density Open Space</i>	0.73	39	4
<i>Farm Animals</i>	0	4,892	1,228
<i>Stream Bank Erosion</i>	9.27	15	4
<i>Subsurface Flow</i>	0	23,663	176
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	242	0
<b>TOTAL</b>	<b>562</b>	<b>33,714</b>	<b>2,604</b>

Sub-Watershed 19 is under tremendous development pressure and will more than likely be developed in the next 10 years with commercial development. Looking at the surrounding watershed all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Things like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 5 proposed Urban BMP's in the future. Riparian buffers on 20 acres in the developed areas, Green Infrastructure approaches on 80 acres of Low-Density development, and 25 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 2,000 ft. and in addition about 3,000 ft. of street sweeping around the outlet mall and other tourist areas.

Agricultural BMP Scenario:

Since the one farm in this watershed has a conservation plan, practices no-till farming, has cover crops, and fully implemented nutrient management plan all 460 acres of cropland were considered in conservation protection measures. The District just recently completed a stream restoration project on this farm operation, so 1,200 ft. of



streambank stabilization has been implemented along with 3 acres of riparian buffer and 1,200 ft. of streambank fencing have all been installed. An additional 26 acres of buffer is proposed along with 1,000 ft. of floodplain restoration in some areas of the farm that will be developed in the future. This option has been discussed by the Township for MS4 credits so this is a plausible option.

Table 19-4: Wiki Watershed Load Reductions for Sub-Watershed 19

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>	<i>Sediment (lbs/yr)</i>	<i>TN (lbs/yr)</i>	<i>TP (lbs/yr)</i>
Initial MMW Load	1,122,103	33,675	2,599	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	234,129	420	353	-	-	-
Loads Removed w/ Existing Agricultural BMP's	585,171	10,281	2,172	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	31,835	150	26	-	-	-
<b>TOTAL Loads Removed</b>	851,135	10,851	2,550	-	-	-
<b>New Reduced Load</b>	270,969	22,824	49	-	-	-
<b>Percent Reduction</b>	<b>76%</b>	<b>32%</b>	<b>98%</b>	-	-	-
<b>TOTAL Baseline Load</b>	536,933	23,394	428	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	265,964	570	379	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>50%</b>	<b>2%</b>	<b>89%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 19-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 42 (Medium-Low Priority)** – lat. 40.0193; long. -76.2067 (E. Lampeter Twp.)
- **Site # 61 (Medium Priority)** – lat. 40.0193; long. -76.2067 (E. Lampeter Twp.)
- **Site # 62 (High Priority)** – lat. 40.0227; long. -76.2012 (E. Lampeter Twp.)
- **Site # 60 (Medium Priority)** – lat. 40.0254; long. -76.2016 (E. Lampeter Twp.)

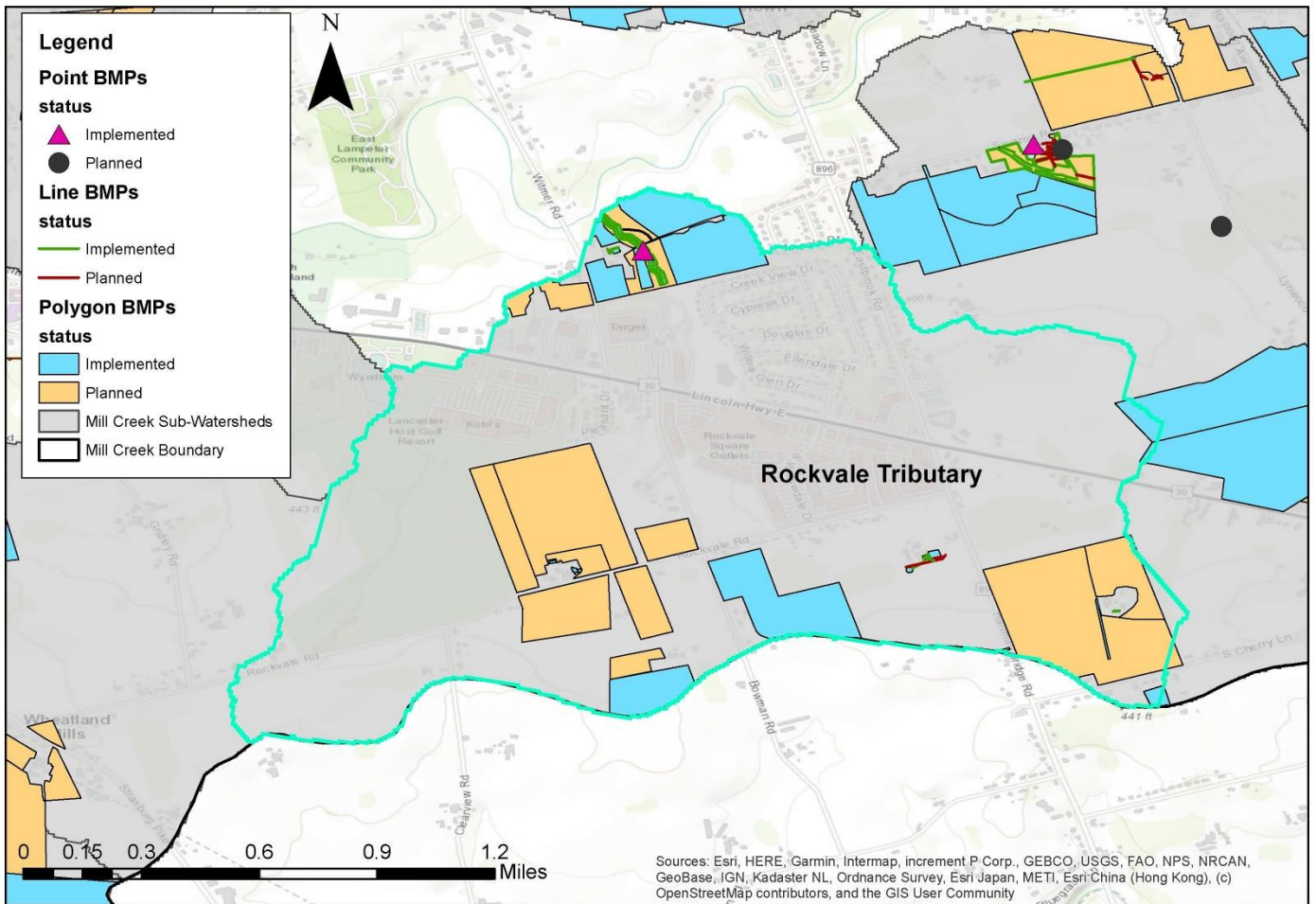
Table 19-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	3.3 ac	\$2,500	\$8,250
Stream bank Stabilization	2,000'	\$130	\$260,000
Impervious surface reduction	17 ac	Varies	Varies
Filtering practices	12 ac	Varies	Varies
Constructed wetlands	15 ac	\$12,000	\$180,000
Rooftop runoff management	5 ac	Varies	Varies
Prescribed grazing	10 ac	\$50	\$500
Cover crop	64 ac	\$20	\$1,280
Stripcropping, contour	64 ac	\$2	\$128
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	22.7 ac	\$2,500	\$57,750
Green Infrastructure	105 ac	Varies	Varies
Street Sweeping	3,000'	Varies	Varies
Floodplain Restoration	1,000'	\$900	\$90,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$597,908</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

# Rockvale Tributary BMPs

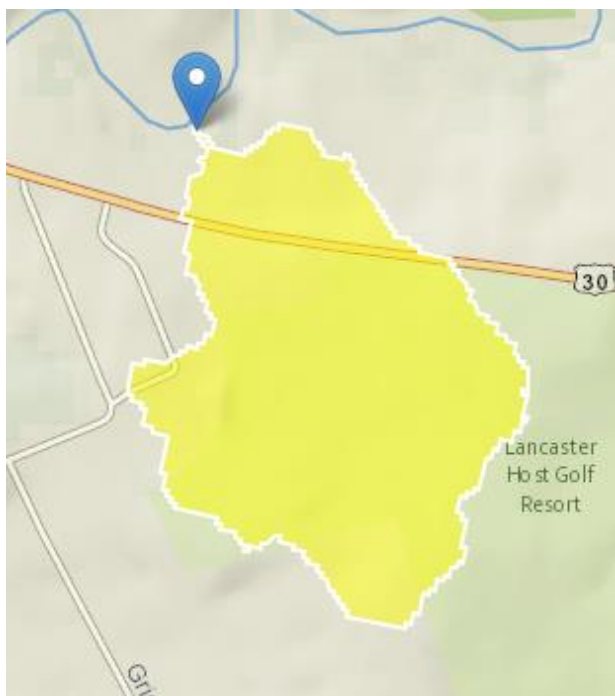


Map19-2: Completed & planned BMP's in the Sub-Watershed 19 according PracticeKeeper (2022)

## Sub-Watershed 19A “Tanger” Tributary

### Priority Level 4

Sub-Watershed 19A, the “Tanger” Tributary, is a 0.16 square mile watershed located east of Millstream Road and mostly south of Route 30 and entering Mill Cr. North of Route 30. The stream is not a NAHD named stream and predominately is an intermittent stream. The tributary is almost exclusively commercial with shopping outlets and amusement parks. There are no current agricultural operations within this sub-watershed, but there is a small area of a golf course in the watershed. With this in mind, the WikiWatershed animal and ag numbers need to be considered.



Map 19A-1: Stream Stat Map of Sub-Watershed 19A

Table 19A-1: Stream Stats Table for Sub-Watershed 19A

<u>Stream STATS Facts</u>	
Latitude of confluence	40.0286
Longitude of confluence	-76.2199
Mean basin slope in degrees	3.83°
Percent of basin with urban development	51.34%
Mean basin elevation	372 ft
Percent of area covered by forest	8.50%
Maximum basin elevation	442 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	84.88%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	35.26%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 19A-2: Wiki Watershed Facts for Sub-Watershed 19A

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Developed, High Intensity</i>	35.03	34.42
<i>Developed, Medium Intensity</i>	20.62	20.26
<i>Developed, Open Space</i>	16.41	16.12
<i>Pasture/Hay</i>	12.64	12.42
<i>Developed, Low Intensity</i>	7.98	7.84
<i>Cultivated Crops</i>	7.54	7.41
<i>Deciduous Forest</i>	0.89	0.87
<i>Mixed Forest</i>	0.67	0.65
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	80.26	78.87
<i>Slow Infiltration</i>	17.96	17.65
<i>High Infiltration</i>	3.55	3.49
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	371 ft	
<i>Minimum</i>	308 ft	
<i>Maximum</i>	422 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	1,635	0
<i>Pigs/hogs/swine</i>	59	0
<i>Turkeys</i>	35	0
<i>Cows, dairy</i>	18	0
<i>Horses</i>	2	0
<i>Sheep</i>	1	0
<i>Chicken, layers</i>	0	0
<i>Cows, beef</i>	0	0



Photo of Sub-Watershed 19A the “Tanger” Tributary



Table 19A-3: Wiki Watershed Loads Calculations for Sub-Watershed 19A

<b><u>Loads</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	19,371	1,362	167
<i>Loading rates (lbs/ac)</i>	189	13	2
<i>Mean Annual Concentration (ppm)</i>	53	4	1
<b><u>Load Sources</u></b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	1.00	15	5
<i>Cropland</i>	7.01	70	16
<i>Wooded Areas</i>	0	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.05	2	0
<i>Medium-Density Mixed</i>	0.57	32	3
<i>High-Density Mixed</i>	0.96	55	6
<i>Low-Density Open Space</i>	0.09	5	0
<i>Farm Animals</i>	0	525	131
<i>Stream Bank Erosion</i>	0.04	0	0
<i>Subsurface Flow</i>	0	595	6
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	67	0
<b>TOTAL</b>	<b>10</b>	<b>1,365</b>	<b>168</b>

Sub-Watershed 19A is a fully developed watershed with little to no infiltration. Any Urban BMP's in this watershed will need to be retrofitted for existing development. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Things like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 5 proposed Urban BMP's in the future. Riparian buffers on 15 acres in the developed areas, Green Infrastructure approaches on 20 acres of Low-Density development, and 20 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 200 ft. where the stream enters the mainstem. We would also propose 3,000 ft. of street sweeping in this very urbanized paved environment.

Agricultural BMP Scenario:

No ag land uses in this watershed so none modeled. We did have to add 1 sheep as an animal unit for the model to function properly.

Table 19A-4: Wiki Watershed Load Reductions for Sub-Watershed 19A

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> <i>(lbs/yr)</i>	<i>TN</i> <i>(lbs/yr)</i>	<i>TP</i> <i>(lbs/yr)</i>	<i>Sediment</i> <i>(lbs/yr)</i>	<i>TN</i> <i>(lbs/yr)</i>	<i>TP</i> <i>(lbs/yr)</i>
Initial MMW Load	19,229	1,360	167	19,237	698	161
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	24,068	61	38	24,068	61	38
Loads Removed w/ Existing Agricultural BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	-	-	-	-	-	-
<b>TOTAL Loads Removed</b>	24,068	61	38	24,068	61	38
<b>New Reduced Load</b>	(4,838)	1,299	130	(4,831)	637	124
<b>Percent Reduction</b>	<b>125%</b>	<b>5%</b>	<b>23%</b>	<b>125%</b>	<b>9%</b>	<b>23%</b>
<b>TOTAL Baseline Load</b>	19,229	1,360	167	19,237	698	161
<b>TOTAL Loads Removed from Baseline</b>	24,068	61	38	24,068	61	38
<b>Percent Reduction from Baseline Load</b>	<b>125%</b>	<b>5%</b>	<b>23%</b>	<b>125%</b>	<b>9%</b>	<b>23%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 19A-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- None

Table 19A-5: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>
<b>BMP's to be Installed From the 2006 WIP (Proposed)</b>			
None			

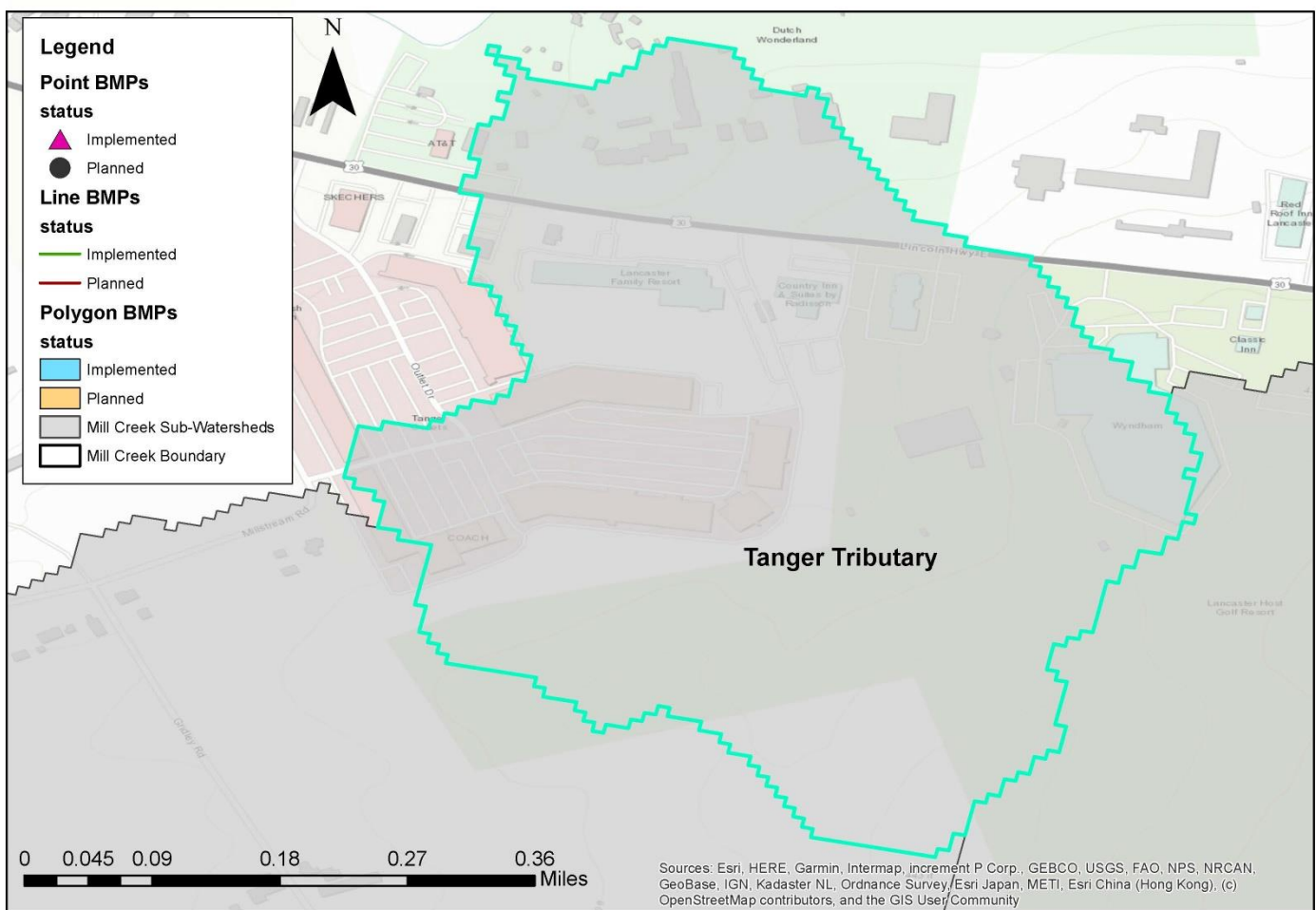
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	15 ac	\$2,500	\$37,500
Green Infrastructure	40 ac	Varies	Varies
Street Sweeping	3,000'	Varies	Varies
Stream bank Stabilization	200'	\$130	\$26,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$63,500</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.



## Tanger Tributary BMPs



Map19A-2: Completed & planned BMP's in the Sub-Watershed 19A according PracticeKeeper (2022)

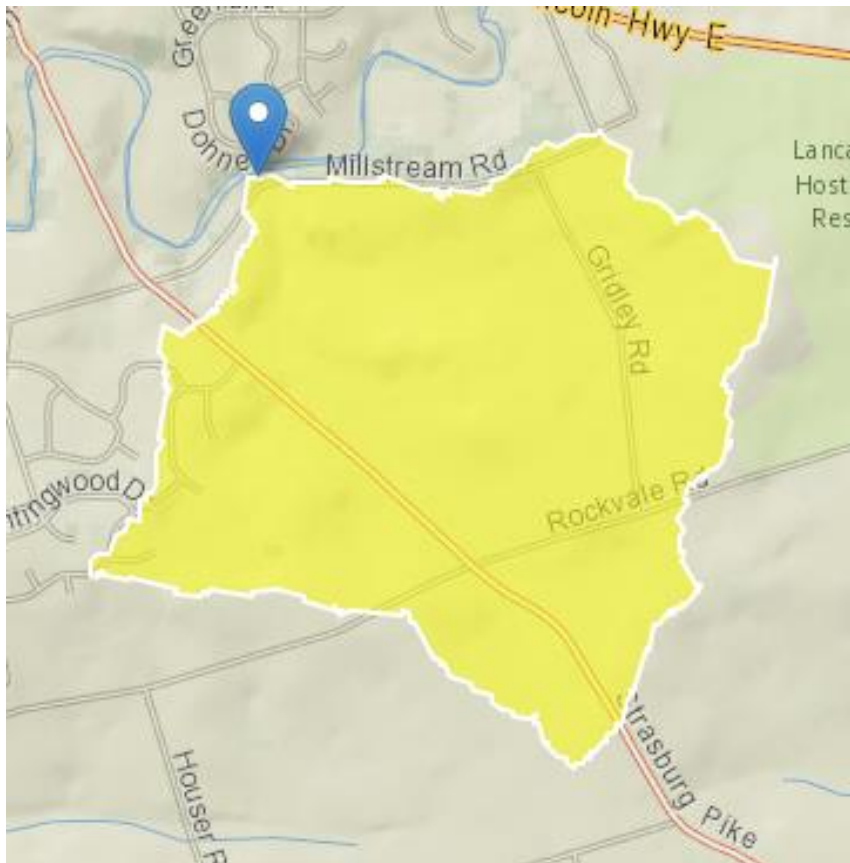
**Sub-Watershed 20 “Millstream” Tributary**

**Priority Level 1**

Sub-Watershed 20, the “Millstream” Tributary, is a 0.96 square mile watershed located mostly North of Rockvale Rd and mostly East of Strasburg Pk. and entering Mill Cr. North of Millstream Rd. The stream is a NAHD named Warm Water Fishery stream with a COMID reach number.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL priority</u>
57464361	2050306004793	0.98	Crop production	Nutrients	Medium
			Grazing in riparian zone	Siltation	High

The tributary is mostly agriculture with some residential areas as well. About 90% of all farm operations have conservation and nutrient management plans in the watershed, with 50% of plans being implemented to date. More outreach could be concentrated in this watershed to potentially delist this predominately ag watershed.



Map 20-1: Stream Stat Map of Sub-Watershed 20

Table 20-1: Stream Stats Table for Sub-Watershed 20

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0229
Longitude of confluence	-76.2341
Mean basin slope in degrees	3.78°
Percent of basin with urban development	2.81%
Mean basin elevation	381 ft
Percent of area covered by forest	5.22%
Maximum basin elevation	443 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	25.30%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	6.59%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 20-2: Wiki Watershed Facts for Sub-Watershed 20

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	274.29	59.03
<i>Pasture/Hay</i>	74.13	16.00
<i>Developed, Low Intensity</i>	51.89	11.17
<i>Developed, Open Space</i>	42.01	8.83
<i>Developed, Medium Intensity</i>	14.83	2.96
<i>Developed, High Intensity</i>	2.47	0.62
<i>Mixed Forest</i>	2.47	0.67
<i>Shrub/Scrub</i>	2.47	0.67
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	313.82	67.48
<i>High Infiltration</i>	76.60	16.48
<i>Medium/Very Slow Infiltration</i>	44.48	9.65
<i>Slow Infiltration</i>	29.65	6.40
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	397 ft	
<i>Minimum</i>	298 ft	
<i>Maximum</i>	442 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	<b><u>Numbers According to PK</u></b>
<i>Chicken, broilers</i>	7,433	0
<i>Pigs/hogs/swine</i>	271	0
<i>Turkeys</i>	161	0
<i>Cows, dairy</i>	83	117
<i>Horses</i>	11	27
<i>Sheep</i>	8	0
<i>Chicken, layers</i>	3	148,500
<i>Cows, beef</i>	0	0





Photos of Sub-Watershed 20 the "Millstream" Tributary



Photos of Sub-Watershed 20 the "Millstream" Tributary

Table 20-3: Wiki Watershed Loads Calculations for Sub-Watershed 20

<b>WATERSHED Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
Total loads (lbs)	664,130	20,721	1,421
Loading rates (lbs/ac)	1,427	45	3
Mean Annual Concentration (ppm)	402	13	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	6.39	62	18
<i>Cropland</i>	320.41	2,677	669
<i>Wooded Areas</i>	0.01	0	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.32	18	2
<i>Medium-Density Mixed</i>	0.44	17	2
<i>High-Density Mixed</i>	0.09	4	0
<i>Low-Density Open Space</i>	0.26	14	2
<i>Farm Animals</i>	0	2,454	616
<i>Stream Bank Erosion</i>	4.90	9	2
<i>Subsurface Flow</i>	0	15,470	113
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	42	0
<b>TOTAL</b>	<b>333</b>	<b>20,768</b>	<b>1,424</b>

Sub-Watershed 20 is almost exclusively in ag land use with nearly all farms in the watershed having conservation plans and nutrient management plans. Only about 50% though have all conservation practices within these plans implemented so that would be a push for future work in the watershed. Additional buffer and streambank implementation should also take place in this priority watershed. Because this is a Priority Level 1 Watershed, the goal would be an 80% implementation rate with the BMP's proposed in this watershed to achieve documented load reductions.

Urban BMP Scenario:

No Urban BMP's are needed in this watershed currently.

Agricultural BMP Scenario:

Since the majority of farms in this watershed have conservation and nutrient management plans, planning efforts in this watershed are fairly completed. However, work still needs to occur on the implementation of conservation practices like no-till, cover crops, and tillage improvements. 50% are implemented now of these practices so we are proposing an additional 50% implementation in the future. Also, presently there are only about 1.2 acres of riparian buffer installed in this watershed. That needs to be increased at least to 23 acres of buffer. Only 50% of the stream miles are fenced, so we are proposing another 2,800 ft. of fencing in the future along with approx. 4,000 ft. of streambank stabilization measures.

Table 20-4: Wiki Watershed Load Reductions for Sub-Watershed 20

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	665,125	20,753	1,423	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Existing Agricultural BMP's	225,625	2,467	488	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	237,122	2,606	431	-	-	-
<b>TOTAL Loads Removed</b>	462,747	5,073	919	-	-	-
<b>New Reduced Load</b>	202,378	15,681	503	-	-	-
<b>Percent Reduction</b>	<b>70%</b>	<b>24%</b>	<b>65%</b>	-	-	-
<b>TOTAL Baseline Load</b>	439,500	18,287	934	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	237,122	2,606	431	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>54%</b>	<b>14%</b>	<b>46%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 20-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 65 (Low Priority)** – lat. 40.0159; long. -76.2199 (E. Lampeter Twp.)
- **Site # 64 (Medium-Low Priority)** – lat. 40.0183; long. -76.2222 (E. Lampeter Twp.)
- **\*\*Site # 52 (Medium Priority)** – lat. 40.0109; long. -76.2250 (E. Lampeter Twp.)
- **Site # 53 (High-Medium Priority)** – lat. 40.0125; long. -76.2259 (E. Lampeter Twp.)
- **Site # 171 (Low Priority)** – lat. 40.0148; long. -76.2287 (E. Lampeter Twp.)
- **\*Site # 54 (High-Medium Priority)** – lat. 40.0196; long. -76.2332 (E. Lampeter Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

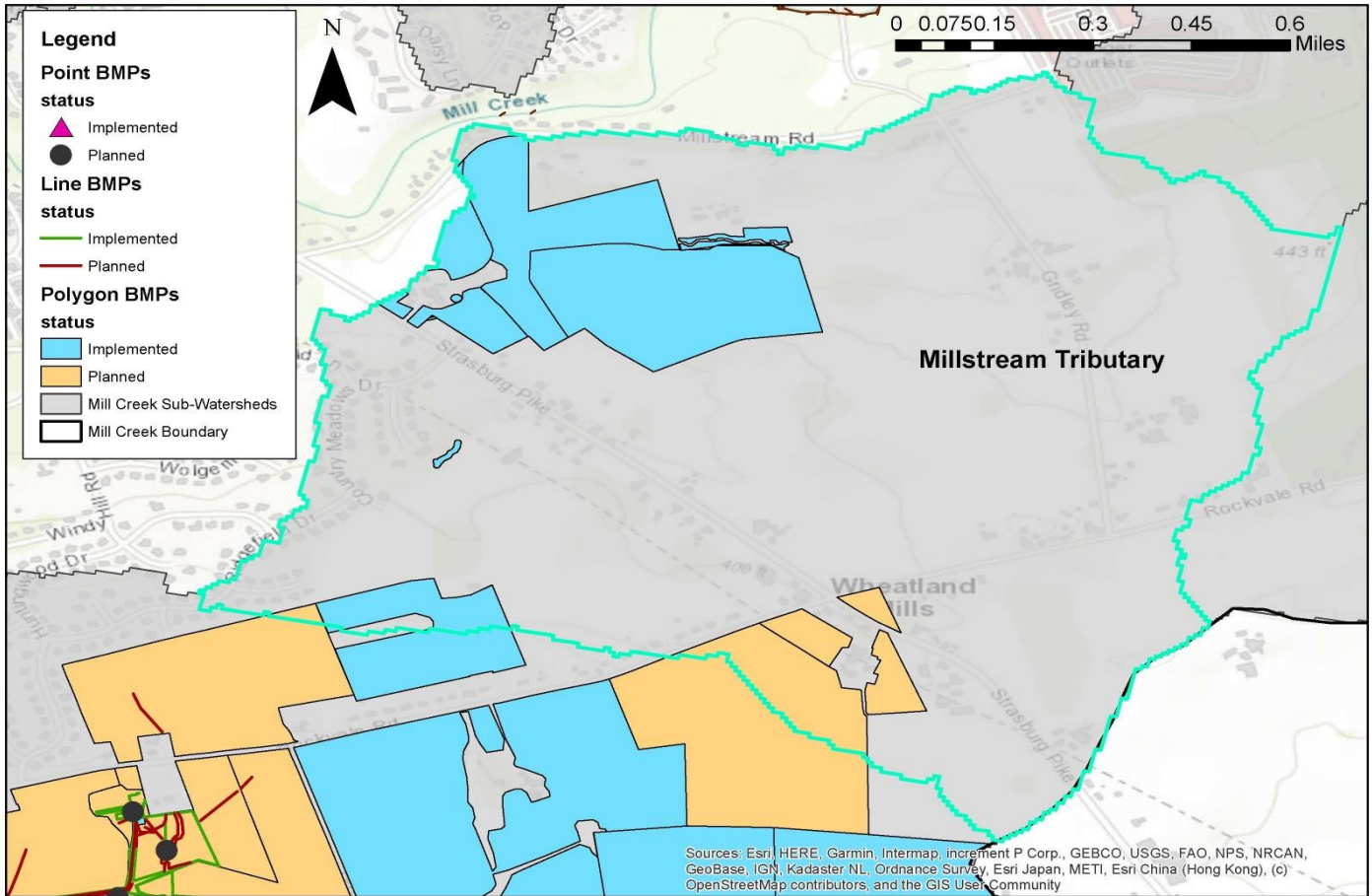
Table 20-5: Existing, Proposed, and New BMP's Estimated Cost

<b><u>Combined BMP's Installed Since the 2006 WIP (Existing)</u></b>	<b><u>Units Installed</u></b>	<b><u>Estimated Cost/Unit</u></b>	<b><u>Cost</u></b>
Streambank Fencing	500'	\$8	\$4,000
Prescribed grazing	10 ac	\$50	\$500
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$4,500</b>
<b><u>Combined BMP's to be Installed From the 2006 WIP (Proposed)</u></b>			
Riparian buffer	6.2 ac	\$2,500	\$15,500
Streambank Fencing	2,800'	\$8	\$22,400
Terraces	1,500'	\$4	\$6,000
Cover crop	6 ac	\$20	\$120
Stream bank Stabilization	4,000'	\$130	\$520,000
<b><u>Additional Future Proposed BMP's (NEW)</u></b>			
Riparian buffer	16.8 ac	\$2,500	\$42,000
Cover Crop	124 ac	\$20	\$2,480
Nutrient Management Plan	140 ac	\$8	\$1,120
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$609,620</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

# Millstream Tributary BMPs



Map20-2: Completed & planned BMP's in the Sub-Watershed 20 according PracticeKeeper (2022)



## Sub-Watershed 21 Big Spring Run Tributary

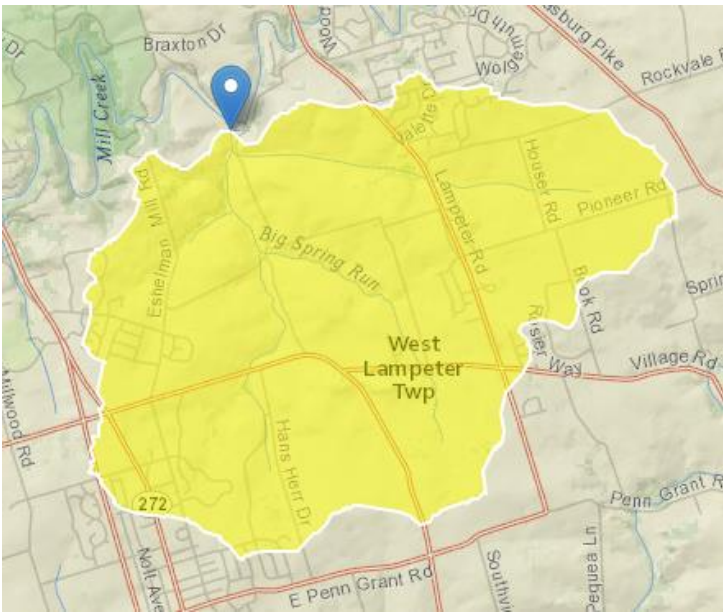
### Priority Level 2

Sub-Watershed 21, the Big Spring Run Tributary, is a 5.82 square mile watershed located west of Strasburg Pike, South of E. Penn Grant Rd., and East of Willow Street Pike and entering Mill Cr. at Gypsy Hill Rd. The stream is a NAHD named stream with seventeen Warm Water Fishery COMID reach numbers.

<u>COMID #</u>	<u>NHD Reach Codes</u>	<u>Length (mi)</u>	<u>Impairment Source</u>	<u>Impairment Cause</u>	<u>TMDL Priority</u>	
57464671	2050306001301	0.8	Agriculture	Nutrients	Medium	
Reach Location: Mouth to Northeast (Lampeter/Houser) tributary confluence			Agriculture	Siltation	High	
57464697	2050306001307	2.15	Crop production	Nutrients	Medium	
Reach Location: Northeast tributary (Lampeter/Houser)			Crop production	Siltation	High	
57464819	2050306001302	0.40	Agriculture	Nutrients	Medium	
Reach Location: Segment between Northeast trib. & West tributary			Agriculture	Siltation	High	
57465211	2050306001303	0.89	Agriculture	Nutrients	Medium	
Reach Location: West Tributary (Eshleman Mill)			Agriculture	Siltation	High	
57464915	2050306001304	0.35	Agriculture	Nutrients	Medium	
Reach Location: Segment between West Trib. & East Tributary			Agriculture	Siltation	High	
57464971	2050306001305	0.70	Agriculture	Nutrients	Medium	
Reach Location: East Trib. From mouth to small trib. spur			Agriculture	Siltation	High	
57464975	2050306004877	0.05	Agriculture	Nutrients	Medium	
Reach Location: Spur tributary on east tributary			Agriculture	Siltation	High	
57464979	2050306001305	0.16	Agriculture	Nutrients	Medium	
Reach Location: Segment of East trib. between spur tributary & North & South tributary confluence			Agriculture	Siltation	High	
57464977	2050306004878	0.88	Agriculture	Nutrients	Medium	
Reach Location: East tributary's North trib. segment			Agriculture	Siltation	High	

57465329	2050306001305	0.88	Agriculture	Nutrients	Medium	
Reach Location: East tributary's South trib. segment			Agriculture	Siltation	High	
57465117	2050306001306	0.54	Agriculture	Nutrients	Medium	
Reach Location: Segment between East trib. & Southwest & South confluence			Agriculture	Siltation	High	
57465307	2050306001306	0.47	Agriculture	Nutrients	Medium	
Reach Location: Segment of Southwest trib. to 2 headwater trib. (Willow Valley & CTC/Hans Herr)			Agriculture	Siltation	High	
57465399	2050306004932	0.43	Agriculture	Nutrients	Medium	
Reach Location: Southwest tributary segment (Willow Valley)			Agriculture	Siltation	High	
57465499	2050306001306	0.53	Agriculture	Nutrients	Medium	
Reach Location: Southwest tributary segment (CTC/Hans Herr)			Agriculture	Siltation	High	
57465317	2050306004924	0.75	Agriculture	Nutrients	Medium	
Reach Location: Segment 1 of South Tributary (mouth)(Route 222)			Agriculture	Siltation	High	
57465323	2050306004924	0.04	Agriculture	Nutrients	Medium	
Reach Location: Segment 2 of South Tributary (Route 222)			Agriculture	Siltation	High	
57465357	2050306004924	0.14	Agriculture	Nutrients	Medium	
Reach Location: Segment 3 of South Tributary (Route 222)			Agriculture	Siltation	High	

The tributary is a mix of agriculture, residential, and commercial. About 75% of the farms in the sub-watershed have conservation and nutrient management plans, but the majority of these plans are only planned BMP's and not implemented at this time so additional outreach is needed to complete these plans. The other major land use in the Southwest tributary of this sub-watershed is large-scale residential with a large retirement community in the headwaters of the watershed. Add in the fact that the watershed also starts in the village of Willow Street with commercial and residential, and the impacts of stormwater cannot be ignored in this tributary watershed. The other side of this tributary, the South side, has seen a lot of floodplain restoration implemented over the last several years from various partners. This section could be reevaluated for potential delisting in a few years as these projects mature.



Map 21-1: Stream Stat Map of Sub-Watershed 21

Table 21-1: Stream Stats Table for Sub-Watershed 21

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0091
Longitude of confluence	-76.2682
Mean basin slope in degrees	2.95°
Percent of basin with urban development	9.24%
Mean basin elevation	390 ft
Percent of area covered by forest	5.81%
Maximum basin elevation	497 ft.
Percentage of impervious area determined from NLCD 2001 impervious dataset	7.68%
Percentage of land-use from NLCD 2001 classes 21-24	27.79%
Percentage of developed (urban) land from NLCD 2011 classes 21-24	32.25%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	9.12%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 21-2: Wiki Watershed Facts for Sub-Watershed 21

<b><u>ENTIRE BIG SPRING RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	1,929.89	52.34
<i>Developed, Low Intensity</i>	509.04	13.81
<i>Developed, Open Space</i>	437.38	11.84
<i>Pasture/Hay</i>	358.30	9.71
<i>Developed, Medium Intensity</i>	256.99	6.99
<i>Developed, High Intensity</i>	74.13	2.03
<i>Mixed Forest</i>	74.13	2.03
<i>Deciduous Forest</i>	29.65	0.78
<i>Shrub/Scrub</i>	7.41	0.17

<i>Evergreen Forest</i>	4.94	0.10
<i>Open Water</i>	2.47	0.07
<i>Grassland/Herbaceous</i>	2.47	0.07
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	2,560.01	69.42
<i>Slow Infiltration</i>	518.92	14.07
<i>High Infiltration</i>	229.81	6.22
<i>Very Slow Infiltration</i>	214.98	5.81
	155.68	4.23
<i>Medium/Very Slow Infiltration</i>		
<i>Slow/Very Slow Infiltration</i>	9.88	0.24
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	394 ft	
<i>Minimum</i>	264 ft	
<i>Maximum</i>	500 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	58,931	
<i>Pigs/hogs/swine</i>	2,148	
<i>Turkeys</i>	1,278	
<i>Cows, dairy</i>	662	
<i>Horses</i>	94	
<i>Sheep</i>	64	
<i>Chicken, layers</i>	29	
<i>Cows, beef</i>	0	



Photos of upper section of Sub-Watershed 21 the Big Spring Run Tributary





*Aerial photos of Sub-Watershed 21 the Big Spring Run Tributary*



*Aerial photos of Sub-Watershed 21 the Big Spring Run Tributary*



*Aerial photos of Sub-Watershed 21 the Big Spring Run Tributary*





Aerial photos of Sub-Watershed 21 the Big Spring Run Tributary



Photos of upper section of Sub-Watershed 21 the Big Spring Run Tributary

Table 21-3: Wiki Watershed Loads Calculations for Sub-Watershed 21

<b>ENTIRE BIG SPRING RUN Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
Total loads (lbs)	4,743,844	149,762	10,319
Loading rates (lbs/ac)	1,286	41	3
Mean Annual Concentration (ppm)	370	12	1

<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (lbs)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	57,710	286	83
<i>Cropland</i>	4,190,760	17,721	4,323
<i>Wooded Areas</i>	326	5	0
<i>Wetlands</i>	4	0	0
<i>Open Land</i>	0	1	0
<i>Barren Areas</i>	1	0	0
<i>Low-Density Mixed</i>	6,313	172	18
<i>Medium-Density Mixed</i>	16,449	334	34
<i>High-Density Mixed</i>	4,760	97	10
<i>Low-Density Open Space</i>	5,412	148	16
<i>Farm Animals</i>	0	19,584	4,917
<i>Stream Bank Erosion</i>	462,108	400	108
<i>Subsurface Flow</i>	0	110,209	809
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	806	0

Sub-Watershed 21 has good and bad influences in it. From the southwest tributary, development pressure from a large-scale retirement community and the village of Willow Street play a major role in what happens in this area. Other headwater sections, like the east tributary are dominated by development and school development pressure. In the middle of the watershed you have the majority of the ag influences in the watershed, which most have plans but not a lot of conservation practices on the ground. Add in the floodplain restoration efforts done in the Southeast tributary for stormwater credits along with buffer implementation in the headwater areas of the eastern tributary and you have both good and bad things happening in the watershed at the same time. With so many things going on in this watershed, trying to get a grip on where it is headed in the future will be a challenge.

Urban BMP Scenario:

The following scenario assumes 5 proposed Urban BMP's in the future. Riparian buffers on 20 acres in the developed areas, Green Infrastructure approaches on 75 acres of Low-Density development, and 35 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 2,000 ft. of developed land in the headwaters and that 3,000 ft. of street sweeping will take place in the developed areas of the watershed.

Agricultural BMP Scenario:

The good news from the ag land use in the watershed is that about 75% of the farms have conservation and nutrient management plans. The flip side of this coin is that most of the conservation work proposed in these plans has not been implemented to date. This implementation side of things needs to be ramped up for significant changes in the water quality to be noticed. Only about 800 acres of conservation practices have been implemented thus far. This would need to increase to 1,110 acres in the future. There are about 5 acres of riparian buffer installed in the watershed but this would need to be increased to 45.9 acres in the future. 10,000 ft. of floodplain restoration has taken place in the watershed. We estimate that an additional 5,000 ft. will take place in the future. The majority of the watershed has livestock fenced out of the stream but we are estimating that total only to be

about 75% or 30,000 ft. that would still leave about 10,000 ft to be installed in the future. Finally, there has been about 1,000 ft. of streambank stabilization in the watershed thus far. We would like to add to this total an additional 5,000 ft. in the future.

Table 21-4: Wiki Watershed Load Reductions for Sub-Watershed 21

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	4,749,202	149,954	10,324	-	-	-
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	252,115	439	357	-	-	-
Loads Removed w/ Existing Agricultural BMP's	1,389,228	31,788	5,670	-	-	-
Loads Removed w/ Proposed Agricultural BMP's	1,324,844	10,182	2,103	-	-	-
TOTAL Loads Removed	2,966,188	42,409	8,129	-	-	-
New Reduced Load	1,783,014	107,545	2,197	-	-	-
Percent Reduction	<b>63%</b>	<b>28%</b>	<b>79%</b>	-	-	-
<b>TOTAL Baseline Load</b>	3,359,973	118,167	4,656	-	-	-
<b>TOTAL Loads Removed from Baseline</b>	1,576,959	10,622	2,459	-	-	-
<b>Percent Reduction from Baseline Load</b>	<b>47%</b>	<b>9%</b>	<b>53%</b>	-	-	-

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 21-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 164 (Medium-Low Priority)** – lat. 39.9750; long. -76.2593 (W. Lampeter Twp.)
- **Site # 165 (Medium-Low Priority)** – lat. 39.9805; long. -76.2501 (W. Lampeter Twp.)
- **Site # 166 (Low Priority)** – lat. 39.9899; long. -76.2573 (W. Lampeter Twp.)
- **Site # 200 (Low Priority)** – lat. 39.9855; long. -76.2734 (W. Lampeter Twp.)
- **\*\*Site # 199 (Medium Priority)** – lat. 39.9848; long. -76.2621 (W. Lampeter Twp.)
- **\*\*Site # 177 (Medium-Low Priority)** – lat. 39.9790; long. -76.2661 (W. Lampeter Twp.)
- **\*\*Site # 197 (High Priority)** – lat. 39.9859; long. -76.2537 (W. Lampeter Twp.)
- **Site # 198 (Medium Priority)** – lat. 39.9908; long. -76.2594 (W. Lampeter Twp.)

- **\*Site # 167 (Medium Priority)** – lat. 39.9910; long. -76.2651 (W. Lampeter Twp.)
- **\*Site # 168 (High-Medium Priority)** – lat. 39.9929; long. -76.2624 (W. Lampeter Twp.)
- **Site # 178 (Medium Priority)** – lat. 39.9959; long. -76.2640 (W. Lampeter Twp.)
- **\*\*Site # 193 (High-Medium Priority)** – lat. 40.0046; long. -76.2230 (W. Lampeter Twp.)
- **Site # 192 (Medium-Low Priority)** – lat. 40.0017; long. -76.2302 (W. Lampeter Twp.)
- **Site # 191 (Medium-Low Priority)** – lat. 40.0037; long. -76.2312 (W. Lampeter Twp.)
- **\*Site # 190 (Medium-Low Priority)** – lat. 40.0049; long. -76.2353 (W. Lampeter Twp.)
- **\*Site # 189 (Medium Priority)** – lat. 40.0050; long. -76.2389 (W. Lampeter Twp.)
- **Site # 188 (Medium Priority)** – lat. 40.0055; long. -76.2481 (W. Lampeter Twp.)
- **Site # 170 (Medium-Low Priority)** – lat. 39.9967; long. -76.2492 (W. Lampeter Twp.)
- **Site # 196 (Medium Priority)** – lat. 39.9958; long. -76.2499 (W. Lampeter Twp.)
- **Site # 169 (Medium Priority)** – lat. 39.9961; long. -76.2525 (W. Lampeter Twp.)
- **\*Site # 180 (Medium Priority)** – lat. 39.9993; long. -76.2559 (W. Lampeter Twp.)
- **Site # 194 (Medium Priority)** – lat. 40.0011; long. -76.2663 (W. Lampeter Twp.)
- **Site # 195 (Medium-Low Priority)** – lat. 40.0043; long. -76.2686 (W. Lampeter Twp.)
- **\*\*Site # 175 (Low Priority)** – lat. 40.0090; long. -76.2682 (W. Lampeter Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 21-5: Existing, Proposed, and New BMP's Estimated Cost

<b>Combined BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Residue management, no-till	61.7 ac	\$19	\$1,172
Nutrient management plan	144.8 ac	\$8	\$1,158
Streambank Fencing	9,900'	\$8	\$79,200
Barnyard runoff controls	2	\$22,000	\$44,000
Waste storage system	2	\$80,000	\$160,000
Stream bank Stabilization	8,550'	\$130	\$1,111,500
Riparian buffer	4.7 ac	\$2,500	\$11,750
Prescribed grazing	10 ac	\$50	\$500
Remove pond & dam	1	Varies	Varies
Grassed waterway	5.2 ac	\$4,500	\$23,400
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$1,432,680</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	16.0 ac	\$2,500	\$40,000
Stream bank Stabilization	4,800'	\$130	\$624,000
Streambank Fencing	8,906'	\$8	\$71,248
Nutrient management plan	119.5 ac	\$8	\$956
Barnyard runoff controls	2	\$22,000	\$44,000
Waste storage system	1	\$80,000	\$80,000
Conservation crop rotation	243.5 ac	\$11	\$2,679
Cover crop	226.1 ac	\$20	\$4,522
Grassed waterway	6.2 ac	\$4,500	\$27,900
Stripcropping, contour	95.7 ac	\$2	\$191
Pasture/hayland plantings	108.2 ac	\$300	\$32,460
Prescribed grazing	76.9 ac	\$50	\$3,845

Contour farming	18.1 ac	\$8	\$145
Residue management, no-till	74.9 ac	\$19	\$1,423
Residue management, seasonal	93 ac	\$20	\$1,860
Impervious surface reduction	10 ac	Varies	Varies
Rooftop runoff management	5 ac	Varies	Varies
Infiltration practices	10 ac	Varies	Varies
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	49.9 ac	\$2,500	\$124,750
Cover Crop	873.9 ac	\$20	\$17,478
Streambank Fencing	1,094'	\$8	\$8,752
Nutrient Management Plan	380.5 ac	\$8	\$3,044
Green Infrastructure	110 ac	Varies	Varies
Street Sweeping	3,000'	Varies	Varies
Stream bank Stabilization	200'	\$130	\$26,000
Floodplain Restoration	5,000'	\$900	\$4,500,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$5,615,253</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

Below is additional WikiWatershed data for tributaries within Big Spring Run. Models were not run on these tributaries but data is provided as background information on them.

<b><u>EAST TRIBUTARY BIG SPRING RUN Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	672.13	64.71
<i>Developed, Low Intensity</i>	126.02	12.03
<i>Developed, Open Space</i>	108.73	10.49
<i>Pasture/Hay</i>	76.60	7.44
<i>Developed, Medium Intensity</i>	24.71	2.37
<i>Mixed Forest</i>	19.77	1.80
<i>Deciduous Forest</i>	4.94	0.43
<i>Developed, High Intensity</i>	2.47	0.21
<i>Shrub/Scrub</i>	2.47	0.13
<i>Grassland/Herbaceous</i>	2.47	0.26
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	728.96	70.38
<i>Slow Infiltration</i>	175.44	16.91
<i>High Infiltration</i>	76.60	7.50
<i>Medium/Very Slow Infiltration</i>	39.54	3.91
<i>Very Slow Infiltration</i>	12.36	1.30



<u>ELEVATION</u>	<u>FEET</u>	
<i>Average</i>	391 ft	
<i>Minimum</i>	275 ft	
<i>Maximum</i>	456 ft	
<u>ANIMALS</u>	<u>NUMBERS</u>	
<i>Chicken, broilers</i>	16,586	
<i>Pigs/hogs/swine</i>	604	
<i>Turkeys</i>	359	
<i>Cows, dairy</i>	186	
<i>Horses</i>	26	
<i>Sheep</i>	18	
<i>Chicken, layers</i>	8	
<i>Cows, beef</i>	0	

<u>EAST TRIBUTARY BIG SPRING RUN Loads</u>			
<u>SOURCES</u>	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
<i>Total loads (lbs)</i>	1,660,904	48,379	3,331
<i>Loading rates (lbs/ac)</i>	1,600	47	3
<i>Mean Annual Concentration (ppm)</i>	451	13	1
<u>Load Sources</u>			
<u>SOURCES</u>	<u>SEDIMENT (lbs)</u>	<u>TOTAL NITROGEN (lbs)</u>	<u>TOTAL PHOSPHORUS (lbs)</u>
<i>Hay/Pasture</i>	13,486	65	19
<i>Cropland</i>	1,605,609	6,678	1,650
<i>Wooded Areas</i>	81	1	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	1	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	1,546	42	4
<i>Medium-Density Mixed</i>	1,647	30	3
<i>High-Density Mixed</i>	148	3	0
<i>Low-Density Open Space</i>	1,348	37	4
<i>Farm Animals</i>	0	5,500	1,381
<i>Stream Bank Erosion</i>	37,039	33	9
<i>Subsurface Flow</i>	0	35,913	260
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	77	0

<b>WEST TRIBUTARY BIG SPRING RUN Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	192.01	48.68
<i>Developed, Low Intensity</i>	74.50	18.89
<i>Developed, Open Space</i>	61.64	15.63
<i>Developed, Medium Intensity</i>	21.28	5.40
<i>Pasture/Hay</i>	20.18	5.12
<i>Mixed Forest</i>	12.86	3.26
<i>Deciduous Forest</i>	5.10	1.29
<i>Shrub/Scrub</i>	3.10	0.79
<i>Developed, High Intensity</i>	2.88	0.73
<i>Barren Land (Rock/Sand/Clay)</i>	0.89	0.22
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	294.05	74.65
<i>High Infiltration</i>	42.01	10.40
<i>Very Slow Infiltration</i>	29.65	7.70
<i>Slow Infiltration</i>	27.18	7.20
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	384 ft	
<i>Minimum</i>	289 ft	
<i>Maximum</i>	472 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	6,305	
<i>Pigs/hogs/swine</i>	229	
<i>Turkeys</i>	136	
<i>Cows, dairy</i>	70	
<i>Horses</i>	10	
<i>Sheep</i>	6	
<i>Chicken, layers</i>	3	
<i>Cows, beef</i>	0	

<b>WEST TRIBUTARY BIG SPRING RUN Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	476,801	14,647	1,080
<i>Loading rates (lbs/ac)</i>	1,208	37	3
<i>Mean Annual Concentration (ppm)</i>	353	11	1

<b>Load Sources</b>			
<b>SOURCES</b>	<b>SEDIMENT (lbs)</b>	<b>TOTAL NITROGEN (lbs)</b>	<b>TOTAL PHOSPHORUS (lbs)</b>
<i>Hay/Pasture</i>	3,412	17	5
<i>Cropland</i>	457,567	1,904	465
<i>Wooded Areas</i>	64	1	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	1	0	0
<i>Low-Density Mixed</i>	930	26	3
<i>Medium-Density Mixed</i>	1,380	26	3
<i>High-Density Mixed</i>	193	4	0
<i>Low-Density Open Space</i>	770	21	2
<i>Farm Animals</i>	0	2,077	522
<i>Stream Bank Erosion</i>	12,483	11	2
<i>Subsurface Flow</i>	0	10,495	79
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	67	0

<b>SOUTHEAST TRIBUTARY BIG SPRING RUN Wiki Watersheds Facts</b>		
<b>LAND USE</b>	<b>ACRES</b>	<b>%</b>
<i>Cultivated Crops</i>	412.67	46.83
<i>Pasture/Hay</i>	130.97	14.96
<i>Developed, Low Intensity</i>	116.14	13.25
<i>Developed, Open Space</i>	111.20	12.64
<i>Developed, Medium Intensity</i>	76.60	8.66
<i>Developed, High Intensity</i>	19.77	2.30
<i>Mixed Forest</i>	4.94	0.53
<i>Open Water</i>	2.47	0.18
<i>Deciduous Forest</i>	2.47	0.40
<i>Evergreen Forest</i>	2.47	0.25
<b>SOILS</b>	<b>ACRES</b>	<b>%</b>
<i>Moderate Infiltration</i>	635.06	72.32
<i>Slow Infiltration</i>	106.26	12.09
<i>Very Slow Infiltration</i>	101.31	11.41
<i>Medium/Very Slow Infiltration</i>	37.07	4.19

<u>ELEVATION</u>	<u>FEET</u>	
<i>Average</i>	394 ft	
<i>Minimum</i>	299 ft	
<i>Maximum</i>	475 ft	
<u>ANIMALS</u>	<u>NUMBERS</u>	
<i>Chicken, broilers</i>	14,045	
<i>Pigs/hogs/swine</i>	512	
<i>Turkeys</i>	304	
<i>Cows, dairy</i>	157	
<i>Horses</i>	22	
<i>Sheep</i>	15	
<i>Chicken, layers</i>	7	
<i>Cows, beef</i>	0	

<u>SOUTHEAST TRIBUTARY BIG SPRING RUN Loads</u>			
<u>SOURCES</u>	<u>SEDIMENT</u>	<u>TOTAL NITROGEN</u>	<u>TOTAL PHOSPHORUS</u>
<i>Total loads (lbs)</i>	1,054,424	36,825	2,426
<i>Loading rates (lbs/ac)</i>	1,201	42	3
<i>Mean Annual Concentration (ppm)</i>	341	12	1
<u>Load Sources</u>			
<u>SOURCES</u>	<u>SEDIMENT (lbs)</u>	<u>TOTAL NITROGEN (lbs)</u>	<u>TOTAL PHOSPHORUS (lbs)</u>
<i>Hay/Pasture</i>	23,293	112	33
<i>Cropland</i>	963,981	4,023	990
<i>Wooded Areas</i>	34	1	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	1,436	39	4
<i>Medium-Density Mixed</i>	4,897	98	10
<i>High-Density Mixed</i>	1,300	26	3
<i>Low-Density Open Space</i>	1,369	37	4
<i>Farm Animals</i>	0	4,650	1,168
<i>Stream Bank Erosion</i>	58,115	51	13
<i>Subsurface Flow</i>	0	27,550	201
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	238	0

<b>SOUTH TRIBUTARY BIG SPRING RUN Wiki Watersheds Facts</b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Cultivated Crops</i>	570.81	47.79
<i>Developed, Low Intensity</i>	185.33	15.43
<i>Developed, Open Space</i>	143.32	11.98
<i>Developed, Medium Intensity</i>	133.44	11.14
<i>Pasture/Hay</i>	91.43	7.73
<i>Developed, High Intensity</i>	49.42	4.05
<i>Mixed Forest</i>	12.36	1.00
<i>Deciduous Forest</i>	7.41	0.69
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	783.32	65.56
<i>Slow Infiltration</i>	205.10	17.14
<i>High Infiltration</i>	81.54	6.89
<i>Very Slow Infiltration</i>	69.19	5.87
<i>Medium/Very Slow Infiltration</i>	54.36	4.53
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	409 ft	
<i>Minimum</i>	294 ft	
<i>Maximum</i>	500 ft	
<b><u>ANIMALS</u></b>	<b><u>NUMBERS</u></b>	
<i>Chicken, broilers</i>	19,079	
<i>Pigs/hogs/swine</i>	695	
<i>Turkeys</i>	414	
<i>Cows, dairy</i>	214	
<i>Horses</i>	30	
<i>Sheep</i>	21	
<i>Chicken, layers</i>	9	
<i>Cows, beef</i>	0	

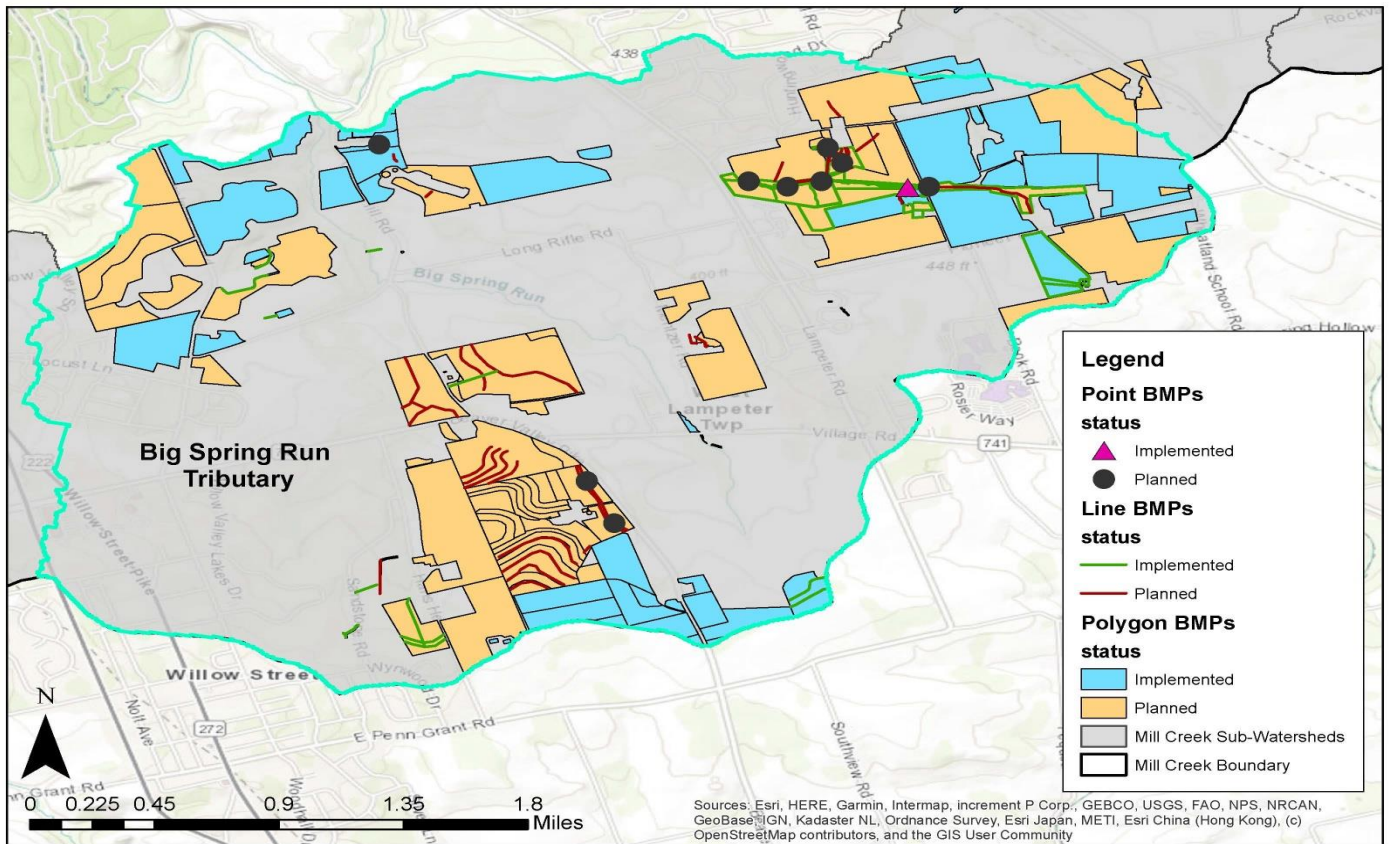
<b>SOUTH TRIBUTARY BIG SPRING RUN Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	1,431,278	46,445	3,260
<i>Loading rates (lbs/ac)</i>	1,199	39	3
<i>Mean Annual Concentration (ppm)</i>	330	11	1



<b>Load Sources</b>			
<b>SOURCES</b>	<b>SEDIMENT (lbs)</b>	<b>TOTAL NITROGEN (lbs)</b>	<b>TOTAL PHOSPHORUS (lbs)</b>
Hay/Pasture	15,781	77	22
Cropland	1,309,596	5,485	1,341
Wooded Areas	64	1	0
Wetlands	4	0	0
Open Land	0	0	0
Barren Areas	0	0	0
Low-Density Mixed	2,309	64	7
Medium-Density Mixed	8,290	174	18
High-Density Mixed	3,009	63	6
Low-Density Open Space	1,791	49	5
Farm Animals	0	6,328	1,589
Stream Bank Erosion	90,433	79	22
Subsurface Flow	0	33,709	250
Point Sources	0	0	0
Septic Systems	0	417	0



## Big Spring Run Tributary BMPs



Map21-2: Completed & planned BMP's in the Sub-Watershed 21 according PracticeKeeper (2022)

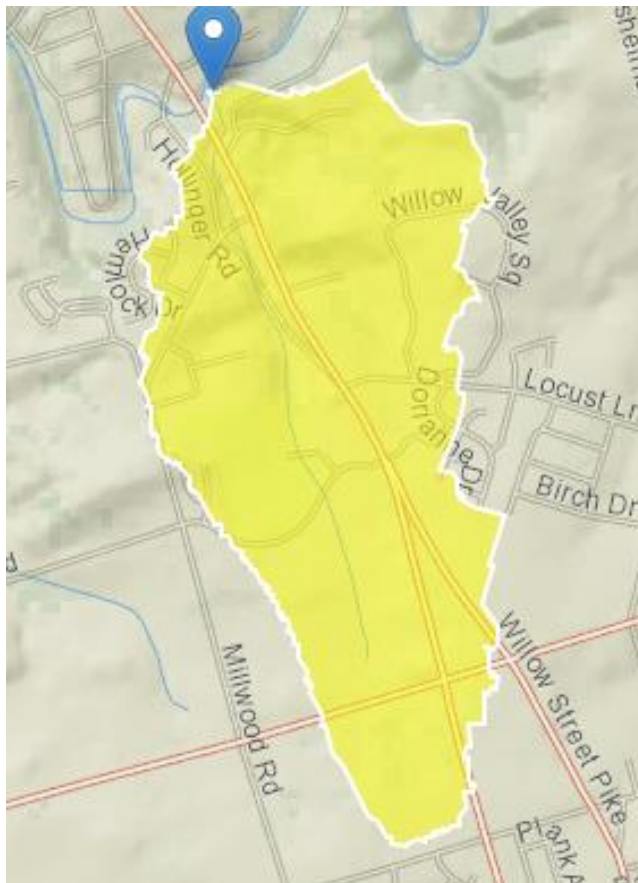
**Sub-Watershed 22 “Willow Street” Tributary**

**Priority Level 3**

Sub-Watershed 22, the “Willow Street” Tributary, is a 0.73 square mile watershed located mostly North of Long Lane and paralleling Willow Street Pk. and entering Mill Cr. East of Willow Street Pk. The stream is a NAHD named Warm Water Fishery stream with a COMID reach number.

<b><u>COMID #</u></b>	<b><u>NHD Reach Codes</u></b>	<b><u>Length (mi)</u></b>	<b><u>Impairment Source</u></b>	<b><u>Impairment Cause</u></b>	<b><u>TMDL priority</u></b>
57465439	2050306001300	1.26	Agriculture	Nutrients	Medium
			Agriculture	Siltation	High

The tributary is divided into thirds with 1/3 being agriculture, 1/3 being residential, and 1/3 being commercial. All ag operations have conservation and nutrient management plans, with most BMP’s implemented in those plans. The largest threat to the watershed is the substantial commercial footprint and stormwater related to this land use. The commercial area is growing currently in the middle reaches of the watershed. The residential area is near the mouth of the watershed and seems to be fairly stable as of now.



Map 22-1: Stream Stat Map of Sub-Watershed 22

Table 22-1: Stream Stats Table for Sub-Watershed 22

<b><u>Stream STATS Facts</u></b>	
Latitude of confluence	40.0029
Longitude of confluence	-76.2924
Mean basin slope in degrees	3.83°
Percent of basin with urban development	13.69%
Mean basin elevation	381 ft
Percent of area covered by forest	21.22%
Maximum basin elevation	493 ft.
Percentage of developed (urban) land from NLCD 2011 classes 21-24	54.42%
Average percentage of impervious area determined from NLCD 2011 impervious dataset	16.94%

\*NLCD classes: 21-developed, open space; 22-developed, low intensity; 23-developed, medium intensity; 24-developed, high intensity

Table 22-2: Wiki Watershed Facts for Sub-Watershed 22

<b><u>Wiki Watersheds Facts</u></b>		
<b><u>LAND USE</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Developed, Low Intensity</i>	106.20	22.39
<i>Developed, Open Space</i>	96.00	20.24
<i>Developed, Medium Intensity</i>	87.36	18.42
<i>Cultivated Crops</i>	68.29	14.40
<i>Mixed Forest</i>	45.23	9.54
<i>Pasture/Hay</i>	29.93	6.31
<i>Developed, High Intensity</i>	17.52	3.69
<i>Deciduous Forest</i>	10.86	2.29
<i>Shrub/Scrub</i>	9.09	1.92
<i>Evergreen Forest</i>	2.44	0.51
<i>Open Water</i>	1.11	0.23
<i>Woody Wetlands</i>	0.22	0.05
<b><u>SOILS</u></b>	<b><u>ACRES</u></b>	<b><u>%</u></b>
<i>Moderate Infiltration</i>	271.82	57.50
<i>High Infiltration</i>	116.14	24.59
<i>Slow Infiltration</i>	46.95	10.00
<i>Medium/Very Slow Infiltration</i>	24.71	5.33
<i>Very Slow Infiltration</i>	12.36	2.57
<b><u>ELEVATION</u></b>	<b><u>FEET</u></b>	
<i>Average</i>	385 ft	
<i>Minimum</i>	257 ft	
<i>Maximum</i>	486 ft	



<u>ANIMALS</u>	<u>NUMBERS</u>	<u>Numbers According to PK</u>
<i>Chicken, broilers</i>	7,581	0
<i>Pigs/hogs/swine</i>	276	0
<i>Turkeys</i>	164	0
<i>Cows, dairy</i>	85	3
<i>Horses</i>	12	10
<i>Sheep</i>	8	0
<i>Chicken, layers</i>	3	185,400
<i>Cows, beef</i>	0	0



*Photos of Sub-Watershed 22 the "Willow Street" Tributary*



*Photos of Sub-Watershed 22 the "Willow Street" Tributary*

Table 22-3: Wiki Watershed Loads Calculations for Sub-Watershed 22

<b>WATERSHED Loads</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT</u></b>	<b><u>TOTAL NITROGEN</u></b>	<b><u>TOTAL PHOSPHORUS</u></b>
<i>Total loads (lbs)</i>	210,863	13,293	907
<i>Loading rates (lbs/ac)</i>	445	28	2
<i>Mean Annual Concentration (ppm)</i>	126	8	1
<b>Load Sources</b>			
<b><u>SOURCES</u></b>	<b><u>SEDIMENT (tons)</u></b>	<b><u>TOTAL NITROGEN (lbs)</u></b>	<b><u>TOTAL PHOSPHORUS (lbs)</u></b>
<i>Hay/Pasture</i>	2.60	25	7
<i>Cropland</i>	83.15	690	168
<i>Wooded Areas</i>	0.13	2	0
<i>Wetlands</i>	0	0	0
<i>Open Land</i>	0	0	0
<i>Barren Areas</i>	0	0	0
<i>Low-Density Mixed</i>	0.66	36	4
<i>Medium-Density Mixed</i>	2.84	110	11
<i>High-Density Mixed</i>	0.57	22	2
<i>Low-Density Open Space</i>	0.60	32	4
<i>Farm Animals</i>	0	2,515	631
<i>Stream Bank Erosion</i>	15.14	27	7
<i>Subsurface Flow</i>	0	9,590	75
<i>Point Sources</i>	0	0	0
<i>Septic Systems</i>	0	274	0
<b>TOTAL</b>	<b>106</b>	<b>13,323</b>	<b>909</b>

Sub-Watershed 22 is under tremendous development pressure and will more than likely be developed in the next 10 years with residential or commercial development. Looking at the surrounding watershed all indications point to this happening. For this reason, we proposed additional Green Infrastructure BMP's within this watershed for the future. Practices like rain gardens, buffers, bioretention areas, permeable pavements, and other GI approaches are needed now and, in the future, when the last farm in the watershed is developed.

Urban BMP Scenario:

The following scenario assumes 5 proposed Urban BMP's in the future. Riparian buffers on 10 acres in the developed areas, Green Infrastructure approaches on 60 acres of Low-Density development, and 30 acres of Medium-Density development. This scenario also assumes stream restoration work will be conducted on about 2,000 ft. of ag land that will be developed in the future. Finally, 3,000 ft of street sweeping is also proposed for this highly developed area as well.

Agricultural BMP Scenario:

Since the ag operations in this watershed have conservation plans, nutrient management plans, and most conservation practices in place, 100% of cropland acres were considered in conservation protection measures. If by chance the farms would stay agricultural in the future we proposed about 4.6 acres of a riparian buffer from what is already there which is minimal. We also proposed if the farms would stay in place add 500 ft. of



streambank stabilization measures. All of this could go away again if the farms are developed which is what is expected in the future.

Table 22-4: Wiki Watershed Load Reductions for Sub-Watershed 22

	<b>ENTIRE WATERHSED</b>			<b>URBAN AREA</b>		
	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)	<i>Sediment</i> (lbs/yr)	<i>TN</i> (lbs/yr)	<i>TP</i> (lbs/yr)
Initial MMW Load	210,153	13,291	905	210,159	3,427	830
Loads Removed w/ Existing Urban BMP's	-	-	-	-	-	-
Loads Removed w/ Proposed Urban BMP's	237,923	422	353	237,923	422	353
Loads Removed w/ Existing Agricultural BMP's	84,524	4,265	1,238	84,524	4,265	1,238
Loads Removed w/ Proposed Agricultural BMP's	25,554	124	21	25,554	124	21
<b>TOTAL Loads Removed</b>	348,002	4,811	1,612	348,002	4,811	1,612
<b>New Reduced Load</b>	(137,849)	8,479	(707)	(137,843)	(1,384)	(782)
<b>Percent Reduction</b>	<b>166%</b>	<b>36%</b>	<b>178%</b>	<b>166%</b>	<b>140%</b>	<b>194%</b>
<b>TOTAL Baseline Load</b>	125,629	9,025	(333)	125,635	(838)	(408)
<b>TOTAL Loads Removed from Baseline</b>	263,478	546	374	263,478	546	374
<b>Percent Reduction from Baseline Load</b>	<b>210%</b>	<b>6%</b>	<b>-112%</b>	<b>210%</b>	<b>-65%</b>	<b>-92%</b>

^The above model run calculates both BMP's installed since the 2006 WIP (existing) and proposed BMP's in the future

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table 22-4 but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement. Instead of looking at the loads reduced in this model, one should look at the % reduction in these cases to get a better feel for BMP's implementation efficiency. Finally, it should also be noted that further post-BMP implementation monitoring should take place if any of the future BMP's listed here were installed to get a more accurate account of water quality improvements in this sub-watershed. This could include sampling to determine delisting sections of the stream where BMP's are implemented.

Project(s) listed from the original 2006 WIP in this Sub-Watershed

- **Site # 179 (Medium Priority)** – lat. 39.9844; long. -76.2942 (Pequea Twp.)
- **Site # 184 (High-Medium Priority)** – lat. 39.9917; long. -76.2884 (W. Lampeter Twp.)
- **Site # 183 (Medium Priority)** – lat. 39.9934; long. -76.2893 (W. Lampeter Twp.)

Table 22-5: Existing, Proposed, and New BMP's Estimated Cost

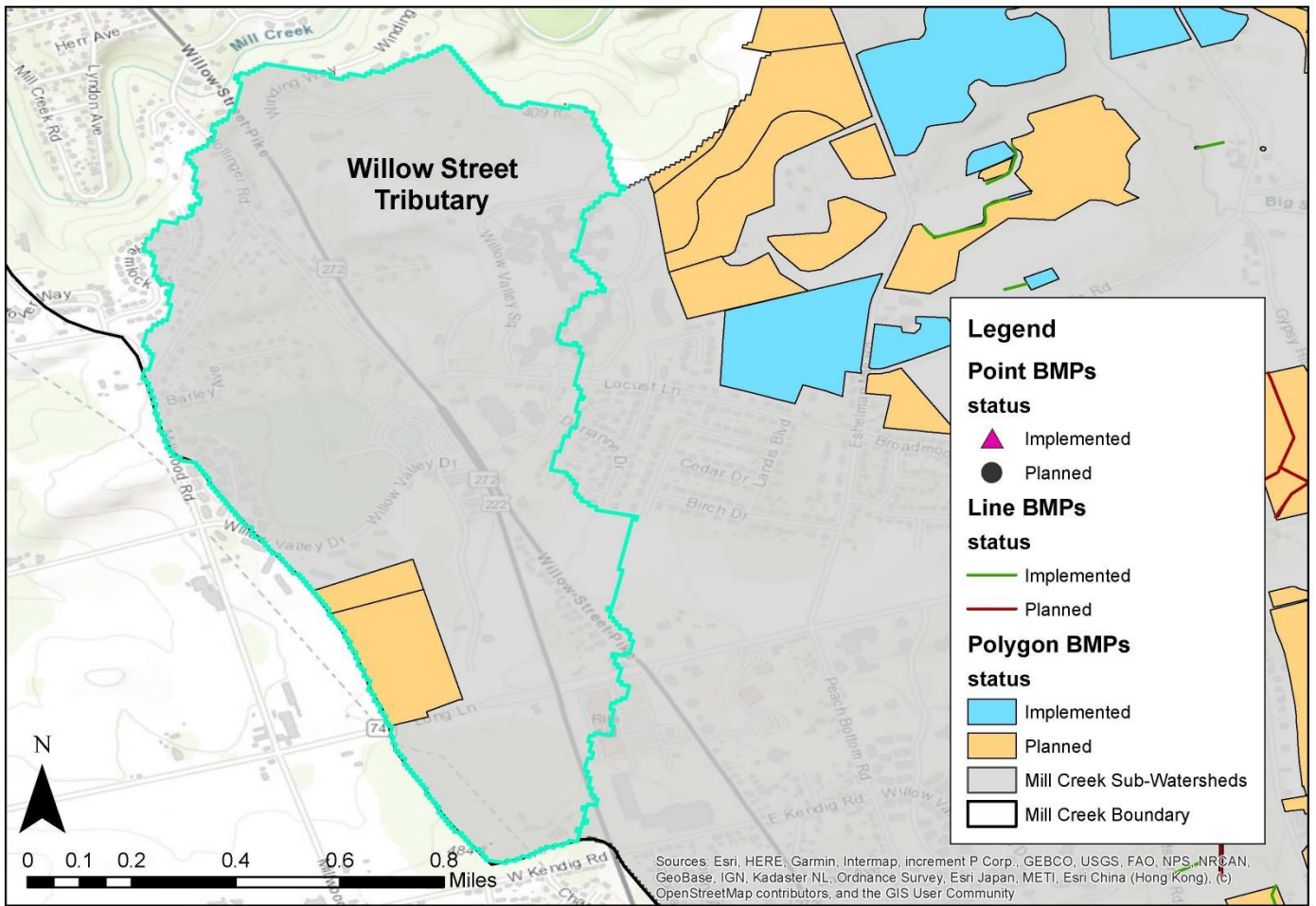
<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
None			N/A
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$N/A</b>

<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	1.3 ac	\$2,500	\$3,250
Pond issues	1	Varies	Varies
Constructed wetlands	5 ac	\$12,000	\$60,000
Impervious surface reduction	5 ac	Varies	Varies
Rooftop runoff management	5 ac	Varies	Varies
Stream bank Stabilization	900'	\$130	\$117,000
Nutrient management plan	51.4 ac	\$8	\$411
Conservation crop rotation	51.4 ac	\$11	\$565
Contour farming	51.4 ac	\$8	\$411
Cover crop	51.4 ac	\$20	\$1,028
Grassed waterway	0.8 ac	\$4,500	\$3,600
Residue management, no-till	51.4 ac	\$19	\$977
Terrace	4,100'	\$4	\$16,400
Barnyard runoff controls	1	\$22,000	\$22,000
<b>Additional Future Proposed BMP's (NEW)</b>			
Riparian buffer	13.3 ac	\$2,500	\$33,250
Green Infrastructure	90 ac	Varies	Varies
Street Sweeping	3,000'	Varies	Varies
Stream bank Stabilization	1,600'	\$130	\$208,000
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$466,892</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

There may be additional water quality BMP work needed in this sub-watershed but with no roads and limited aerial coverage, it was difficult to access and see every section of this tributary.

# Willow Street Tributary BMPs



Map22-2: Completed & planned BMP's in the Sub-Watershed 22 according PracticeKeeper (2022)

## Main Stem Section (from Headwaters to Mouth)

Projects listed in the original 2006 WIP that were on the mainstem of the Mill Cr. are listed below. A good majority of these projects have been accomplished thus far but we still wanted to list these projects because they were in the original 2006 WIP document. These are cumulative totals of these BMP's both completed and yet to be completed. For project-specific BMP's visit the original 2006 Mill Cr. WIP.

Project(s) listed from the original 2006 WIP on the mainstem of Mill Creek

- **Site # 37 (Medium Priority)** – lat. 40.0976; long. -76.0563 (E. Earl Twp.)
- **\*\*Site # 36 (Medium Priority)** – lat. 40.0970; long. -76.0576 (E. Earl Twp.)
- **\*\*Site # 21 (High-Medium Priority)** – lat. 40.0891; long. -76.0697 (Earl Twp.)
- **\*Site # 20 (Medium Priority)** – lat. 40.0865; long. -76.0739 (Earl Twp.)
- **Site # 19 (Medium-Low Priority)** – lat. 40.0856; long. -76.0748 (Earl Twp.)
- **\*\*Site # 11 (Medium-Low Priority)** – lat. 40.0817; long. -76.0865 (Earl Twp.)
- **\*\*Site # 10 (High-Medium Priority)** – lat. 40.0785; long. -76.0933 (Earl Twp.)
- **\*\*Site # 9 (Medium Priority)** – lat. 40.0776; long. -76.0941 (Earl Twp.)
- **\*\*Site # 8 (Medium Priority)** – lat. 40.0767; long. -76.0972 (Earl Twp.)
- **Site # 7 (Medium-Low Priority)** – lat. 40.0725; long. -76.1037 (Earl Twp.)
- **Site # 93 (Medium Priority)** – lat. 40.0607; long. -76.1049 (Leacock Twp.)
- **\*\*Site # 104 (Medium Priority)** – lat. 40.0707; long. -76.106349 (Leacock Twp.)
- **\*\*Site # 125 (High-Medium Priority)** – lat. 40.0709; long. -76.1120 (Leacock Twp.)
- **\*\*Site # 153 (High-Medium Priority)** – lat. 40.0680; long. -76.1210 (Upper Leacock Twp.)
- **\*\*Site # 84 (High-Medium Priority)** – lat. 40.0659; long. -76.1263 (Leacock Twp.)
- **Site # 127 (Medium Priority)** – lat. 40.0674; long. -76.1327 (Upper Leacock Twp.)
- **\*Site # 102 (High Priority)** – lat. 40.0646; long. -76.1353 (Leacock Twp.)
- **Site # 124 (Medium-Low Priority)** – lat. 40.0639; long. -76.1395 (Leacock Twp.)
- **Site # 133 (Medium Priority)** – lat. 40.0661; long. -76.1342 (Upper Leacock Twp.)
- **\*\*Site # 161 (Medium-Low Priority)** – lat. 40.0661; long. -76.1402 (Upper Leacock Twp.)
- **Site # 160 (Medium Priority)** – lat. 40.0637; long. -76.1465 (Upper Leacock Twp.)
- **Site # 159 (Medium Priority)** – lat. 40.0656; long. -76.1478 (Upper Leacock Twp.)
- **Site # 132 (Medium Priority)** – lat. 40.0656; long. -76.1536 (Upper Leacock Twp.)
- **\*Site # 139 (Medium Priority)** – lat. 40.0625; long. -76.1568 (Upper Leacock Twp.)
- **\*\*Site # 121 (Medium Priority)** – lat. 40.0567; long. -76.1649 (Upper Leacock Twp.)
- **\*\*Site # 83 (Medium Priority)** – lat. 40.0550; long. -76.1694 (Leacock Twp.)
- **\*\*Site # 138 (High Priority)** – lat. 40.0552; long. -76.1723 (Upper Leacock Twp.)
- **\*\*Site # 141 (Medium Priority)** – lat. 40.0538; long. -76.1729 (Upper Leacock Twp.)
- **\*Site # 130 (Medium-Low Priority)** – lat. 40.0558; long. -76.1808 (Upper Leacock Twp.)
- **\*\*Site # 143 (Medium Priority)** – lat. 40.0576; long. -76.1821 (Upper Leacock Twp.)
- **\*\*Site # 126 (High Priority)** – lat. 40.0528; long. -76.1933 (Upper Leacock Twp.)
- **Site # 136 (High Priority)** – lat. 40.0531; long. -76.1910 (Upper Leacock Twp.)
- **Site # 45 (Medium Priority)** – lat. 40.0463; long. -76.1936 (E. Lampeter Twp.)
- **Site # 46 (High-Medium Priority)** – lat. 40.0470; long. -76.1978 (E. Lampeter Twp.)
- **Site # 63 (Medium Priority)** – lat. 40.0441; long. -76.1950 (E. Lampeter Twp.)
- **\*Site # 79 (High-Medium Priority)** – lat. 40.0420; long. -76.1960 (E. Lampeter Twp.)
- **\*Site # 68 (High Priority)** – lat. 40.0356; long. -76.2013 (E. Lampeter Twp.)

- **Site # 69 (Medium Priority)** – lat. 40.0344; long. -76.1981 (E. Lampeter Twp.)
- **Site # 59 (High Priority)** – lat. 40.0304; long. -76.2070 (E. Lampeter Twp.)
- **\*Site # 58 (High-Medium Priority)** – lat. 40.0304; long. -76.2117 (E. Lampeter Twp.)
- **Site # 56 (Medium Priority)** – lat. 40.0310; long. -76.2155 (E. Lampeter Twp.)
- **Site # 57 (High Priority)** – lat. 40.0308; long. -76.2184 (E. Lampeter Twp.)
- **Site # 44 (Medium Priority)** – lat. 40.0323; long. -76.2222 (E. Lampeter Twp.)
- **\*\*Site # 55 (High Priority)** – lat. 40.0256; long. -76.2264 (E. Lampeter Twp.)
- **Site # 51 (Medium-Low Priority)** – lat. 40.0235; long. -76.2335 (E. Lampeter Twp.)
- **\*\*Site # 50 (High Priority)** – lat. 40.0235; long. -76.2335 (E. Lampeter Twp.)
- **\*\*Site # 49 (Medium Priority)** – lat. 40.0264; long. -76.2418 (E. Lampeter Twp.)
- **Site # 186 (Medium Priority)** – lat. 40.0207; long. -76.2498 (E. Lampeter Twp.)
- **\*Site # 174 (Medium-Low Priority)** – lat. 40.0136; long. -76.2680 (W. Lampeter Twp.)
- **\*Site # 173 (Low Priority)** – lat. 40.0185; long. -76.2722 (W. Lampeter Twp.)
- **Site # 185 (Medium Priority)** – lat. 40.0098; long. -76.2770 (W. Lampeter Twp.)
- **\*Site # 176 (Low Priority)** – lat. 40.0098; long. -76.2770 (W. Lampeter Twp.)
- **Site # 182 (Medium-Low Priority)** – lat. 40.0026; long. -76.2941 (W. Lampeter Twp.)
- **Site # 181 (Low Priority)** – lat. 40.0034; long. -76.2990 (W. Lampeter Twp.)

\*denotes project with partially completed BMP's since the 2006 WIP

\*\*grayed denotes completely finished projects and BMP's since the 2006 WIP

Table 23: Existing, Proposed, and New BMP's Estimated Cost

<b>BMP's Installed Since the 2006 WIP (Existing)</b>	<b>Units Installed</b>	<b>Estimated Cost/Unit</b>	<b>Cost</b>
Riparian buffer	30.0 ac	\$2,500	\$75,000
Nutrient management plan	311 ac	\$8	\$2,488
Stream bank Stabilization	20,762'	\$130	\$2,699,060
Terraces (2 x 1,000')	2,000'	\$4	\$8,000
Barnyard runoff controls	7	\$22,000	\$154,000
Filter strip	1 ac	\$200	\$200
Waste storage system	2	\$80,000	\$160,000
Prescribed grazing	10 ac	\$50	\$500
Streambank Fencing	8,200'	\$8	\$65,600
<b>TOTAL COST OF INSTALLED BMP'S</b>			<b>\$3,164,848</b>
<b>Combined BMP's to be Installed From the 2006 WIP (Proposed)</b>			
Riparian buffer	23.0 ac	\$2,500	\$57,500
Dam Removal	8	Varies	Varies
Stream bank Stabilization	8,150'	\$130	\$1,059,500
Stripcropping, contour	109 ac	\$2	\$218
Grassed waterway	5.1 ac	\$4,500	\$22,950
Residue management, seasonal	34 ac	\$20	\$680
Barnyard runoff controls	5	\$22,000	\$110,000
Waste storage system	4	\$80,000	\$320,000
Nutrient management plan	65 ac	\$8	\$520
Prescribed grazing	53.5 ac	\$50	\$2,675
Contour farming	113 ac	\$8	\$904



Conservation crop rotation	159 ac	\$11	\$1,749
Streambank Fencing	14,100'	\$8	\$112,800
Cover crop	108.5 ac	\$20	\$2,170
Pasture/hayland planting	17 ac	\$300	\$5,100
<b>Additional Future Proposed BMP's (NEW)</b>			
NONE			
<b>TOTAL COST OF PROPOSED &amp; NEW BMP's</b>			<b>\$1,696,766</b>

\*grayed BMP's are ones completed since the 2006 Mill Cr. WIP

**Table E: Summary table of the above information from watershed name and number, to ranking, cost of installed and proposed BMP's to % reduction for key parameters. All of this plus a grand total of all cost using 2022 BMP costs.**

Sub-Watershed #	Sub-Watershed Name	Priority Ranking	Total Cost of BMP's Installed Since 2006 WIP	Total Cost of Existing & New BMP's Yet to be Installed	% Reduction/ % Reduction from Baseline Load of Sediment	% Reduction/ % Reduction from Baseline Load of Nitrogen	% Reduction/ % Reduction from Baseline Load of Phosphorus
1	Bare	3	\$8,678	\$102,365	119/153	37/8	123/294
1A	Waterfront Estates	3	\$0	\$64,000	1,159/1,159	19/6	146/220
2	Sloyer	2	\$0	\$186,844	126/126	31/19	74/32
3	Wal-Mart	3	\$0	\$285,025	263/-8	32/1	102/-59
3A	East Town Mall	4	\$0	\$64,000	1,282/1,282	25/6	109/126
4	Hobson	1	\$240	\$444,032	146/16	29/20	86/79
4A	Smoketown	4	\$0	\$18,250	97/94	39/8	85/40
4B	Mill Creek Road	2	\$0	\$68,000	53/3	38/1	91/8
4C	Beechdale	2	\$0	\$7,486	53/45	23/15	54/42
4D	Stumptown	2	\$0	\$4,350	51/42	22/16	59/50
#5	Reeser's Run	1	\$111,242	\$942,707	58/49	33/15	77/57
6	Lantz	2	\$249,366	\$618,684	58/18	30/7	72/27
7	CHNA	3	\$0	\$406,850	71/31	26/4	83/22
8	Shultz	3	\$4,070	\$755,930	73/57	15/4	30/12
9	Petra	3	\$0	\$299,000	141/179	38/9	118/177
10	Ranck	1	\$22,000	\$672,700	59/34	33/4	87/46
11	Welsh Mtn.	Not Impaired	\$0	\$342,814	126/211	41/11	85/43

12	New Holland Road	Not Impaired	\$13,651	\$1,074,855	90/74	26/8	69/35
13	Groff Run	1	\$2,276	\$2,639,135	73/67	21/8	64/41
14	Tabor	2	\$0	\$97,270	63/49	34/17	86/73
15	Mascot	2	\$22,000	\$427,455	100/100	38/21	98/96
*16	Muddy Run	1	\$174,337	\$2,274,690	56/44	31/14	79/59
17	Bird-in-Hand	3	\$0	\$490,538	69/59	24/13	61/45
18	Lynnwood	2	\$123,290	\$439,710	61/41	33/14	89/72
19	Rockvale	3	\$0	\$597,908	76/50	32/2	98/89
19A	Tanger	4	\$0	\$63,500	125/125	5/5	23/23
20	Millstream	1	\$4,500	\$609,620	70/54	24/14	65/46
21	Big Spring Run	2	\$1,432,680	\$5,615,253	63/47	28/9	79/53
22	Willow Street	3	\$0	\$466,892	166/210	36/6	178/-112
<b>TOTAL for Sub-Watersheds</b>			<b>\$2,168,330</b>	<b>\$20,079,863</b>			
Mainstem Mill Cr.			\$3,164,848	\$1,696,766			
<b>GRAND TOTAL for Entire Mill Cr.</b>			<b>\$5,333,178</b>	<b>\$21,776,629</b>			

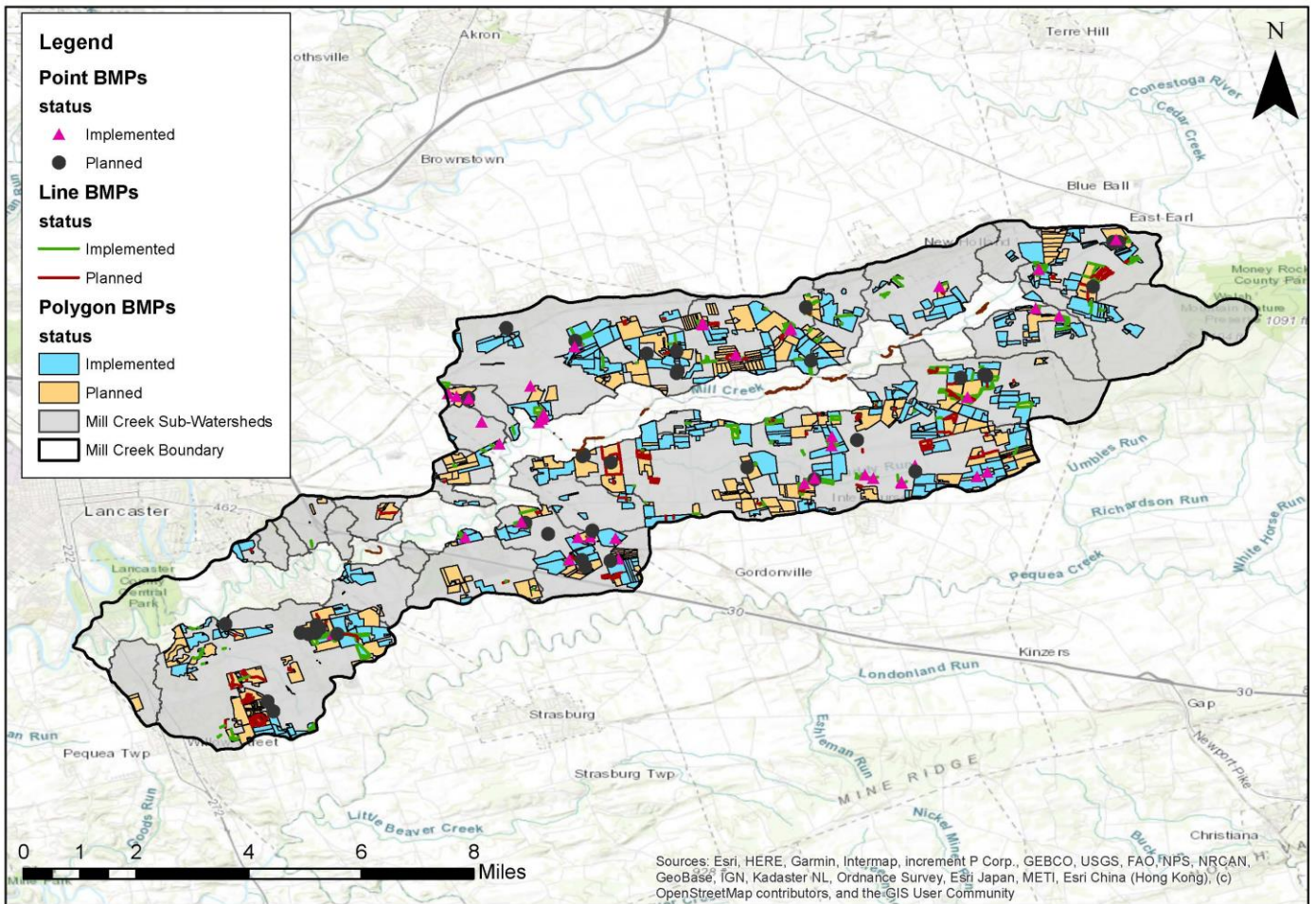
\* Has a TMDL

# Has a TMDL within a portion of the Watershed

**\*\*Modeling Caveat\*\***

Please note that the Wiki Watershed model was used for the Load Reductions found in Table E but that this model is a sediment delivery model and does have drawbacks when using it for nutrient reduction calculations in smaller sub-watersheds (less than 0.5 sq. mi.). Unfortunately, this is the best model we have at this time so that is why Wiki Watershed was used for this WIP supplement.

# Mill Creek Sub-Watershed BMPs



Map 3: All the implemented or yet to be implemented projects throughout the Mill cr. Watershed since the 2006 WIP (this map is comparable to the Figure 7 in the original 2006 WIP)