



# Lititz Run TMDL Plan / Lititz Borough and Warwick Township Pollutant Reduction Plan

Lititz, PA

Date: August 29, 2017



*Prepared for:*  
Lititz Borough  
7 South Broad Street  
Lititz, PA 17543

Warwick Township  
315 Clay Road  
Lititz, PA 17543

Manheim Township  
1840 Municipal Drive  
Lancaster, PA 17601

*Prepared by:*  
LandStudies, Inc.  
315 North Street  
Lititz, PA 17543



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## Approach

Lititz Borough and Warwick Township have applied for a Joint Municipal Separate Storm Sewer System (MS4) Permit and are required to submit an Impaired Waters Plan (IWP) for the Little Conestoga Creek, Conestoga Creek, Hammer Creek and Cocalico Creek watersheds. They also must submit a Total Maximum Daily Load (TMDL) Plan to address the existing sediment TMDL for the Lititz Run Watershed as well as a Chesapeake Bay Pollution Reduction Plan (CBPRP) for the Lititz Run watershed. Manheim Township has partnered with Lititz Borough and Warwick Township on the development and submittal of the TMDL/CBPRP portion of this report. These plans are a requirement of Lititz Borough's existing Permit PAG#133539, Warwick Township's existing permit PAG#133565 and Manheim Township's existing permit PAG#133534 for their MS4.

Warwick Township and Lititz Borough previously submitted a TMDL Update Plan dated February 1, 2013 in which it was demonstrated that the 2004 sediment TMDL for the Lititz Run watershed was met based on a comparison of the watershed based 2012 unit area loading rate to the prescribed unit area loading rate in the 2004 TMDL. The 2013 TMDL update built upon the 2004 watershed model and considered land use changes and BMPs implemented after 2004. Although the TMDL has been met there is still an Appendix D Chesapeake Bay load reduction requirement for Lititz Run.

The 2017 Lititz Run Watershed TMDL Plan assumes the TMDL has been met as demonstrated in the previously submitted plan. This 2017 Plan provides an update of the site conditions and modeling input in the Lititz Run watershed, and uses the latest version of the MapShed model. Note that due to significant changes in the MapShed model and improved accuracy of agricultural input data (to be discussed later), the reported pollutant loadings cannot be directly compared to the 2004 or 2013 results. The load resulting from Lititz Borough, Warwick Township and Manheim Township Urban Area will be calculated using the urban area tool in MapShed and no parsing will be used to reduce the existing load.

Although the TMDL has been met, Warwick Township and Lititz Borough continue to implement BMPs that will improve local water quality, provide community benefits and improve the greater Chesapeake Bay watershed. The BMPs proposed over the next 5 year permit cycle will be described in this report and will meet the Chesapeake Bay Appendix D pollution reduction requirement as well as the IWP Requirement. The IWP, CBPRP and TMDL Plan have been combined into one Pollution Reduction Plan (PRP) document.

Planning areas were identified for the Little Conestoga, Conestoga, Hammer and Cocalico Creek watersheds and parsing was used to exclude areas as described later in this report. The load from the identified planning areas was calculated using the simplified method and then normalized to be consistent with the magnitude of loads calculated using the MapShed model. All the loads in Lititz Borough and Warwick Township were then aggregated, as

discussed with DEP, and BMPs were identified to exceed the 10% reduction requirement of the aggregated load.

In summary, this Joint PRP includes public participation documentation, mapping of outfalls and other discharges, pollutant load calculations, best management practices (BMPs) selection, identification of potential funding sources and partners, and operations and maintenance (O&M) activities for Lititz and Warwick Townships and the portion of Manheim Township in the Lititz Run Watershed.

## A. Public Participation

Public participation is an essential part of the PRP because it enhances buy-in from landowners that may have an impact on pollutant discharges, can uncover missing elements or errors in calculations, and builds cooperative partnerships among the municipality and other entities.

A copy of the draft Plan was released via public notice. Warwick Township and Lititz Borough issued a joint notice on July 20, 2017 to the Lititz Record Express. The notice ran for 1 day. Manheim Township published public notice on July 16, and July 19, 2017 in LNP. A copy of each public notice is included in Attachment A. The public was given 30 days to provide commentary on the contents of the PRP which was available for review at each municipal office and website. The public was able to provide verbal comments at the regularly scheduled July 25, 2017 Lititz Borough Council meeting, August 14<sup>th</sup> 2017 Manheim Township Commissioners Meeting, and August 16, 2017 Warwick Township Board of Supervisors meeting. Warwick Township provided one staff comment regarding the use of their buffer ordinance to help meet PRP reductions. This comment and response is provided as Appendix A2. There were no additional verbal or written comments.

## B. Map

Lititz Borough, Warwick Township and Manheim Township are located entirely within the Chesapeake Bay Basin. The Lititz Run watershed comprises approximately 99% of Lititz Borough (1,465 acres), 49% of Warwick Township (6,289 acres) and 4% of Manheim Township (567 acres). The remainder of the Lititz Run watershed is located in Penn and Elizabeth Townships. Lititz Run is a tributary of the Conestoga River. Within the Lititz Run Watershed, 100% of Lititz Borough, 75% of Warwick Township, and 77 % of Manheim Township is located within the 2010 UA.

Warwick Township has 1,413 acres of the Hammer Creek and 1,122 acres of the Cocalico Creek Watershed within its UA. The Hammer Creek is a Tributary of the Cocalico Creek which is a tributary of the Conestoga River. The Little Conestoga Creek is also a tributary of the Conestoga River. Warwick Township has 1,496 acres and Lititz Borough has approximately

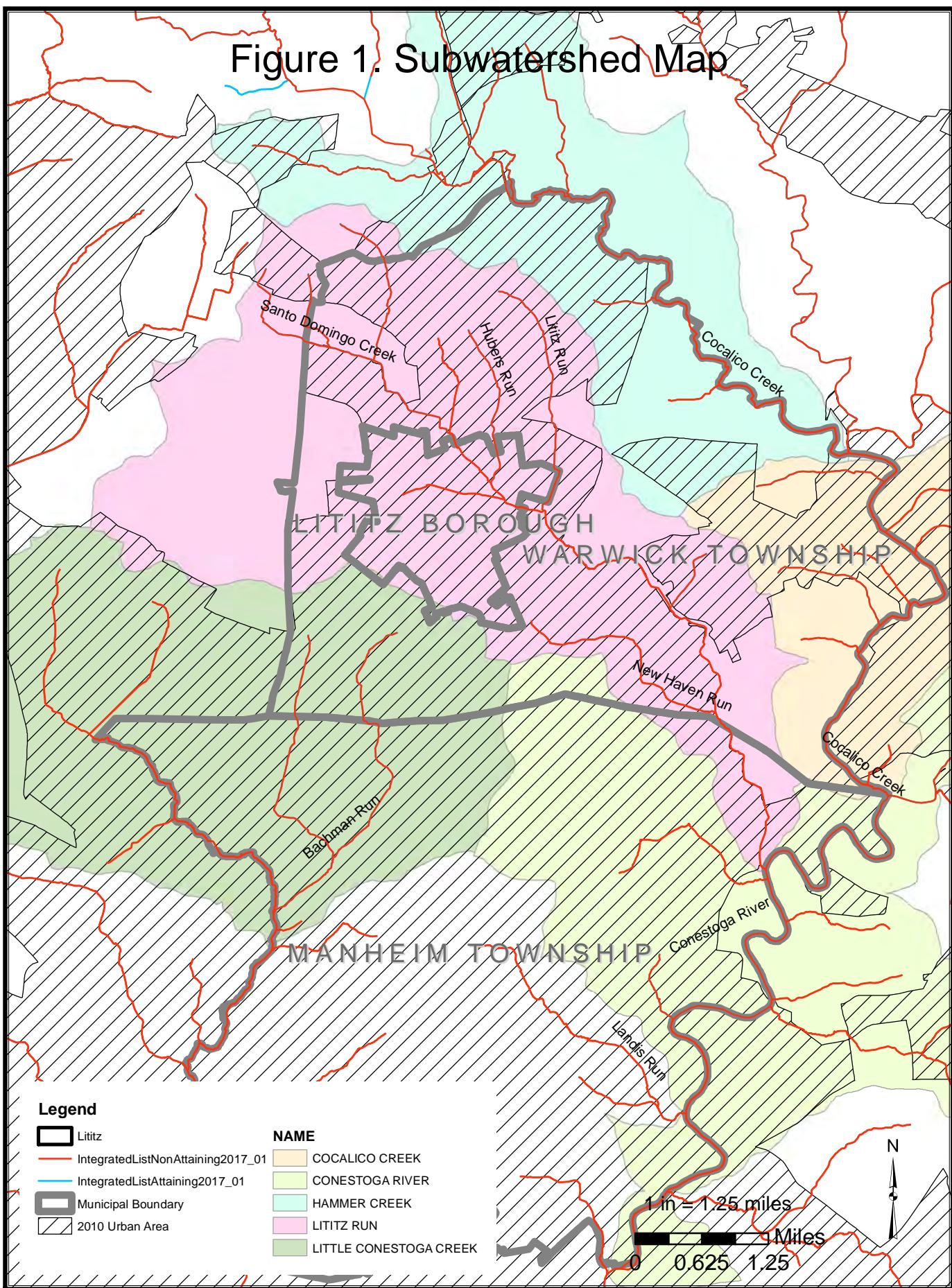
18 acres of UA in the Little Conestoga Creek watershed. Warwick Township also has 248 acres of UA within the Conestoga River watershed.

Figure 1 identifies the subwatershed basins as well as impaired and attaining streams from the DEP 2014 Integrated List and the location of the 2010 Census urban area.

Additional maps are provided in Appendix B. Map B1 Identifies important PRP components including planning areas, outfalls, excluded area, existing BMPs and proposed BMP locations. Warwick Township went through a desktop and field verification exercise to parse eligible land and establish MS4 planning areas outside the Lititz Run Watershed. As part of PRP development Warwick's outfall mapping was added to a base map with the 2010 UA, National Hydrology Dataset (NHD) streams, topography, and watershed boundaries in order to aid in the field drainage boundary assessment to establish MS4 planning areas for the PRP. Mapping also included areas that could be parsed outright such as state owned road right of ways and parcels with individual industrial stormwater management permits. The field review then continued to field verify outfalls on NHD streams with matching observed general drainage flow to the map (or determining that the regulated system (inlets, curb and gutter, etc.) tied to the end point adequately collects stormwater run-off from the drainage areas reviewed). This process involves a visual tracing against the system map. Areas that were field verified that do not drain to regulated outfalls were parsed out (excluded). Areas were field verified as not part of the regulated system where runoff disperses through sheet flow or incidental dispersion or drain directly to the stream without entering the MS4 system. Watershed based planning areas were then drawn to capture the remaining area.

Map B2 identifies the MapShed land cover types throughout the Warwick Township, Lititz Borough and Lititz Run within Manheim Township.

# Figure 1. Subwatershed Map



## C. Pollutants of Concern

Because Warwick Township and Lititz Borough discharge stormwater to a local impaired water they must reduce pollutant loads associated with those impairments. As shown in Figure 1, all streams within the municipalities are impaired. Any proposed BMPs that target the impaired water discharges will have a beneficial impact on the Chesapeake Bay. Both Warwick Township and Lititz Borough are subject to an IWP, TMDL Plan, and CBPRP and will combine their plans into one Pollution Reduction Plan document. Manheim Township is participating in the TMDL/CBPRP portion of this plan because of the small amount of Lititz Run Watershed within its municipal boundaries.

Table 1 shows each of the affected subwatersheds and the pollutant(s) that are of concern to that area as shown on the DEP MS4 requirements table revised 4/7/2017. In planning areas where sediment is listed as a concern, the municipalities must reduce sediment loading by 10 percent; where nutrients are listed as a concern the Township must reduce phosphorus by 5 percent and nitrogen by 3 percent. The PRP is using the presumptive approach in which it is assumed that a 10 percent sediment reduction will also accomplish the required nutrient reduction.

In accordance with DEP's PRP Instructions document (3800-PM-BCW0100K), this report is required specifically for stormwater discharges of nutrients and sediment to surface waters for the Chesapeake Bay (Appendix D) and impaired waters (Appendix E). Separate from the PRP, Pollutant Control Measures (PCMs) described in DEP's General Permit (3800-PMBCW0100d) are to be implemented for Appendix A, B, and/or C pollutants of concern identified in the MS4 Requirements Table.

Table 1. Impaired Downstream Waters and Requirements

MS4 Planning Area	Applicable Municipality	Pollutant(s) of Concern
Bachman Run	Warwick Twp.	Appendix B – Pathogens (5)
New Haven Run	Warwick Twp.	Appendix B – Pathogens (5), Appendix E – Nutrients (5)
Little Conestoga Creek	Warwick Twp.	Appendix B – Pathogens (5), Appendix E – Nutrients, Siltation (5)
Lititz Run TMDL	Warwick Twp., Lititz Borough, Manheim Twp.	TMDL Plan – Siltation, Suspended Solids, Turbidity (4a)
Lititz Run	Warwick Twp., Lititz Borough, Manheim Twp.	Appendix B – Pathogens (5),
Hammer Creek	Warwick Twp.	Appendix E – Nutrients, Siltation (5)
Conestoga River	Warwick Twp., Lititz Borough	Appendix B – Pathogens (5), Appendix E – Organic Enrichment/Low D.O., Siltation (5)
Cocalico Creek	Warwick Twp.	Appendix E – Nutrients, Siltation (5)
Chesapeake Bay Nutrients/Sediment	Warwick Twp., Lititz Borough, Manheim Township	Appendix D-Nutrients, Siltation (4a)

#### D. Existing Load for Pollutants of Concern

Existing loads were calculated using MapShed for the Lititz Run Watershed and Simplified Method in the Little Conestoga, Conestoga, Hammer and Cocalico Creek Watersheds. Since all loads will be aggregated across all watersheds, the Planning Areas calculated using the simplified method will be converted to MapShed values by dividing by the sediment delivery ratio of 0.181. Detailed descriptions of how the existing loads were calculated are provided below.

##### D.1 Lititz Run Watershed TMDL

The Lititz Run watershed was modeled in MapShed in order to generate the existing UA loading for Warwick, Lititz and Manheim Township. See Figure 2 for a map of the 17.4 square mile modeled basin. In addition to the input data gathered by MapShed from various GIS data layers, MapShed allows custom data to be entered into the model. The following custom data was input into MapShed for the base model run. All data entered into the model is summarized in Appendix C.

- Groundwater nitrate – 2016 average groundwater nitrate levels from three wells (2 in Warwick, 1 in Lititz Borough)
- Lititz Sewer Authority - The Sewer Authority is the only point source besides the MS4 that contributes nutrients and suspended-solid loading in the watershed. The discharge concentrations entered in the model were based on NPDES permitting

requirements and not what the plant is actually discharging. This should represent a conservative modeling approach, as the WWTP consistently performs below its effluent limits.

- On-lot septic systems as entered in the 2013 TMDL update
- The percent bank fraction was adjusted to reflect soil nutrient concentrations documented in the “Recommendation of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (2014).”
- Land cover changes from 2011 (the year of the MapShed land cover GIS layer) to the present
- Agricultural data – Lancaster Farmland Trust (LFT) performed a 2017 inventory of all agricultural operations in Warwick Township and documented inventory results in an ESRI geodatabase which allowed for a detailed evaluation of only the farms in the Lititz Run Watershed. Data that they collected that was used to populated the MapShed model includes: types of crops and acreage, an inventory of animals on the operation, whether conservation and nutrient management plans were required and up to date, acres of pasture, animals on pasture, and condition of pasture, presence of BMPs such as no-till, minimum-till, contour farming, strip cropping, rotational grazing, manure storages, composting facilities, barnyard improvements, CREP stream buffers, streambank fencing. In 2007, Warwick Township began an initiative to ensure each farm within the Township has a current Conservation Plan outlining BMPs that the farms will implement to comply with Erosion and Sediment Control and Manure Management regulations. This effort was a partnership between private consultants, LCCD and the Township. Aerial photography was used to estimate additional animals and agricultural BMPs present in Elizabeth and Penn Townships.
- Existing stream restoration BMPs were entered into the base model run to remain consistent with 2012 model input. Stream BMPs included total length of agricultural stream buffers from LFT’s CREP inventory as well as municipal records, livestock fencing, and agricultural stream restoration projects. Urban stream buffers were also entered in addition to the percent of urban streams treated by buffers and length of stream stabilization projects. If buffers, fencing or stabilization were documented as only one side of the stream the length was reduced by half when entered into MapShed. The Lititz Run watershed has an active history of partnerships and cooperation to achieve improved water quality through restoration efforts and the implementation of Best Management Practices (BMPs). LRWA restoration efforts began in 1992 and continue today. The support of local government, Warwick Township and Lititz Borough, has been the driving force in the success of LRWA and the restoration efforts.

Figure 2. Modeled MapShed Basin

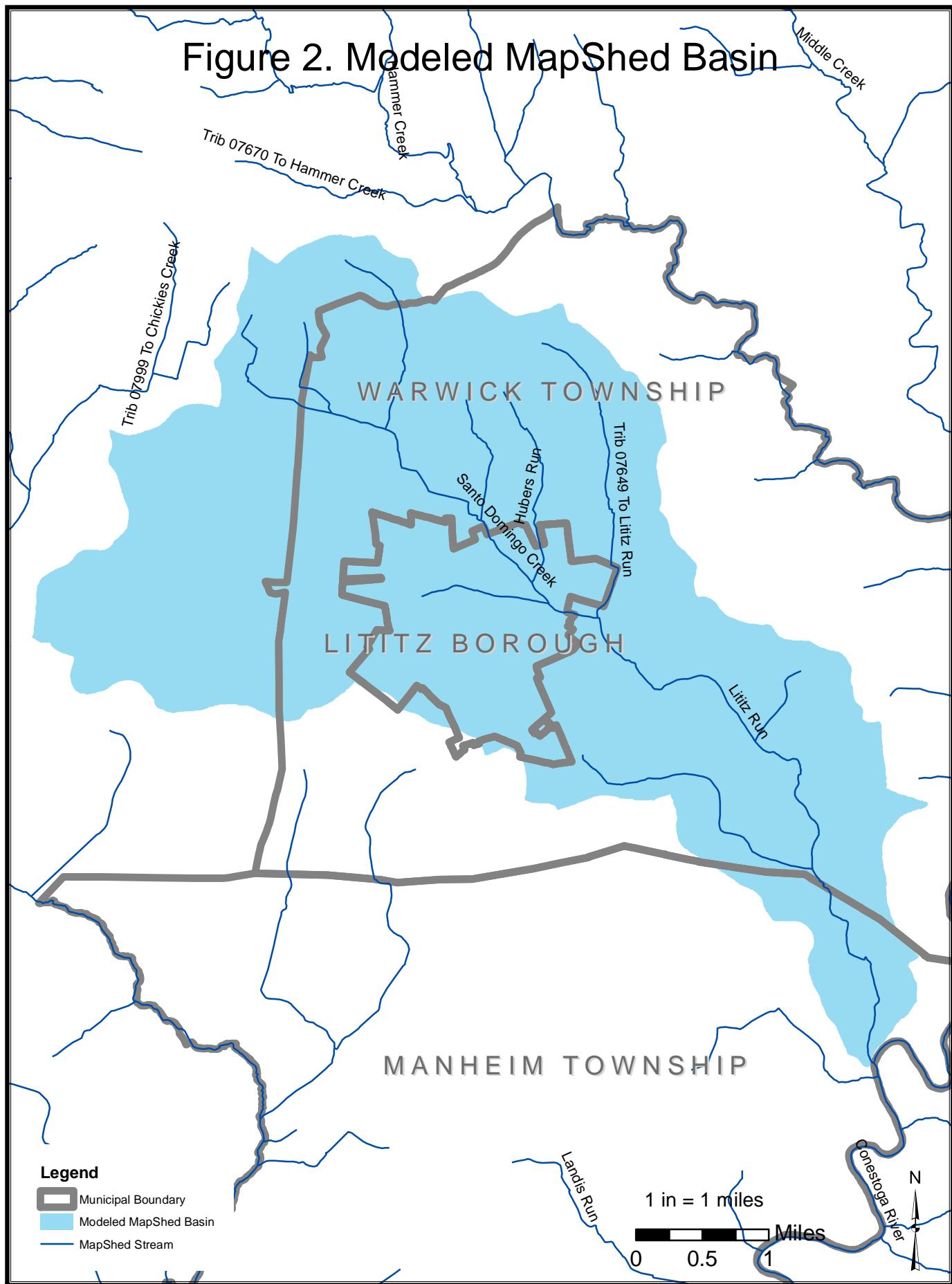


Table 3 shows the total sediment and nutrient loading rate for the entire Lititz Run watershed as well as the sediment and nutrient loading rates for each land cover type resulting from the Lititz Run Watershed Base Model Run. Table 4 shows the nutrient and sediment load for each municipality's UA.

In those areas where structural BMPs are currently in place and functioning, the existing loading estimate was adjusted to account for pollutant reductions from those BMPs. Article VI and Article VII of Warwick Township's and Lititz Borough's Stormwater Management Ordinance describes Operation and Maintenance (O&M) requirements. Both municipalities require the submittal of an O&M plan that includes but is not limited to BMP inspection annually for the first 5 years and once every three years thereafter. The Ordinance also specifies who is responsible for maintenance under various situations.

Lititz Borough and Warwick Township created an inventory of their existing and functioning BMPs from NPDES permit data and stormwater management plans filed with the Township and Borough. There were only small BMPs located in Manheim Township's portion of the watershed and detailed information was not available so these BMPs were excluded. BMPs were identified as runoff reduction (RR) or stormwater treatment (ST) practices. One RR and one ST model run (as applicable) for each municipality was completed by aggregating existing BMP data in the MapShed Urban BMP Editor to determine the sediment reductions resulting from the existing BMPs. The sediment load for each BMP model run was compared to the Lititz Run Baseline watershed model run and the difference was attributed to the existing BMPs included in the BMP editor. See Table 2. The BMP inventory and calculated information needed to populate the MapShed Urban BMP Editor is provided as Appendix C. Screenshots of the Urban BMP editor for each model run is included in Appendix D. In addition to stormwater BMPs, a two acre wetland was constructed along the headwater of Lititz Run in 1997 by Warwick Township. The Township facility is a sediment sink during high flows. Between 2014 and 2016 the township dredged 520 Tons of sediment which equates to 520,000 lbs. of sediment removed annually by the water quality facility. In order to calculate nitrogen and phosphorus reductions 520 Tons of sediment was multiplied by 2.28 lbs. of nitrogen per Ton and 1.05 lbs. of phosphorus per Ton, which are the default soil nutrient concentrations found in the "Recommendation of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (2014).

Based on these existing load calculations it was determined Warwick's existing sediment loading is 1,170,858 lbs., Lititz Borough existing load is 543,789 lbs. and Manheim Township's existing load is 153,012 lbs of sediment. The total load from the combined UA of all three municipalities is 1,867,659 lbs. of sediment and the required 10% sediment load reduction is 186,766 lbs. See Table 4.

Table 2. Summary of Existing BMP Model Run Results

Existing BMP model runs	Lititz Run Baseline Model Sediment Load (T)	BMP Run Sediment Load (T)	Sediment Reduction (T)	Sediment Reduction (lb)
Warwick Township Lititz Run RR	2118.2	2095.0	23.2	46,400
Warwick Township Lititz Run ST	2118.2	2112.2	6.0	12,000
Lititz Borough Lititz Run RR	2118.2	2115.6	2.6	5,200
Lititz Borough Lititz Run ST	2118.2	2054.5	63.7	127,400
<b>TOTAL</b>			<b>95.5</b>	<b>191,000</b>

The total watershed load for the 2017 Lititz Run Base MapShed Model run is 2,118.2 Tons/yr (Table 3). After subtracting 95.5 T of reduction from existing BMPs this equates to 2022.7 Tons/yr of sediment compared to 2523.8 Tons/yr of sediment in the 2012 Lititz Run Base MapShed Model Run. See Figure 3 for the MapShed screenshot of the 2012 model run result output. The sediment load between 2012 and 2016 has been reduced by 501.1 Tons. 352.3 Tons is a result of the land use load and 53.1 Tons is a result of a reduction in streambank loading. These reductions can be attributed to changes in the MapShed Land Cover dataset, additional BMP implementation and more accurate inventory of existing agricultural and urban BMPs in the watershed, as well as additional stream buffers and restoration in both urban and rural environments.

Figure 3. 2012 Lititz Run Watershed Model Run Results

GWLF Total Loads for file: 2012LR-0				Period of analysis: 21 years from 1978 to 1998				
Source	Area [Acres]	Runoff [in]	Tons		Total Loads [Pounds]			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2446	3.1	754.8	96.3	1183.2	1584.9	163.8	303.6
Cropland	3548	5.3	12796.2	926.4	8972.1	14373.3	268.8	1841.9
Forest	1208	2.7	34.1	4.9	138.4	158.2	7.3	14.6
Wetland	5	7.9	0.3	0.0	1.7	1.9	0.1	0.2
Disturbed	59	9.4	9.5	1.4	2.5	8.0	1.3	3.3
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	20	3.5	0.0	0.1	1.5	5.1	0.2	0.6
MD Mixed	554	9.6	0.0	11.9	141.4	466.1	20.6	53.7
HD Mixed	603	13.6	0.0	13.0	154.1	507.8	22.4	58.5
LD Residential	131	3.5	0.0	0.7	9.7	34.0	1.4	3.7
MD Residential	2543	5.9	0.0	54.8	649.7	2141.3	94.6	246.9
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					40904.8		9173.9	
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1414.1		2859.4		1406.5
<b>Groundwater</b>					326369.7	326369.7	1232.4	1232.4
<b>Point Sources</b>					70363.2	70363.2	9381.8	9381.8
<b>Septic Systems</b>					4223.8	4223.8	48.8	48.8
<b>Totals</b>	11117.3	5.30	13594.8	2523.8	412211.1	464001.8	11243.6	23770.6

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Although the 2004 TMDL uses a different model (AVGWLF vs MapShed), it is worth noting the 2004 TMDL Waste Load Allocation (WLA) per acre loading rates against the 2017 model run per acre urban area loading rates. In 2004 the total sediment load from the MS4 was 2,422,202.2 lbs. per year. The acreage within the MS4 was 5,582 acres for a loading rate of 434 lbs. of sediment per acre. See Figure 4. The 2017 Total UA Load from the Baseline Watershed Run is 2,003,003.3 lbs. of sediment (this includes the MapShed baseline loading from Elizabeth and Penn Township UAs – see Table 4). There is 7,021 acres of UA within the watershed which equates to 285.3 lbs. per acre. This is a conservative load since urban BMPs were not included for Elizabeth or Penn Townships.

Figure 4. WLA Table from 2004 Lititz Run TMDL

<i>Table 6. Sediment Waste Load Allocations for MS4 Designated Areas within Lititz Run</i>					
<b>Pollutant Source</b>	<b>Acres</b>	<b>Unit Area Loading Rate (lbs/ac/yr)</b>		<b>Pollutant Loading (lbs/yr)</b>	
		<b>Current</b>	<b>Allowable</b>	<b>Current</b>	<b>Allowable (WLA)</b>
Hay/Pasture	814.00	76.66	59.19	62,401.24	48,180.66
Cropland	2,758.00	1,267.93	533.18	3,496,950.94	1,470,510.44
Developed	2,010.00	89.12	449.51	179,131.20	903,511.10

From Table 6:

$$\text{WLA (sediment)} = 351,495 \text{ lbs/yr (sewer discharge)} + 2,422,202.20 \text{ lbs/yr (MS4)}$$
$$\text{WLA (sediment)} = 2,773,697.20 \text{ lbs/yr}$$

TABLE 3. Lititz Run MapShed Base Model Results

Land Use	Acres	Sed. ( Lb/ac)	Sed. (T/yr)	TN (lb/ac)	TN (lb/yr)	TP (lb/ac)	TP (lb/yr)
Hay/ Pasture	2,226	62.44	69.5	0.4	876.4	0.09	208.5
Row Crops	3,138	326.83	512.8	2.3	7,317.4	0.21	660.8
Forest	667	11.69	3.9	0.1	84.5	0.01	9.2
Wetland	12	16.67	0.1	0.4	4.3	0.03	0.4
Disturbed/ Transition	12	66.67	0.4	0.2	2.1	0.07	0.8
Turf/ Golf	-	-	-	-	-	0.00	-
Open Space	778	149.61	58.2	-	881.5	0.00	96.3
LD Mixed	395	12.15	2.4	0.3	126.2	0.04	14.0
MD Mixed	670	57.01	19.1	1.1	744.8	0.13	85.1
HD Mixed	605	57.19	17.3	1.1	673.3	0.13	77.0
LD Res	64	12.50	0.4	0.3	20.5	0.04	2.3
MD Res	2,558	57.15	73.1	1.1	2,844.5	0.13	325.1
HD Res	-	-	-	-	-	-	-
<b>Subtotal</b>	<b>11,125</b>		<b>757.2</b>		<b>13,575.5</b>		<b>1,479.5</b>
Farm Animals*				-	96,776.2		27,272.8
<b>Streambank</b>		<b>2,722,000.00</b>	<b>1,361.0</b>		<b>3,198.9</b>		<b>1,417.6</b>
Groundwater					248,388.7		460.6
Point Sources*				-	70,321.2		9,375.8
OLSS				0	4,124.2		47.4
<b>Total</b>	<b>11,125.0</b>	<b>4,236,400.0</b>	<b>2,118.2</b>		<b>436,384.7</b>		<b>40,053.7</b>

TABLE 4. Urban Area Loading by Municipality

	LititzRunBase_6-27-17 Loading Rates			Warwick Township UA (LititzRunBase_6-27-17)				Lititz Borough UA (LititzRunBase_6-27-17)				Manheim Township UA (LititzRunBase_6-27-17)			
	U/A Sediment Loading Rate (lb/ac)	U/A Nitrogen Loading (lb/ac)	U/A Phosphorus Loading (lb/ac)	Acres	Total Sediment Load (lb)	Total Nitrogen Load (lb)	Total Phosphorus Load (lb)	Acres	Total Sediment Load (lb)	Total Nitrogen Load (lb)	Total Phosphorus Load (lb)	Acres	Total Sediment Load (lb)	Total Nitrogen Load (lb)	Total Phosphorus Load (lb)
Hay/Pasture	62.4	0.39	0.09	771	48,110	300.7	69.4	54	3,370	21.1	4.9	133	8,299	51.9	12.0
Cropland	326.8	2.33	0.21	932	304,578	2,171.6	195.7	17	5,556	39.6	3.6	106	34,641	247.0	22.3
Forest	11.6	0.13	0.01	531	6,160	69.0	5.3	7	81	0.9	0.1	15	174	2.0	0.2
Wetland	16.5	0.36	0.03	7	116	2.5	0.2	0	0	0.0	0.0	0	0	0.0	0.0
Disturbed	66.1	0.17	0.07	12	793	2.0	0.8	0	0	0.0	0.0	0	0	0.0	0.0
Turfgrass	0.0	0.00	0.00	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
Open Land	149.6	1.13	0.12	334	49,966	377.4	40.1	104	15,558	117.5	12.5	69	10,322	78.0	8.3
LD Mixed	12.0	0.32	0.04	151	1,812	48.3	6.0	25	300	8.0	1.0	25	300	8.0	1.0
MD Mixed	57.1	1.11	0.13	247	14,104	274.2	32.1	198	11,306	219.8	25.7	15	857	16.7	2.0
HD Mixed	57.2	1.11	0.13	156	8,923	173.2	20.3	257	14,700	285.3	33.4	40	2,288	44.4	5.2
LD Residential	12.1	0.32	0.04	5	61	1.6	0.2	0	0	0.0	0.0	0	0	0.0	0.0
MD Residential	57.1	1.11	0.13	1572	89,761	1,744.9	204.4	803	45,851	891.3	104.4	32	1,827	35.5	4.2
HD Residential	0.0	0.00	0.13	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
Water	0.0	0.00	0.00	2	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
<b>Subtotal</b>	-			<b>4720</b>	<b>524,383</b>	<b>5,165.4</b>	<b>574.5</b>	<b>1465</b>	<b>96,722</b>	<b>1,583.5</b>	<b>185.5</b>	<b>435</b>	<b>58,708</b>	<b>483.3</b>	<b>55.0</b>
Farm Animals					30,774.9	8,672.8			1,258.1	354.5				4,258.2	1,200.0
Tile Drainage					0.0	0.0			0.0	0.0				0.0	0.0
Streambank	-				1,224,875	1,439.5	637.9		579,667	681.2	301.9		94,304	110.8	49.1
Groundwater					98,610.4	182.9			34,774.5	64.5				8,942.0	16.6
Point Sources					34,387.1	4,584.8			23,557.6	3,140.9				1,969.0	262.5
Septic System					317.6	3.6			0.0	0.0				0.0	0.0
<b>Total Lititz Run Base UA</b>	-			<b>1,749,258</b>	<b>170,694.9</b>	<b>14,656.5</b>		<b>676,389</b>	<b>61,854.9</b>	<b>4,047.3</b>		<b>153,012</b>	<b>15,763.3</b>	<b>1,583.2</b>	
Total Lititz Run Base SWBMP RR Reduction					46,400	163.30	35.30		5,200.00	19.50	3.70		0.00	0.00	0.00
Total Lititz Run Base SWBMP ST Reduction					12,000	31.30	7.50		127,400.00	319.00	90.00		0.00	0.00	0.00
Water Quality Facility Sediment Reduction					520,000	592.80	273.00								
<b>Final Existing Load UA</b>					<b>1,170,858</b>	<b>169,908</b>	<b>14,341</b>		<b>543,789</b>	<b>61,516</b>	<b>3,954</b>		<b>153,012</b>	<b>15,763</b>	<b>1,583</b>

**TOTAL UA LOAD** 1,867,659 lbs Sediment  
247,187 lbs Nitrogen  
19,878 lbs Phosphorus

10% Sediment Reduction 186765.9 lbs sediment

Additional Municipalities in the Lititz Run Watershed - MapShed Baseline UA Load

Elizabeth and Penn Townships UA Sediment Load (lbs)	135,344.20
Elizabeth and Penn Townships UA Acreage	401.00

## D.2 Impaired Waters Existing Load

Due to the small size of the planning areas within Warwick Township in the Little Conestoga, Conestoga, Hammer, and Cocalico Creek watersheds it was determined the Simplified Method was the best approach. A very small portion of Lititz Borough drains to the Little Conestoga Creek. The following percent cover was used in the Warwick Township calculations (Table 5) and Lititz Borough calculations (Table 6). The state-wide loading rates are provided in Table 7.

*Table 5. Statewide MS4 Land Cover Estimates for Warwick Township and Developed Land Use Loading Rates for PA Counties – Lancaster County*

UA % Impervious	20%
UA % Pervious	80%
Non-UA %Impervious	16%
Non-UA % Pervious	84%

*Table 6. Statewide MS4 Land Cover Estimates for Lititz Borough and Developed Land Use Loading Rates for PA Counties – Lancaster County*

UA % Impervious	51%
UA % Pervious	49%
Non-UA %Impervious	51%
Non-UA % Pervious	49%

*Table 7. Developed Land Use Loading Rates for PA Counties – Lancaster County*

	Sediment (lb/ac/yr)
UA Impervious Loading	1480.43
UA Pervious Loading	190.93
Undeveloped (Non UA) Loading	234.6

Lititz Borough has approximately 18 acres of regulated UA in the Little Conestoga watershed. Table 8 summarizes the required 10% reduction for each watershed- based planning area which was calculated using Tables 5-7 above and applying sediment reductions from existing stormwater BMPs that are located within the planning areas. An inventory of these BMPs is provided in Appendix E and the BMPs are identified on the PRP map in Appendix B. In addition to stormwater BMPs, extensive stream restoration projects on the Cocalico Creek were implemented in the early 2000s totaling 9,550 LF of streambank. These restorations are still functioning and were included to reduce the existing load at 44.88 lbs. per ft. of stream restored. The locations of these restoration projects are also provided on the PRP Map.

Table 8. Summary of Existing Load Simplified Method

	Warwick Township UA Sediment Load (lb)	Lititz Borough UA Sediment Load (lb)	Total Planning Area (Acres)	Sub Total Sediment Load (lbs)	Existing SWBMP Load Reduction (lbs)	Final Existing Sediment Load (lb)	10% Required Sediment Reduction Simplified (lbs)
Hammer Creek Planning Area	317,819	0	708	317,819	9,492 SW BMPs 428,604 Snavely/Good/ Fox Stream Restoration	214,660	<b>21,466</b>
Cocalico Creek Planning Area	334,937	0	149	334,937			
Little Conestoga/Conestoga	377,364	15,444	859	392,808	11,034 SW BMPs	381,775	<b>38,177</b>

### D.3 Aggregated Existing Sediment Load

The Planning Areas calculated using the simplified method will be converted to MapShed by dividing by the sediment delivery ratio of 0.181. The Total Aggregated 10 percent required sediment reduction is therefore 516,287 lbs. The nutrient reduction requirements for the impaired waters are assumed to be addressed by the 10 percent sediment reductions.

*Table 9. Summary of Aggregated Existing Sediment Load and Required Reduction*

	Final Existing Sediment Load - Simplified (lb)	Final Existing Load - MapShed (lb)	10% Required Sediment Reduction Simplified (lbs)	10% Required Reduction (MapShed)
Hammer Creek Planning Area - Simplified Method	214,660	n/a	<b>21,466</b>	<b>118,597</b>
Cocalico Creek Planning Area - Simplified Method				
Little Conestoga/Conestoga - Simplified Method	381,775	n/a	<b>38,177</b>	<b>210,925</b>
Lititz Run - MapShed Method	n/a	1,867,659	<b>n/a</b>	<b>186,766</b>
<b>TOTAL</b>				<b>516,288</b>

### E. BMPs Selected to Achieve the Minimum Required Reductions in Pollutant Loading

Warwick Township and Lititz Borough plan to implement the following ten Best Management Practices after considering the following criteria:

- **Sediment reductions**
- **Cost per pound of pollutant reduction**
- **Coordination with already proposed work/development**
- **Funding and Workforce availability**
- **Community benefit (site accessibility, visibility to the public, ability of public to experience benefits)**
- **Connectivity to other completed or proposed stormwater BMPs**
- **Timeframe to implement**

The purpose of the evaluation was to determine the BMPs that would reduce the most pollutants for the least amount of money while getting closer to the goal of removing streams from the impaired waters list and protecting the Chesapeake Bay.

The minimum sediment reduction required is 516,288 lbs. (as shown in Table 8). Since MapShed was used to calculate the existing load, it was also used to calculate the load reductions resulting from the implementation of the proposed stormwater BMPs in the Lititz Run Watershed (BMP #7 and #8). Individual model runs were completed for each proposed stormwater BMP by entering the required site-specific planning-level BMP information into the MapShed Urban BMP Editor for the Lititz Run Baseline watershed model. The new reduced loading resulting from the BMP was then subtracted from the Lititz Run Watershed Baseline loading of 2,118.2 Tons and the difference is attributed to the implementation of the BMP. Screenshots from the MapShed Urban BMP Editor used in each model run are provided in Appendix D. Sediment reductions from proposed BMP projects outside of Lititz Run were calculated using Expert Panel Report methodologies and the PADEP Stormwater Effectiveness Values Table, and then converted using the sediment delivery ratio.

Warwick Township and Lititz Borough propose the implementation of the following BMPs to meet this target pollutant load reduction. These BMPs will be implemented by the end of the 5-year permit cycle. A summary of all the proposed BMPs and how they meet the required load reduction is included as Table 10. Detailed information about each project is provided below.

*Table 10. Summary of Proposed BMPs*

BMP ID Number	BMP Project	Sediment Load Reduction (lbs)
1	Lititz Run Rd – Stream Restoration and Buffer	195,500
2	Millport Conservancy – Stream Restoration and Buffer	161,000
3	Route 501 Stream Restoration	23,000
4	Warwick Township Linear Park	51,750
5	Locust Street Stream Restoration	28,175
6	Oak Street Wetland Creation	7,188
7	Rain Gardens – Blackberry Lane and North Lane	2,200
8	Lititz Reserve Bioswale	27,331
9	Lititz Bend Riparian Buffer	15,159
10	Snavely's Mill Wetland Creation	8,969
<b>Total Proposed BMP Sediment Reductions</b>		<b>520,272</b>
<b>Required BMP Sediment Reductions</b>		<b>516,288</b>

### **BMP 1 Lititz Run Road Stream Restoration and Buffer**

The Lititz Run Road Stream Restoration is a will be implemented on 1,700 LF of Lititz Run in Warwick Township. Both streambanks will be restored. The restoration will take place on Warwick Sewer Authority Property and private property. The actively eroding streambanks are vertical and 3 feet high. The stabilization project will include the creation of low floodplain benches and gentle grading of stream side slopes established with native vegetation. According to the DEP PRP Instructions a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 195,500 lbs. of sediment reduction. This project is located in the UA.

### **BMP 2: Millport Conservancy Stream Restoration and Buffer**

The Millport Conservancy Stream Restoration and Buffer that will be implemented on 1400 LF of Lititz Run in Warwick Township. Both streambanks will be restored. The restoration will take place at the Millport Conservancy and continue onto adjacent private property. The actively eroding streambanks are vertical and 3 feet high. The stabilization project will include the creation of low floodplain benches and gentle grading of stream side slopes established with native vegetation. According to the DEP PRP Instructions a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 161,000 lbs. of sediment reduction.

### **BMP 3: Route 501 Stream Restoration**

The Route 501 Stream Restoration will be done in conjunction with a paving project in Warwick Township. Approximately 200 LF of the Santo Domingo Creek (Lititz Run Watershed) will be implemented upstream and downstream of Route 501. Both sides of the stream will be restored. The actively eroding streambanks are vertical and 3-4 feet high. According to the DEP PRP Instructions a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 23,000 lbs. of sediment reduction. This project is located in the UA.

### **BMP 4: Warwick Township Linear Park Stream Restoration**

The Warwick Township Park Stream Restoration will be implemented on 450 LF of the Santo Domingo Creek (Lititz Run Watershed) in the Lititz Run watershed immediately downstream of the water quality facility. Both sides of the stream will be restored. The actively eroding streambanks are vertical and 3 feet high. According to the DEP PRP Instructions a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 51,750 lbs. of sediment reduction. This project is located in the UA.

### **BMP 5: Locust Street Stream Restoration**

The Locust Street Restoration will be implemented on 245 LF of the Santo Domingo Creek (Lititz Run Watershed) between the Locust Street and Front Street bridges in Lititz Borough. Banks are currently 4 feet high, vertical, and actively eroding. Both sides of the stream will be restored and the project is located in the UA. According to the DEP PRP Instructions a 115 lb. /ft. sediment load reduction can be applied to this project resulting in 28,175 lbs. of sediment reduction. The design calls for the creation of low wetland/floodplain benches and

the gentle grading of streambanks to tie into the original grade. A GP-3 for this project has already been submitted.

#### **BMP 6: Oak Street Wetland Creation**

The Oak Street wetland creation will be implemented adjacent to Lititz Run west of Oak Street in Lititz Borough. A restoration waiver for this project has already been submitted and approved. Bank heights are approximately 3-4' high and vertical through this reach. The purpose of the project is to create floodplain wetlands. A floodplain wetland complex will be excavated on the north side of the stream to relieve the stresses on the banks above the bridge while providing a biologically diverse, high quality wetland which will provide biological treatment of storm flows from Lititz Run. The proposed project site is an accumulation of legacy sediment that has been formed by the dam for S.E. Keller's Carding Mill. The wetland will alleviate stress on approximately 125 feet of streambank. A sediment removal of 57.5 lb. /ft of stream bank protected by the wetland (half of the 115 lb/ft value) was applied to this project.

#### **BMP 7: Low Volume Road Rain Gardens – Blackberry Lane and North Lane**

Lititz Borough intends to construct three rain gardens to treat runoff as part of their dirt and gravel and low volume road maintenance grant funding. Design characteristics are provided in Table 11 below. Since MapShed was used to calculate the existing load it was also used to calculate the load reduction resulting from the implementation of the rain gardens.

Screenshots from the MapShed Urban BMP Editor used in the model run are provided in Appendix D.

*Table 11. Low Volume Road Rain Gardens*

BMP	BMP Area (ac)	Acres Treated (ac)	BMP Depth Treated (ft)	Runoff Storage (RS) (ac ft)	Impervious Area (IA) (ac)	(RS)(12)/IA (Min=0, Max=2.5)	MapShed BMP sediment removal (lb)
Low Volume Road Rain Gardens	.045	10.83	0.5	.023	4.85	0.5	2,200

### BMP 8: Lititz Reserve Bioswale

The Lititz Reserve community intends to construct a bio-swale to treat runoff from the 130 acre development site. Design information was available for the entire 1,800 foot swale and the load reductions provided below assume the full 1,800 feet is constructed, however, only a portion of the swale may be completed. Design characteristics are provided in Table 12 below. Screenshots from the MapShed Urban BMP Editor used in the model run are provided in Appendix D.

The swale will provide sediment load reductions as part of the NPDES permit requirements for the proposed activity. To determine the annual sediment loading resulting from the commercial development area, the 130.8 ac parcel was multiplied by the annual MapShed loading rate for medium density mixed which is 57.1 lbs. /ac. This equates to 7,469 lbs. per year loading from the site that must be removed to meet NPDES permit requirements. The bioswale addresses all peak rate and volume impacts resulting from the development site, so additional downstream bank erosion loading is not a factor. Therefore the final sediment reduction resulting from the project is 27,374 lbs. of sediment.

*Table 12. Lititz Reserve Bioswale*

BMP	Total BMP Area (ac)	Total Acres Treated (ac)	Runoff Storage (RS) (ac ft)	Impervious Area (IA) (ac)	(RS)(12)/IA (Min=0, Max=2.5)	MapShed BMP sediment removal (lb)	NPDES Permit requirement	Final Sediment Reduction (lb)
Lititz Reserve Bioswale	4.6	130.8	7.56	68.0	1.33	34,800	7,469	27,331

### BMP 9: Lititz Bend Riparian Buffer

As part of the Lititz Bend community land development the developer has agreed to implement a 2,800 LF riparian buffer that is 35 feet wide along the west side of a headwater tributary of the Little Conestoga Creek. Buffer criteria is provided in Table 13 below. It was assumed 52% of the drainage area would be impervious surface (the average impervious surface assumed in MapShed Medium Density Residential Land Cover). Since the simplified method was used to calculate existing loads in the Little Conestoga Watershed the sediment load reduction resulting from the buffer was calculated using the DEP effectiveness value of 50% for riparian buffers. Since all watershed were aggregated the sediment load reduction was then normalized to MapShed values by dividing by the 0.181 sediment delivery ratio.

Table 13. Lititz Bend Riparian Buffer

BMP	Buffer Area	Acres Treated (ac)	Impervious Acres Treated	Pervious Acres Treated	Impervious Area TSS Loading (lbs/ac/yr)*	Perv. Area TSS Loading (lb/ac/yr)*	Simplified Method Sediment Removal (lb)	MapShed BMP sediment removal (lb)
Lititz Bend Riparian Buffer	2.25	9	3.15	4.32	4,663	824.73	2,744	15,159

\*Based on PADEP's BMP Effectiveness Values (3800-PM-BCW0100m), 5/2016

\*\*Loading Rates from DEP PRP Instructions, Attachment B "Developed Land Loading Rates for PA Counties" May, 2016; Lancaster County values (See table 7)

#### BMP 10: Snavely Mill Created Wetland

Warwick Township is planning to create a wetland along the Hammer Creek at Snavely's Mill. The wetland will be approximately 0.25 acres and will treat stormwater runoff from the upslope mill operation. Design information was not yet available at the time of PRP submittal. The drainage area to the wetland is assumed to be approximately 2 acres with 75% of the drainage area impervious surface. Sediment reductions were calculated using the Expert Panel Report to Define Removal Rates for Urban Stormwater Retrofit Projects (2015). Since all watershed were aggregated the simplified method sediment load reduction was then normalized to MapShed values by dividing by the 0.181 sediment delivery ratio.

Table 14. Snavely Mill Created Wetland

BMP	Total BMP Area (ac)	Total Acres Treated (ac)	Runoff Storage (RS) (ac ft)	Impervious Area (IA) (ac)	(RS)(12)/IA (Min=0, Max=2.5)	Sediment Load (lb)	Sediment Removal %	Sediment Reduction Simplified (lb)	Sediment Removal MapShed (lb)
Snavely Mill Created Wetland	0.25	2	0.126	1.5	1.01	2,316	70%	1,623	8,967

\*\*Loading Rates from DEP PRP Instructions, Attachment B "Developed Land Loading Rates for PA Counties" May, 2016; Lancaster County values (See table 7)

#### F. Funding Mechanism Identification

In order to install and maintain the BMPs listed in Section E, the Municipalities propose the following sponsors/partners and funding sources.

Table 15. BMP funding Sources

BMP#	Sponsor/Partner/Funding Sources
1	Warwick Township and the Lititz Run Watershed Association will seek funds to design, permit, implement, monitor and maintain the Lititz Run Rd stream restoration project.
2	The Lititz Run Watershed Association and Millport Conservancy will budget funds to design, permit, implement, monitor and maintain the Millport Conservancy stream restoration project.
3	The Route 501 stream restoration will be implemented with PennDOT funds as part of the paving project. Warwick Township will commit budget funds to monitor maintain the restoration.
4	Warwick Township will commit budget funds to design, permit, implement, monitor and maintain the Warwick Township Linear Park stream restoration.
5	Lititz Borough will use funds from Exelon that were distributed via the Lancaster County Conservation District to implement the project. Lititz Borough will monitor and maintain the Locust Street stream restoration project.
6	Lititz Borough has acquired grant funds through PADEP to implement the Oak Street wetland creation project. Budget funds will be committed to monitor and maintain the project.
7	Lititz Borough has acquired grant funding through the Lancaster County Conservation District to implement the rain gardens. Budget funds will be committed to monitoring and maintenance.
8	The Lititz Reserve developer has committed to fund the implementation, monitoring and maintenance of a portion of the bioswale designed for the development site. Monitoring and maintenance will be financed by the developer or community.
9	The Lititz Bend community developer has committed to fund the implementation, monitoring and maintenance of a 35 foot wide riparian buffer through the proposed community.
10	Snavely's Mill has agreed to fund the design, implementation, monitoring and maintenance of a wetland to capture and treat runoff from the Mill.

## G. Responsible Parties for Operation and Maintenance (O&M) of BMPs

All stormwater BMPs installed under this PRP are subject to the municipality's' stormwater management ordinance which states O&M requirements. The ordinances requires that the BMPs are inspected at a minimum annually for the first five years and once every three years thereafter.

The Operation and Maintenance (O&M) activities for each BMP are included in the table below. If the BMP is located on private land, the landowner must convey an easement to the Township to allow for access for periodic inspections and maintenance, as needed. Actual O&M activities will be listed in the Annual MS4 Status Report sent to the PADEP under the General Permit.

Table 16. BMP O&M Activities

BMP #	Parties Responsible for O&M	O&M Activities	Frequency for O&M Activities
1, 3, 4	Warwick Township	Monitored for stability and plant establishment and according to permit requirements	Biannual inspections for first three years and annual inspections thereafter. Additional inspections following large storm events
2	Millport Conservancy and Lititz Run Watershed Association	Monitored for stability and plant establishment and according to permit requirements	Biannual inspections for first three years and annual inspections thereafter. Additional inspections following large storm events
5 -6	Lititz Borough	Monitored for stability and plant establishment and according to permit requirements	Biannual inspections for first three years and annual inspections thereafter. Additional inspections following large storm events
7	Lititz Borough	Inspection, mowing and weeding, trash cleanout	Biannual inspections for first three years and annual inspections thereafter.
8	The developer will sign an O&M agreement with Warwick Township that will be reviewed and approved by Warwick Township.	Inspection, mowing and weeding, trash cleanout	Biannual inspections for first three years and annual inspections thereafter.
9	The developer will sign an O&M agreement that will be reviewed and approved by Warwick Township.	Inspection, mowing and weeding, control of invasive species to promote tree establishment, tree replacement.	Biannual inspections for first three years and annual inspections thereafter.
10	Snavely's Mill will sign an O&M agreement that will be reviewed and approved by Warwick Township.	Inspection, mowing and weeding, control of invasive species to promote tree establishment, tree replacement.	Biannual inspections for first three years and annual inspections thereafter.

## H. Works Cited

Integrated List Non-Attaining 2014\_01. Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division.

Schueler, T. and C. Lane. January 20, 2015. Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit. Chesapeake Bay Program Urban Stormwater Workgroup.

Pennsylvania Department of Environmental Protection (PADEP). 2016. PRP / TMDL Plans MS4 Workshop. Harrisburg, PA.

PA Department of Environmental Protection, Central Office, Office of Water Management. 2004. Total Maximum Daily Load, Lititz Run, Lancaster County.

Pennsylvania Department of Environmental Protection (PADEP) Bureau of Clean Water. 2016. National Pollutant Discharge Elimination System(NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems BMP Effectiveness Values (3800-PM-BCW0100m). Harrisburg, PA.

**Appendix A**  
Public Participation:  
A1 Proof of Publication  
A2 Record of Comments and Responses

## PROOF OF PUBLICATION NOTICE IN

State of Pennsylvania}

} ss:

County of Lancaster}

Carole A Good of the County and State aforesaid, being duly sworn, deposes and says that THE LITITZ RECORD EXPRESS , a newspaper of general circulation published at Ephrata, County and State aforesaid, was established 1877 since which date said newspaper has been regularly issued in said county, and that a copy of the printed notice or publication is attached hereto exactly the same as was printed and published in the regular editions and issues of LITITZ RECORD EXPRESS, on the following:

20<sup>TH</sup> DAY OF JULY 2017

Affiant further deposes that she is the Clerk duly authorized by the Lancaster County Weeklies, Inc., a corporation, publisher of said Lititz Record Express, a newspaper of general circulation, to verify the foregoing statement under oath, and also declares that affiant is not interested in the subject matter of the aforesaid notice or advertisement, and that all allegations in the foregoing statement as to time, place and character of publication are true.

### NOTICE OF OPPORTUNITY FOR PUBLIC REVIEW AND COMMENT

**NOTICE IS HEREBY GIVEN** that the Board of Supervisors of Warwick Township (Township) and the Council of Lititz Borough (Borough) will jointly receive public comment(s) on the proposed Warwick Township-Lititz Borough-Manheim Township Lititz Run TMDL Plan and the Warwick Township-Lititz Borough Nutrient/Sediment Pollutant Reduction Plan (PRP) and Chesapeake Bay Pollutant Reduction Plan (CBPRP) required by the Individual MS4 Permit. The proposed TMDL Plan, PRP, and CBPRP include:

- (1) Current status of sediment reductions in relation to the Lititz Run TMDL Waste Load Allocation (WLA);
- (2) Identification and locations of structural Best Management Practices (BMPs) for implementation during the permit period to reduce loadings of nutrients and sediment as required by the MS4 Permit;
- (3) Explanation of the methodology used to calculate existing nutrients/sediment loadings and corresponding reductions from applicable watersheds with regulated MS4; and
- (4) Locations of local waterways with nutrients/sediment impairments.

### DOCUMENT AVAILABILITY

The proposed TMDL Plan, PRP, and CBPRP are available for review at the Township office located at 315 Clay Road, Lititz, PA 17543 and the Borough office located at 7 S. Broad Street, Lititz, PA 17543 from 8:30am to 4:00pm Monday-Friday beginning July 19, 2017.

The proposed TMDL Plan, PRP, and CBPRP are available to view or download at [warwicktownship.org](http://warwicktownship.org) or [lititzborough.org](http://lititzborough.org).

### SUBMISSION OF COMMENTS

The Township and Borough shall jointly accept written comments for a minimum of 30 days from the date of public notice. Interested parties may submit written comments electronically, by mail, or hand delivery. Written comments must be received by 12:00 noon on August 21, 2017 and addressed to:

DAN ZIMMERMAN  
TOWNSHIP MANAGER  
WARWICK TOWNSHIP  
315 CLAY ROAD, LITITZ, PA 17543

Comments may be submitted electronically, in PDF text format (if less than 1.0 megabytes in total size), to via email at [dzimmerman@warwicktownship.org](mailto:dzimmerman@warwicktownship.org). Please also indicate in the subject line, **“Comments-Warwick Township-Lititz Borough TMDL Plan, PRP, and CBPRP”**.

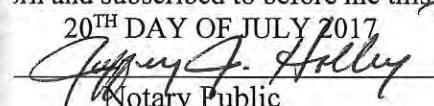
The Township Board of Supervisors will provide an opportunity for interested parties to provide comments during the regularly scheduled meeting to be held on August 16, 2017 at 7:00pm. The Borough Council will provide an opportunity for interested parties to provide comments during the regularly scheduled meeting to be held on July 25, 2017

  
(Signature)

### OF NOTICE OF PUBLICATIONS

and subscribed to before me this

20<sup>TH</sup> DAY OF JULY 2017

  
Notary Public

commission expires 6-10-21

COMMONWEALTH OF PENNSYLVANIA  
NOTARIAL SEAL  
Jeffrey J. Hollinger, Notary Public  
City of Lancaster, Lancaster County  
My Commission Expires June 10, 2021  
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

**PROOF OF PUBLICATION NOTICE IN**

State of Pennsylvania}  
} ss:  
County of Lancaster}

An Affiant of the County and State aforesaid, being duly sworn, deposes and says that the LNP, a daily newspaper of general circulation published at Lancaster, County and State aforesaid, was established 1794-1877 since which date said daily newspaper has been regularly issued in said county, and that a copy of the printed notice or publication is attached hereto exactly the same as was printed and published in the regular editions and issues of said daily newspaper on the following dates:

16<sup>TH</sup> AND 19<sup>TH</sup> DAY OF JULY 2017

Affiant further deposes that he/she is the Clerk duly authorized by the LNP Media Group, Inc., a corporation, publisher of said LNP, a newspaper of general circulation, to verify the foregoing statement under oath, and also declares that affiant is not interested in the subject matter of the aforesaid notice or advertisement and that all allegations in the foregoing statement as to time, place and character of publication are true.

**PUBLIC NOTICE**  
Manheim Township has created a Pollutant Reduction Plan (PRP) and Lititz Run TMDL Plan (LRTMDLP) to meet the requirements of its Municipal Separate Storm Sewer (MS4) permit with the Department of Environmental Protection (DEP). The PRP and LRTMDLP include estimates of the existing pollutants that are discharged to streams within the Township and the associated reductions that are required by DEP. The plans also identify proposed stormwater improvements needed to meet these pollutant reduction requirements. Possible funding sources and ongoing operation and maintenance responsibilities for the proposed stormwater improvements are included in the PRP and LRTMDLP. A draft of the PRP and LRTMDLP will be available for public inspection at the Township office located at 1840 Municipal Drive, Lancaster, Mondays through Fridays between the hours of 8 am and 5 pm. An initial presentation of the plans will be offered at the Commissioners meeting on July 24, 2017, and the public review period will begin on July 25, 2017, and will continue for 30 days until August 24, 2017. During this period, comments will be accepted verbally at the Commissioner's meeting on August 14, 2017, or can be submitted in writing to the Township office or via email to pmellott@manheimtownship.org.

*Carole A. Hood*

(Affiant's Signature)

**COPY OF NOTICE OF PUBLICATION**

Sworn and subscribed to before me this  
19<sup>TH</sup> DAY OF JULY 2017 -

*Jeffrey J. Hollinger*

Notary Public

COMMONWEALTH OF PENNSYLVANIA

NOTARIAL SEAL  
Jeffrey J. Hollinger, Notary Public  
City of Lancaster, Lancaster County  
My Commission Expires June 10, 2021  
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

## **Appendix A2**

### **Record of Comments Received and Comment Responses – Warwick Township**

#### **Comment 1**

July 31, 2017 – Dan Zimmerman, Township Manager

Dan Zimmerman commented that he would like to apply sediment reductions to their PRP that will result from the implementation of riparian buffers as part of Warwick's Riparian Corridor Ordinance included in their Stormwater Management Standards. The ordinance states that a 35' riparian corridor easement shall be created and recorded as part of any subdivision or land development that encompasses a riparian corridor. The minimum management requirement is to maintain existing native vegetation and wherever practicable plant with native trees and shrubs. The riparian corridor easement shall be enforceable by the Township and shall be recorded in the Lancaster County Recorder of Deeds Office.

#### **Record of Response**

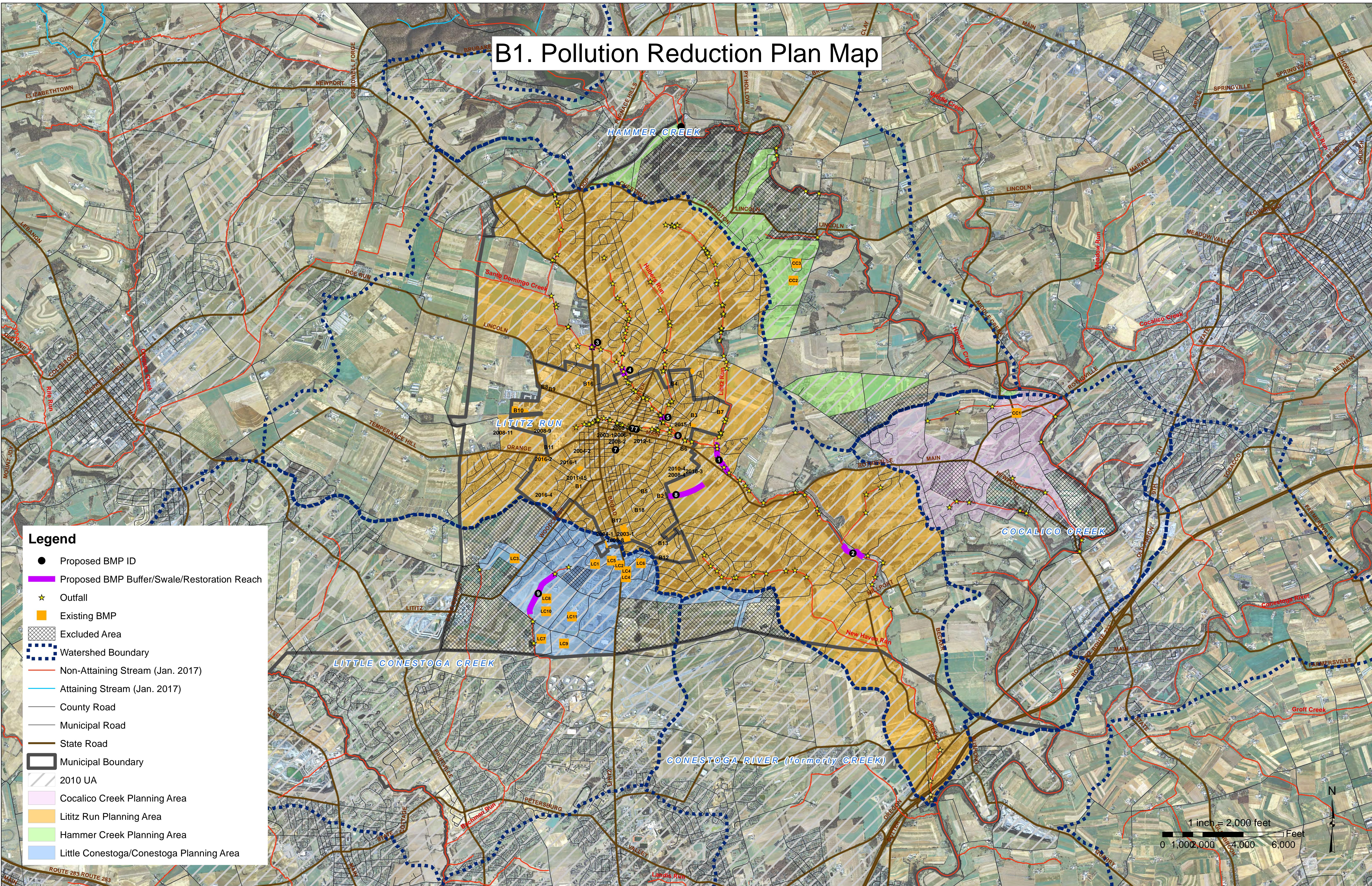
This is a viable approach that will result in sediment reductions that can be applied to the PRP. Any amendment to the PRP will include this as a BMP with an estimation of expected reductions based on implementation of previous riparian corridor easements.

## Appendix B

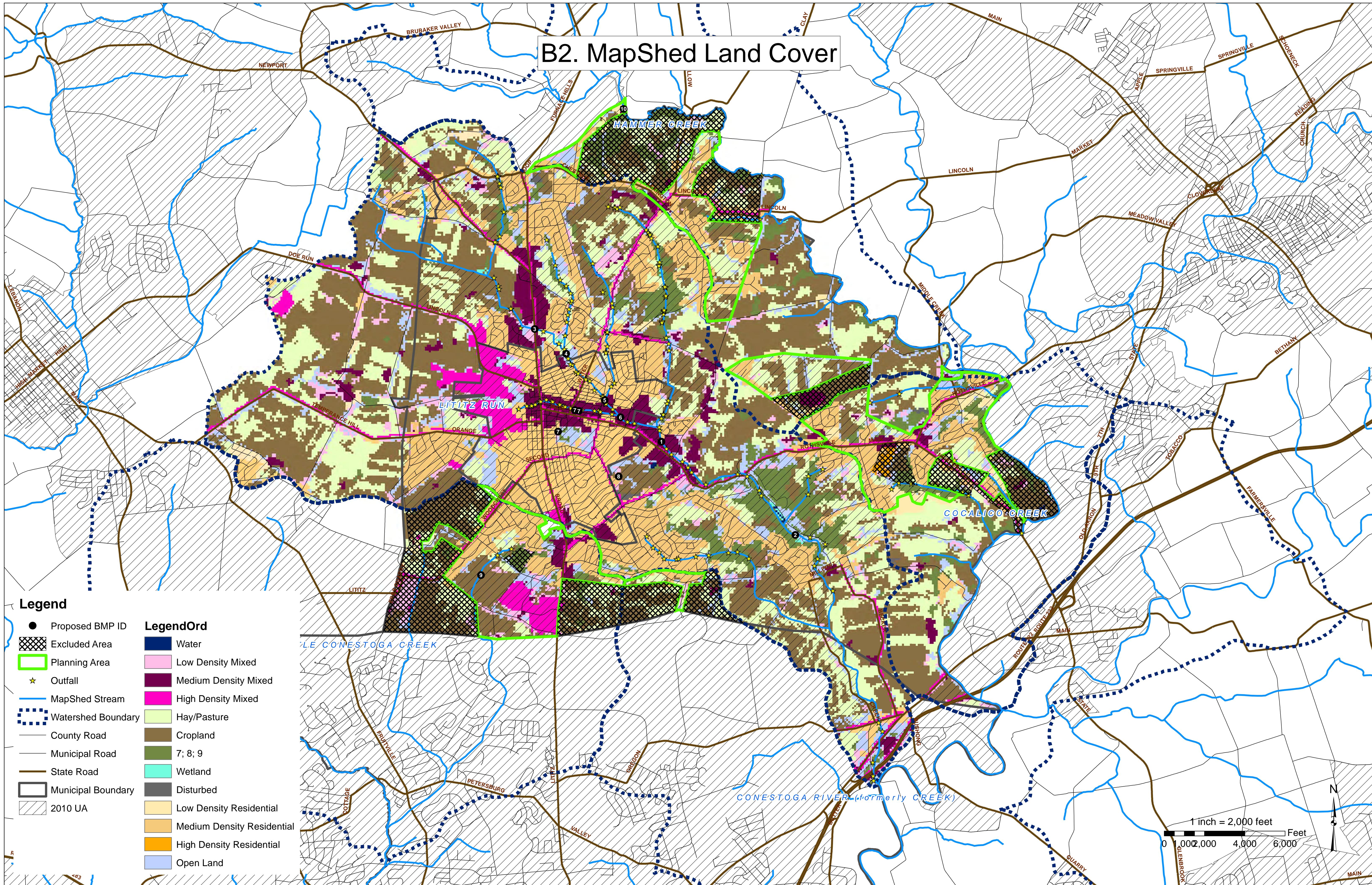
### Maps:

- Item B1) Pollution Reduction Plan Map;
- Item B2) MapShed Land Cover

## B1. Pollution Reduction Plan Map



## B2. MapShed Land Cover



## Appendix C

### Summary Tables of MapShed Input for Lititz Run Watershed

## Lititz Run Baseline Model Input

Lititz Run Land Cover	Base MapShed 2011 Lititz Run Land Cover (ha)	Change in Land Cover 2011 - 2017	2017 Model Run Land Cover (ha)
Hay	901		901
Row Crops	1305	-35	1270
Forest	270		270
Disturbed	5		5
Wetland	5		5
Open Space	315		315
Low Intensity Residential (<30% Impervious)	26		26
Med. Intensity Residential (30%-75% Impervious)	1023	12*	1035
High Intensity Residential (>75% Impervious)	0		0
Low Intensity Mixed Urban (<30% Impervious)	160		160
Med. Intensity Mixed (30%-75% Impervious)	248	23	271
High Intensity Mixed (>75% Impervious)	245		245

\*The 12 hectares changed from row crops to medium density residential were located within the UA and the UA acres in the .gms file were adjusted accordingly. The 23 hectares converted to medium density mixed are located outside the UA.

Lititz Run Watershed Existing Riparian BMPs	Date	Urban or Rural	Buffer Length	Buffer Width	Bank Stabilization	Wetland Created
Banta Ecological Restoration	2005	R	2250	150	2250	6.15
Millport Conservancy		R	750	50	750	
Greg Wilson		R	1500	50		0.5
West Newport Rd	2003	R	3320	60		
Creek Rd	2010	R	930	50		
Creek Rd	2010	R	420	180		
Rothsville Rd	2003	R	2040	180		
Unvisited LFT Farm	2017	R	1000	50		
48 W Newport Rd		R	300	35		
1140 Brunerville Rd		R	50	35		
1141 Brunerville Rd		R	50	35		
337 E Lexington Rd		R	50	35		
LFT Farms CREP	Through 2017	R	6173	50		
Newport Square	2003	U	2350	180		1.25
New Street Ecological Park FPR	2004	U	900	55	900	0.75
John Gibble (#60)	1/27/2010	U	1800	70		
Sechan Electronic (#2)	10/21/2009	U	488	60		
Rock Lititz	2014	U	2556	100	2556	
New Street Phase 2	2016	U	0	0	481	
Water Quality Facility		U				2

Warwick Twp. Linear Park		U	50	35		
Warwick Twp. Riparian Park		U	100	35	600	0.25

URBAN Stream BMP Summary	ft	km	width (ft)	Width (m)	Fraction of Streams Treated
Vegetated Buffers	8244	2.51	107.6	32.8	0.12
Bank Stabilization	4537	1.38			
Total Urban Stream Length	20.2				
RURAL Stream BMP Summary	ft	km			
Vegetated Buffers	18833	5.74			
Fencing	13791	4.20			
Bank Stabilization	3000	0.91			

Lititz Run Groundwater and Point Source Loading Data		2016/17 Averages
Average TN in Groundwater (From WTP ) Well #1 mg/L May 2017		11.70
Average Monthly Groundwater Withdrawal (WTP) Well #1 gal/d		151,816.00
Average TN in Groundwater (From WTP ) Well #2 mg/L April 2017		13.50
Average Monthly Groundwater Withdrawal (WTP) Well #2 gal/d		30,303.00
Lititz Borough TN mg/L		10.20
Lititz Borough Water Withdrawal gal/d		1,861,992.00
Average mg/L		10.36
Avg monthly discharge from WWTP (MGD)		2.70
Avg TN discharge from WWTP (mg/L)		5.96
Avg TP discharge from WWTP (mg/L)		0.67
Avg TSS discharge from WWTP (mg/L)		6.45
Permitted monthly discharge from WWTP (MGD)		Annual Avg. rated capacity =3.85 MGD
Permitted TN discharge from WWTP (mg/L)		70,319 lbs/yr annual loading allowance
Permitted TP discharge from WWTP (mg/L)		9,376 lbs/yr annual loading allowance
Permitted TSS discharge from WWTP (mg/L)		963 lbs/day monthly avg.

% Bank Fraction*	Default	Adjusted	Soil Conc (lb/t) - default
<b>Nitrogen</b>	0.25	0.57	4
<b>Phosphorus</b>	0.25	0.73	1.432

\*Percent bank fraction was adjusted so soil nutrient concentration match what is included in the "Recommendation of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects (2014). N – 2.28 and P – 1.05

Agricultural BMPs	Units	Lititz Run 2017
Cover Crop	% Acres Treated	69%
Conservation Tillage	% Acres Treated	78%
Strip Cropping/ Contour Farming	% Acres Treated	21%
Conservation Plan	% Acres Treated	88%
Nutrient Management	% Acres Treated	88%
Grazing Land Management	% Acres Treated	56%
Manure Storage (Livestock)	% Animals	68%
Manure Storage (Poultry)	% Animals	100%
Barnyard Runoff Control	% Animals	68%
Phytase	% Animals	100%

2017 Animal Numbers	No.
Dairy Cows	1159
Beef Cows	193
Broilers	271600
Layers	950000
Hogs/Swine	4666
Sheep	11
Horses	108
Turkeys	8987
Other	

## Lititz Run Watershed Stormwater BMP Inventory

Map ID	NPDES Permit #	Municipality	Date Installed	BMP Type	RR or ST	Latitude	Longitude	Acres Treated (ac)	Impervious Area Treated (ac) <sup>1</sup>	BMP VolumeTreated (cf) <sup>2</sup>	Runoff Storage (RS)(12)/IA (in)
		Warwick Twp	2006	Homeowner Infiltration Facility 1	RR			0.39	0.13	1,393.00	2.95
2015-1	n/a	Lititz Borough	2015	Homeowner Seepage pit	RR	40.1573531	-76.2922684	0.79	0.79	980.00	0.34
2010-1	n/a	Lititz Borough	2012	Linden Hall School Green Roof	RR	40.1558917	-76.3013885	0.04	0.04	168.00	1.20
2014-1	PAG02003614045	Lititz Borough	2014	Lititz Rec Center Pervious Pavement	RR	40.158097	-76.3154848	2.46	2.20	23,622.00	2.96
2014-3	PAG02003614045	Lititz Borough	2014	Lititz Rec Center Rain Garden	RR	40.1577968	-76.3154912	0.30	0.15	765.00	1.40
2008-4thru7	n/a	Lititz Borough	2008	Luther Acres Ally Rain Gardens 1-4	RR	40.1508283	-76.2936343	0.53	0.25	5,039.00	5.64
2010-4	PAG2003604108	Lititz Borough	2010	Luther Acres Porous Parking Lot	RR	40.1513705	-76.293463	1.09	0.86	9,327.00	2.97
2010-2	PAG2003604108	Lititz Borough	2010	Luther Acres Hershey Expansion Rain Garden	RR	40.1512787	-76.2922939	0.23	0.08	1,042.00	3.41
2010-3	PAG2003604108	Lititz Borough	2010	Luther Acres Hershey Expansion Rain Garden	RR	40.1509788	-76.2909164	0.47	0.14	1,080.00	2.08
2011-15	PAG02003610006-R	Lititz Borough	2011	Movavian Manor Infiltration Basin	RR	40.1502211	-76.3114556	3.37	1.43	6,765.00	1.30
2003-1 thru 4	PAG2003603149	Lititz Borough	2004	Keller Subdivision infiltration	RR	40.142651	-76.3029029	8.42	3.25	15,647.00	1.33
2008-1,2	n/a	Lititz Borough	2009	Trinity Lutheran Infiltration Trenchs (2)	RR	40.1552573	-76.3041391	0.29	0.21	1,570.00	2.06
2012-1	n/a	Lititz Borough	2013	Word of Life Church Bioswales	RR	40.1551224	-76.2995352	0.29	0.24	69.03	0.08
				Total Acres/inches				18.67			27.73
				MapShed Hectares/Cm				7.56			70.43
		Warwick Townsh	2016	Rock Lititz Floodplain Restoration/bioretention/rain garde	RR	40.175	-76.32222	64.51	22.46	283,374.00	3.48
		Warwick Twp	2006	Homeowner Infiltration Facility 2	RR			0.18	0.16	1,123.00	1.93
	PAG02003613059	Warwick Twp	2013 or later	Bottom Line Contracting Infiltration Trench	RR			0.39	0.23	1,958.00	2.35
		Warwick Twp	2012	CVS/Keller Bros. Infiltration Basins (2)	RR			3.75	2.00	6,381.00	0.88
	PAG02003615129	Warwick Twp	2013 or later	East Woods Drive Rain Gardens/Bioretention	RR			2.98	1.28	10,308.00	2.22
	PAG02003615119	Warwick Twp	2013 or later	GarDel, LLC - Infiltration Trench	RR			0.30	0.30	2,805.00	2.58
		Warwick Twp	2010	Garman Infiltration	RR			0.05	0.05	122.00	0.67
		Warwick Twp	2007	Groff Infiltration Facilities (5)	RR			5.12	1.50	2,628.00	0.48
		Warwick Twp	2009	Poultry Barn Basin	RR			1.70	0.70	1,860.00	0.73
	PAG02003614047	Warwick Twp	2013 or later	Hometowne Terrace - Rain gardens/Bio-retention	RR			2.63	1.26	15,953.00	3.49
		Warwick Twp	2010	Beiler Subdivision Roof Infiltration	RR			0.16	0.16	1,124.00	1.94
		Warwick Twp	2010	Beiler Seepage Pit #1	RR			0.12	0.04	1,080.00	7.44
		Warwick Twp	2010	Beiler Seepage Pit 2	RR			0.08	0.02	640.00	8.82
	PAG02003613075	Warwick Twp	2013 or later	Hurst/Beiler Partners - Infiltration basin - Beiler Lane	RR			4.11	0.38	4,441.00	3.22
		Warwick Twp	2007	Subdivision Infiltration	RR			0.42	0.42	3,944.00	2.59
	PAG02003610009-R	Warwick Twp	2013 or later	Lancaster Evangelical Free Church - Rain gardens/Bio-retention	RR			23.88	3.01	22,957.00	2.10
		Warwick Twp	2012	Landis Seepage Pits	RR			0.32	0.32	2,248.00	1.94
		Warwick Twp	2007	Layla LLC-5A infiltration bed	RR			0.73	0.09	6,710.00	20.54
		Warwick Twp	2007	Layla LLC-5B infiltration bed	RR			0.76	0.13	7,710.00	16.34
		Warwick Twp	2013 or later	Lititz Reserve Phase 5 and 6 - Rain Gardens/Bioretention	RR			18.48	12.40	113,740.00	2.53
		Warwick Twp	2010	Sewer Plant Building B-6 Infiltration	RR			0.09	0.09	345.00	1.06
		Warwick Twp	2010	Sewer Plant Building B-5 Infiltration	RR			0.06	0.06	240.00	1.10
	PAC360037	Warwick Twp	2013 or later	Victory Church Infiltration Basin	RR			4.15	1.62	8,925.00	1.52
	n/a	Warwick Twp	2006	Warwick Municipal Campus Bio Basin and Forebay	RR	40.155	-76.279	32.93	5.46	24,598.00	1.24
	n/a	Warwick Twp	2006	Warwick Municipal Campus Pervious Pavement	RR	40.155	-76.279	1.35	1.35	35,283.60	7.20
	n/a	Warwick Twp	2006	Warwick Municipal Campus Porous Concrete	RR	40.155	-76.279	0.21	0.21	5,488.56	7.20
		Warwick Twp	2012	Wenger Infiltration Trench	RR	XXX	XXX	0.17	0.11	2,080.00	5.21
		Warwick Twp	2006	West Ridge Infiltration Facility	RR			0.24	0.24	2,253.00	2.59
		Warwick Twp	2009	Zimmerman Infiltration Trench	RR			0.71	0.03	896.00	8.23
				Total Acres/inches		Total	Ac	170.58			121.58

## Lititz Run Watershed Stormwater BMP Inventory

Map ID	NPDES Permit #	Municipality	Date Installed	BMP Type	RR or ST	Latitude	Longitude	Acres Treated (ac)	Impervious Area Treated (ac) <sup>1</sup>	BMP Volume Treated (cf) <sup>2</sup>	Runoff Storage (RS)(12)/IA (in)
				MapShed Hectares/Cm		Total	Ha	69.03			308.81
B12	PAR10-O-524	Lititz Borough	2001	216 Landis Valley Road Detention Basin (South - 'A')	ST	40.1393073	-76.2961551	2.26	1.18	15,696.00	3.66
B13	PAR10-O-524	Lititz Borough	2001	217 Landis Valley Road Detention Basin (North - 'B')	ST	40.1413331	-76.2961583	4.26	2.70	28,508.00	2.91
B10	n/a	Lititz Borough	2003	400 W. Lincoln Avenue Detention Basin	ST	40.159562	-76.3216412	242.00	36.52	926,496.00	6.99
	n/a	Lititz Borough	2012	Butterfly Acres Bioswale	ST	40.1455628	-76.3000163	156.00	54.60	33,000.00	0.17
2004-1	PAG2003604108	Lititz Borough	2004	Keller Bros Ford Stormwater Basin	ST	40.1540016	-76.3102377	2.29	0.88	10,214.00	3.20
B15	n/a	Lititz Borough	2002	Church of Brethren Detention Basin	ST	40.1528573	-76.3133502	4.30	1.97	20,980.00	2.93
2003-1,2	PAG2003603109	Lititz Borough	2003	Lititz Elementary School Underground Detention	ST	40.1560859	-76.3060566	2.12	1.64	10,416.00	1.75
B7	PAG2003607042	Lititz Borough	2002	Cambridge Lane Detention Basin	ST	40.1589543	-76.2856076	58.20	31.80	309,276.00	2.68
2004-2	PAG2003604045	Lititz Borough	2001	Walnut Street Apartments SW Basin	ST	40.1540016	-76.3102377	2.29	0.88	34,904.58	10.93
				Total Acres/inches				473.72			35.22
				MapShed Hectares/Cm				191.7078519			89.45
	Warwick Twp	2007	Millrace Basin Creekside Structures	ST				2.67	1.38	1,533.00	0.31
	Warwick Twp	2004	Ponding Stormwater Facility	ST				0.12	0.11	682.00	1.71
	Warwick Twp	2007	Donald Groff Basin	ST				0.10	0.10	1,773.00	4.88
	Warwick Twp	2010	Grace Church Sediment Forebay	ST				7.40	1.00	5,532.00	1.52
	Warwick Twp	2006	Green Hills Farm Discount Grocer Detention Basin	ST				3.20	1.23	3,826.00	0.86
	Warwick Twp	2010	Beiler Basin B	ST				3.00	0.95	20,779.00	6.03
	Warwick Twp	2010	Beiler Basin C	ST				2.00	0.30	810.00	0.74
	Warwick Twp	2007	Martin Res. Tennis Courts - Underground Detention	ST				0.15	0.15	1,046.00	1.92
	Warwick Twp	2008	Penn Manufacturing Detention Basin	ST				1.55	0.68	2,626.00	1.06
	Warwick Twp	2007	Red Rose Cabinetry Basin	ST				1.20	0.64	3,728.00	1.60
	Warwick Twp	2009	Rohrer Farms Swale	ST				0.16	0.16	450.00	0.77
	Warwick Twp	2008	S&A Paint&Repair - Basin	ST				0.55	0.31	618.00	0.55
	Warwick Twp	2008	Shale Ridge Farm - infiltration berms	ST				2.00	0.80	4,319.00	1.49
	Warwick Twp	2011	Warwick Crest - 2 forebays	ST				12.23	3.15	4,310.00	0.38
	Warwick Twp	2006	West Ridge Detention Basin	ST				3.05	1.12	3,807.00	0.94
	Warwick Twp	2006	Wrigley Trace Soil Stockpile Facility - Basin	ST				3.00	1.00	6,368.00	1.75
PAG02003613082	Warwick Twp	2013 or later						2.55	1.15		0.00
				Total Acres/inches				44.93			26.52
				MapShed Hectares/Cm			Ha/cm	18.18			67.35

## Appendix D

### MapShed Input and Results Screen Shots

## Lititz Run Baseline Watershed Results

GWLF Total Loads for file: LititzRunBase\_6-27-17-9412 Period of analysis: 21 years from 1978 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2226	2.8	741.2	69.5	624.1	876.4	138.3	208.5
Cropland	3138	4.9	13400.4	512.8	4122.7	7317.4	138.8	660.8
Forest	667	2.4	26.8	3.9	69.0	84.5	3.6	9.2
Wetland	12	7.4	0.7	0.1	3.9	4.3	0.2	0.4
Disturbed	12	8.8	2.8	0.4	0.5	2.1	0.2	0.8
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	778	7.4	401.5	58.2	648.6	881.5	13.0	96.3
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	395	3.1	0.0	2.4	40.8	126.2	5.6	14.0
MD Mixed	670	8.5	0.0	19.1	226.2	744.8	32.6	85.1
HD Mixed	605	12.0	0.0	17.3	204.5	673.3	29.5	77.0
LD Residential	64	3.1	0.0	0.4	6.6	20.5	0.9	2.3
MD Residential	2558	5.2	0.0	73.1	864.1	2844.5	124.5	325.1
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					96776.2			27272.8
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1361.0		3198.9		1417.6
<b>Groundwater</b>					248388.7	248388.7	460.6	460.6
<b>Point Sources</b>					70321.2	70321.2	9375.8	9375.8
<b>Septic Systems</b>					4124.2	4124.2	47.4	47.4
<b>Totals</b>	11127.1	5.10	14573.4	2118.0	329645.1	436384.8	10371.1	40053.7

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## Lititz Run Baseline Watershed Run Transport Data

Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	160	0.15	92	74
MD Mixed	271	0.52	98	79
HD Mixed	245	0.87	98	79
LD Residential	26	0.15	92	74
MD Residential	1035	0.52	92	74
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	901	75	0.295	0.5	0.03	0.45
Cropland	1270	82	0.297	0.455	0.42	0.45
Forest	270	73	0.279	0.955	0.002	0.45
Wetland	5	87	0.293	1.188	0.01	0.1
Disturbed	5	89	0.24	0.699	0.08	0.1
Turf/Golf	0	0	0.0	0.0	0.0	0.0
Open Land	315	87	0.291	0.589	0.04	0.45
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.63	1.0	9.4	0	0.12	0.0	0.0
Feb	0.68	1.0	10.4	0	0.12	0.0	0.0
Mar	0.71	1.0	11.8	0	0.3	0.0	0.0
Apr	0.85	1.0	13.2	1	0.3	0.0	0.0
May	0.93	1.0	14.3	1	0.3	0.0	0.0
Jun	0.98	1.0	14.9	1	0.3	0.0	0.0
Jul	1.01	1.0	14.6	1	0.3	0.0	0.0
Aug	1.02	1.0	13.6	1	0.3	0.0	0.0
Sep	1.03	1.0	12.2	1	0.3	0.0	0.0
Oct	1.04	1.0	10.8	1	0.12	0.0	0.0
Nov	0.92	1.0	9.7	0	0.12	0.0	0.0
Dec	0.85	1.0	9.1	0	0.12	0.0	0.0

Sediment A Factor	2.0631E-03	Values 0 - 1	
Sed A Adjustment	1.0	GW Recess Coeff	0.1
Avail Water Cap (cm)	21.141	GW Seepage Coeff	0.0
Sed Delivery Ratio	0.145	% Tile Drained (Ag)	0.0

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## Lititz Run Baseline Watershed Nutrient Data

## Lititz Watershed Baseline Watershed Animal Data

Animal Data			Daily Loads (Kg/AEU)		Fecal Coliform		Manure Data Check		
Type	Number	Average Grazing Wt. (Kg)	N	P	Orgs/ Day		% Land applied	0.8	
Dairy Cows	11159	Y 640	0.44	0.07	1.00E+11				
Beef Cows	193	Y 360	0.31	0.09	1.00E+11				
Broilers	271600	N 0.9	1.07	0.3	1.40E+08				
Layers	950000	N 1.8	0.85	0.29	1.40E+08				
Hogs/Swine	4666	N 61	0.48	0.15	1.10E+10				
Sheep	11	Y 50	0.37	0.1	1.20E+10				
Horses	108	Y 500	0.28	0.06	4.20E+08				
Turkeys	8987	N 6.8	0.59	0.2	9.50E+07				
Other	0	N 0	0	0	0.00E+00				

Initial Non-Grazing Animal Totals											
	N (Kg/Yr)	689020									
	P (Kg/Yr)	227814									
	FC (Orgs/Yr)	1.24E+15									

NON-GRAZING ANIMAL DATA												
Manure Spreading Contribution												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
% of annual load applied to crops/pasture	0.01	0.01	0.15	0.1	0.05	0.03	0.03	0.03	0.11	0.1	0.1	0.08
Base nitrogen loss rate	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Base phosphorus loss rate	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Base fecal coliform loss rate	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
% of manure load incorporated into soil	0	0	0	0	0	0	0	0	0	0	0	0

Barnyard/Confined Area Contribution												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Base nitrogen loss rate	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Base phosphorus loss rate	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Base fecal coliform loss rate	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12

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## Lititz Run Baseline Watershed Rural BMP Data

**Rural Land BMP Scenario Editor**

	<b>Hectares</b>		<b>BMP1</b>	<b>BMP2</b>	<b>BMP3</b>	<b>BMP4</b>	<b>BMP5</b>	<b>BMP6</b>	<b>BMP7</b>	<b>BMP8</b>
Row Crops	1,270	% Existing	69.0	78.0	21.0	88.0	0.0	88.0	0.0	0.0
Hay/Pasture	901	% Existing				88.0	0.0	88.0	56.0	0.0
Streams in Agricultural Areas	12.5	Km								% Existing
Total Stream Length	32.7	Km								68.0
Unpaved Road Length	0.0	Km								100
										Runoff Control
										Phytase in Feed
										Stream Km with Vegetated Buffer Strips
										Stream Km with Fencing
										Stream Km with Bank Stabilization
										Unpaved Road Km with E and S Controls
										Existing Km
										5.7
										4.2
										0.9
										0.0

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## Lititz Run Baseline Watershed Urban BMP Data

### Urban Scenario BMP Editor

#### Performance Standard Calculations

##### Retrofits

BMP Type	
Select BMP Type	
Area Treated (ha)	Existing Area (ha)
LD Residential	LD Residential 26
MD Residential	MD Residential 1035
HD Residential	HD Residential 0
LD Mixed	LD Mixed 160
MD Mixed	MD Mixed 271
HD Mixed	HD Mixed 245
<b>Total</b>	<b>Total 1737</b>

Rainfall Captured (2.54 cm = 1 in)	
Depth (cm)	Volume (m³)
2.54	0
<b>Run</b>	

Calculated Reduction Efficiency		
TN	TP	TSS
0.00	0.00	0.00

##### New Development

BMP Type	
Select BMP Type	
Area Developed (ha)	Area Replaced (ha)
LD Residential	Hay/Pasture 0
MD Residential	Cropland 0
HD Residential	Forest 0
LD Mixed	Disturbed 0
MD Mixed	Turfgrass 0
HD Mixed	Open Land 0
<b>Total</b>	<b>Total 0</b>

Rainfall Captured (2.54 cm = 1 in)	
Depth (cm)	Volume (m³)
7.10	0
<b>Run</b>	

Calculated Reduction Efficiency		
TN	TP	TSS
0.00	0.00	0.00

#### Stream Protection

Vegetative buffer strip width (m)	32.8
Fraction of streams treated (0-1)	0.12
Total streams in non-ag areas (km)	20.2
Streams w/bank stabilization (km)	1.38

#### Street Sweeping

Fraction of area treated (0-1)	1.000						
Sweep Type	<input checked="" type="radio"/> Mechanical <input type="radio"/> Vacuum						
Times/month							
Jan	0	Apr	0	Jul	0	Oct	0
Feb	0	May	0	Aug	0	Nov	0
Mar	0	Jun	0	Sep	0	Dec	0

[Rural BMP Editor](#)

[BMP Efficiency Editor](#)

[Export to JPEG](#)

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## Lititz Run Baseline Watershed Input Data

#### Attenuation

Flow Distance (km)	0.0
Flow Velocity (km/hr)	4.0

#### Loss Rate (% per day) (0 - 1)

N	0.287
P	0.226
TSS	0.000
Pathogen	0.000

#### Streamflow Volume

Adjustment Factor	1.00
-------------------	------

#### Retention

Total N	0.12
Total P	0.29
Total Sed	0.84

#### Percent Drainage

Percentage of watershed area that drains into a lake or wetlands (0 - 1)	0.00
--	------

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## Existing Stormwater BMP Model Runs

The following screen shots represent the entries into the Urban BMP Editor in the MapShed model as well as the MapShed model run results. Aside from the inputs into the Urban BMP editor, all inputs matched the Lititz Run Baseline Watershed Run.

### Warwick Township Existing Runoff Reduction BMPs Input

**Urban Scenario BMP Editor**

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## Warwick Township Existing Runoff Reduction BMPs Results

GWLF Total Loads for file: LititzRunBase\_6-27-17\_Warw Period of analysis: 21 years from 1978 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2226	2.8	741.2	69.5	624.1	876.4	138.3	208.5
Cropland	3138	4.9	13400.4	512.8	4122.7	7317.4	138.8	660.8
Forest	667	2.4	26.8	3.9	69.0	84.5	3.6	9.2
Wetland	12	7.4	0.7	0.1	3.9	4.3	0.2	0.4
Disturbed	12	8.8	2.8	0.4	0.5	2.1	0.2	0.8
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	778	7.4	401.5	58.2	648.6	881.5	13.0	96.3
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	395	3.1	0.0	2.3	39.7	122.8	5.4	13.6
MD Mixed	670	8.5	0.0	18.5	220.2	725.0	31.6	82.5
HD Mixed	605	12.0	0.0	16.7	199.1	655.5	28.6	74.6
LD Residential	64	3.1	0.0	0.4	6.4	20.0	0.9	2.2
MD Residential	2558	5.2	0.0	70.6	841.1	2769.0	120.7	315.2
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					96776.2			27272.8
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1341.6		3152.6		1397.7
<b>Groundwater</b>					248388.7	248388.7	460.6	460.6
<b>Point Sources</b>					70321.2	70321.2	9375.8	9375.8
<b>Septic Systems</b>					4124.2	4124.2	47.4	47.4
<b>Totals</b>	11127.1	5.10	14573.4	2094.9	329609.5	436221.6	10365.2	40018.5

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## Warwick Township Existing Stormwater Treatment BMPs Input

### Urban Scenario BMP Editor

Performance Standard Calculations																																																																						
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## Warwick Township Existing Stormwater Treatment BMPs Results

GWLF Total Loads for file: LititzRunBase\_6-27-17\_Warv Period of analysis: 21 years from 1978 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2226	2.8	741.2	69.5	624.1	876.4	138.3	208.5
Cropland	3138	4.9	13400.4	512.8	4122.7	7317.4	138.8	660.8
Forest	667	2.4	26.8	3.9	69.0	84.5	3.6	9.2
Wetland	12	7.4	0.7	0.1	3.9	4.3	0.2	0.4
Disturbed	12	8.8	2.8	0.4	0.5	2.1	0.2	0.8
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	778	7.4	401.5	58.2	648.6	881.5	13.0	96.3
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	395	3.1	0.0	2.3	40.6	125.7	5.5	14.0
MD Mixed	670	8.5	0.0	19.0	225.3	741.7	32.4	84.6
HD Mixed	605	12.0	0.0	17.2	203.7	670.6	29.3	76.5
LD Residential	64	3.1	0.0	0.4	6.6	20.4	0.9	2.3
MD Residential	2558	5.2	0.0	72.5	860.5	2832.8	123.7	323.0
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					96776.2			27272.8
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1355.9		3185.7		1413.2
<b>Groundwater</b>					248388.7	248388.7	460.6	460.6
<b>Point Sources</b>					70321.2	70321.2	9375.8	9375.8
<b>Septic Systems</b>					4124.2	4124.2	47.4	47.4
<b>Totals</b>	11127.1	5.10	14573.4	2112.0	329639.6	436353.5	10369.8	40046.0

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## Lititz Borough Existing Runoff Reduction BMPs Input

### Urban Scenario BMP Editor

Performance Standard Calculations																																																																						
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<b>Totals</b>	11127.1	5.10	14573.4	2115.4	329641.2	436365.4	10370.5	40049.8

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## Lititz Borough Existing Stormwater Treatment BMPs Input

### Urban Scenario BMP Editor

Performance Standard Calculations																																																																						
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## Lititz Borough Existing Stormwater Treatment BMPs Results

GWLF Total Loads for file: LititzRunBase\_6-27-17\_Lititz | Period of analysis: 21 years from 1978 to 1998

Source	Area (Acres)	Runoff (in)	Tons		Total Loads (Pounds)			
			Erosion	Sediment	Dissolved N	Total N	Dissolved P	Total P
Hay/Pasture	2226	2.8	741.2	69.5	624.1	876.4	138.3	208.5
Cropland	3138	4.9	13400.4	512.8	4122.7	7317.4	138.8	660.8
Forest	667	2.4	26.8	3.9	69.0	84.5	3.6	9.2
Wetland	12	7.4	0.7	0.1	3.9	4.3	0.2	0.4
Disturbed	12	8.8	2.8	0.4	0.5	2.1	0.2	0.8
Turfgrass	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Open Land	778	7.4	401.5	58.2	648.6	881.5	13.0	96.3
Bare Rock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sandy Areas	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LD Mixed	395	3.1	0.0	2.2	39.0	120.7	5.2	13.1
MD Mixed	670	8.5	0.0	17.5	216.4	712.5	30.3	79.2
HD Mixed	605	12.0	0.0	15.8	195.7	644.1	27.4	71.6
LD Residential	64	3.1	0.0	0.4	6.3	19.6	0.8	2.1
MD Residential	2558	5.2	0.0	66.9	826.6	2721.2	115.9	302.6
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					96776.2			27272.8
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1306.8		3071.0		1362.5
<b>Groundwater</b>					248388.7	248388.7	460.6	460.6
<b>Point Sources</b>					70321.2	70321.2	9375.8	9375.8
<b>Septic Systems</b>					4124.2	4124.2	47.4	47.4
<b>Totals</b>	11127.1	5.10	14573.4	2054.4	329586.9	436065.9	10357.7	39963.7

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## Lititz Reserve Bioswale Proposed BMP Model Input

### Urban Scenario BMP Editor

#### Performance Standard Calculations

##### Retrofits

BMP Type	
Rain Garden / Bioretention	
Area Treated (ha)	
LD Residential	0
MD Residential	0
HD Residential	0
LD Mixed	0
MD Mixed	4.38
HD Mixed	0
<b>Total</b>	<b>4</b>
Existing Area (ha)	
LD Residential	26
MD Residential	1035
HD Residential	0
LD Mixed	160
MD Mixed	271
HD Mixed	245
<b>Total</b>	<b>1737</b>

Rainfall Captured (2.54 cm = 1 in)

Depth (cm)	0.50	<b>Run</b>
Volume (m <sup>3</sup> )	114	

Calculated Reduction Efficiency

TN	0.23	TP	0.27	TSS	0.29
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##### New Development

BMP Type	
Select BMP Type	
Area Developed (ha)	
LD Residential	0
MD Residential	0
HD Residential	0
LD Mixed	0
MD Mixed	0
HD Mixed	0
<b>Total</b>	<b>0</b>
Area Replaced (ha)	
Hay/Pasture	0
Cropland	0
Forest	0
Disturbed	0
Turfgrass	0
Open Land	0
<b>Total</b>	<b>0</b>
Existing Area (ha)	
Hay/Pasture	901
Cropland	1270
Forest	270
Disturbed	5
Turfgrass	0
Open Land	315
<b>Total</b>	<b>2761</b>

Rainfall Captured (2.54 cm = 1 in)

Depth (cm)	7.10	<b>Run</b>
Volume (m <sup>3</sup> )	0	

Calculated Reduction Efficiency

TN	0.00	TP	0.00	TSS	0.00
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#### Stream Protection

Vegetative buffer strip width (m)	32.8
Fraction of streams treated (0-1)	0.120
Total streams in non-ag areas (km)	20.2
Streams w/bank stabilization (km)	1.38

#### Street Sweeping

Fraction of area treated (0-1)	1.000						
Sweep Type	<input checked="" type="radio"/> Mechanical <input type="radio"/> Vacuum						
Times/month							
Jan	0	Apr	0	Jul	0	Oct	0
Feb	0	May	0	Aug	0	Nov	0
Mar	0	Jun	0	Sep	0	Dec	0



## Lititz Reserve Bioswale Proposed BMP Model Results

GWLF Total Loads for file: LititzRunBase\_6-27-17\_LRes Period of analysis: 21 years from 1978 to 1998

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Unpaved Roads	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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MD Mixed	670	8.5	0.0	18.7	222.0	730.8	31.9	83.2
HD Mixed	605	12.0	0.0	16.9	200.7	660.7	28.8	75.3
LD Residential	64	3.1	0.0	0.4	6.5	20.1	0.9	2.2
MD Residential	2558	5.2	0.0	71.3	847.8	2791.0	121.8	318.0
HD Residential	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<b>Farm Animals</b>					96776.2			27272.8
<b>Tile Drainage</b>				0.0		0.0		0.0
<b>Stream Bank</b>				1346.4		3163.6		1402.1
<b>Groundwater</b>					248388.7	248388.7	460.6	460.6
<b>Point Sources</b>					70321.2	70321.2	9375.8	9375.8
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<b>Totals</b>	11127.1	5.10	14573.4	2100.8	329619.9	436266.7	10366.8	40027.2

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**Appendix E**  
Existing Stormwater BMP Inventory:  
Hammer Creek  
Cocalico Creek  
Little Conestoga Creek  
Conestoga River

