BUFFALO CREEK TRIBUTARIES TMDL

Union and Centre Counties

Prepared for:

Pennsylvania Department of Environmental Protection

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TMDL SUMMARIES

1. The impaired stream segments addressed by this Total Maximum Daily Load (TMDL) are located in Lewis, West Buffalo, Buffalo, and Kelly Townships in Union County, Pennsylvania. The stream segments drain approximately 5.32 square miles as part of State Water Plan subbasin 10C. The aquatic life existing uses for Buffalo Creek, including its tributaries, are cold water fisheries (25 Pa. Code Chapter 93).

2. Pennsylvania's 1998 303(d) list identified 15.46 miles within the Buffalo Creek Watershed as impaired by nutrients and sediment from agricultural and residential land use practices. The miles impaired were then increased from 15.46 miles in 1998 to 29.90 in 2002 and 33.48 on Pennsylvania's 2008 303(d) list. The 1998 listings were based on data collected prior to 1996 through the Pennsylvania Department of Environmental Protection's (PADEP's) Surface Water Monitoring Program. In order to ensure attainment and maintenance of water quality standards in the Buffalo Creek Watershed, mean annual loading for sediment will need to be limited from 138.848 to 1,292.1930 pounds per day (lbs/day) and for phosphorus from 0.3290 to 1.1170 lbs/day.

   The major components of the Buffalo Creek Watershed TMDL are summarized below.

UNTs 19042, 19041, 19039 Components	**Total Phosphorus (lbs/day)**	**Sediment (lbs/day)**
TMDL (Total Maximum Daily Load)	1.1170	471.5980
WLA (Wasteload Allocation)	-	-
MOS (Margin of Safety)	0.1117	47.1598
LA (Load Allocation)	1.0053	424.4382

UNTs 19034, 19035 Components	**Total Phosphorus (lbs/day)**	**Sediment (lbs/day)**
TMDL (Total Maximum Daily Load)	0.3290	138.9480
WLA (Wasteload Allocation)	-	-
MOS (Margin of Safety)	0.0329	13.8948
LA (Load Allocation)	0.2961	125.0532

UNTs 19005, 19006, 19007, 19008 Components	**Total Phosphorus (lbs/day)**	**Sediment (lbs/day)**
TMDL (Total Maximum Daily Load)	1.0950	462.4500
WLA (Wasteload Allocation)	-	-
MOS (Margin of Safety)	0.1095	46.2450
LA (Load Allocation)	0.9855	416.2050

Muddy Run Segment, UNT 18967 Components	**Sediment (lbs/day)**
TMDL (Total Maximum Daily Load)	304.1360
WLA (Wasteload Allocation)	-
MOS (Margin of Safety)	30.4136
LA (Load Allocation)	273.7224

UNT 18921 Components	Total Phosphorus (lbs/day)	Sediment (lbs/day)
TMDL (Total Maximum Daily Load)	0.5240	221.4260
WLA (Wasteload Allocation)	-	-
MOS (Margin of Safety)	0.0524	22.1426
LA (Load Allocation)	0.4716	199.2834

Beaver Run Components	Sediment (lbs/day)
TMDL (Total Maximum Daily Load)	1,292.1930
WLA (Wasteload Allocation)	-
MOS (Margin of Safety)	129.2193
LA (Load Allocation)	1,162.9737

3. Mean daily sediment and phosphorus loadings are estimated to range from 242.433 to 6,803.296 lbs/day and 0.342 to 1.911 lbs/day, respectively. To meet the TMDL, the sediment and phosphorus loadings will require reductions of 48 to 83 percent and 0 to 39 percent, respectively.

4. There are no point sources addressed in these TMDL segments.

5. The adjusted load allocation (ALA) is the actual portion of the load allocation (LA) distributed among nonpoint sources receiving reductions, or sources that are considered controllable. Controllable sources receiving allocations are hay/pasture, cropland, developed lands, and streambanks. The sediment and phosphorus TMDL includes a nonpoint source ALA that ranges from 124.9436 to 1,162.919 lbs/day and 0.2213 to 0.7294 lbs/day, respectively. Sediment and phosphorus loadings from all other sources, such as forested areas, were maintained at their existing levels. Allocations of sediment and phosphorus to controllable nonpoint sources, or the ALA, for the Buffalo Creek Watershed TMDL are summarized below.

UNTs 19042, 19041, 19039: Adjusted Load Allocations for Sources of Sediment and Phosphorus			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	471.5980	419.3972	11
Phosphorus	1.1170	0.7294	35

UNTs 19034, 19035: Adjusted Load Allocations for Sources of Sediment and Phosphorus			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	138.9480	124.9436	10
Phosphorus	0.3290	0.2213	33

UNTs 19005, 19006, 19007, 19008: Adjusted Load Allocations for Sources of Sediment and Phosphorus			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	462.4500	414.1230	10
Phosphorus	1.0950	0.7003	36

UNT 18921: Adjusted Load Allocations for Sources of Sediment and Phosphorus			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	221.4260	198.9544	10
Phosphorus	0.5240	0.3494	33

Muddy Run Segment, UNT 18967: Adjusted Load Allocations for Sources of Sediment			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	304.1360	273.3384	10

Beaver Run: Adjusted Load Allocations for Sources of Sediment			
Pollutant	**Current Loading (lbs/day)**	**Adjusted Load Allocation (lbs/day)**	**% Reduction**
Sediment	1,292.193	1,162.919	10

6. Ten percent of the Buffalo Creek Watershed sediment and phosphorus TMDLs were set-aside as a margin of safety (MOS). The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. The MOS for the sediment and phosphorus TMDL ranged from 13.8948 to 129.2193 lbs/day and 0.0329 to 0.1117 lbs/day, respectively.

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

WATERSHED BACKGROUND

The Buffalo Creek Watershed is approximately 133.6 square miles in area. The headwaters of Buffalo Creek are located inside the eastern border of Centre County, a few miles north of Laurelton Center, Pa. The watershed is located on the U.S. Geological Survey (USGS) 7.5 minute quadrangles of Carroll, Williamsport SE, Allenwood, Woodward, Hartleton, Mifflinburg, and Lewisburg, Pa. The stream flows east from eastern Centre County into eastern Union County, where it joins the West Branch Susquehanna River. The major tributaries to Buffalo Creek include Coal Run, North Branch Buffalo Creek, Rapid Run, Stony Run, Beaver Run, Muddy Run, Black Run, Spruce Run, and Little Buffalo Creek. The largest municipalities include Lewisburg and Mifflinburg. Smaller towns include Buffalo Crossroads, Vicksburg, Cameron, Mazeppa, Johnstown, Forest Hill, Pleasant Grove, Red Bank, and Kelly Crossroads. U.S. Route 15 travels north through Lewisburg near the mouth of Buffalo Creek. State Highway 192 travels through the majority of the watershed. State Highways 45 and 104 bisect portions of the watershed near Mifflinburg, Pa. Township routes 757 and 725 provided access to other portions of the watershed. Numerous township roads provide access to the Buffalo Creek Watershed and its tributaries.

The TMDL watershed is located within the Appalachian Mountain Section of the Ridge and Valley physiographic province. The highest elevations are located in the western portion of the watershed area on Buffalo Mountain. The total change in elevation in the watershed is approximately 1,800 feet from the headwaters to the mouth.

The majority of the rock type in the upland portions of the watershed is sandstone (45 percent), predominantly associated with the Tuscarora and Juniata Formations and Clinton Group (Figure 1). The remaining rock types found in the lowlands are shale (40 percent), predominantly associated with the Bloomsburg Formation and Mifflintown Formations Undivided and Wills Creek Formation. There is also a presence of carbonate rock type (10 percent) in the southern portion of the watershed that is associated with the Keyser Formation and Tonoloway Formation Undivided. The remaining 5 percent of the geology in the watershed consists of interbedded sedimentary.

The Hazelton-Dekalb-Buchanan series is the predominant soil type in the TMDL watershed. This soil is listed as being extremely stony to loose gravely soil and is mostly associated in the uplands of the watershed (Figure 2). Other dominant soils in the watershed consist of Berks-Weikert-Bedington, Edom-Millheim-Calvin, and Hagerstown-Duffield-Clarksburg.

Based on GIS datasets created in 2001, land use values were calculated for the TMDL watershed. Forested was the dominant land use at approximately 65 percent (Figure 3). Agriculture land uses account for approximately 28 percent of the watershed. Developed areas are 5 percent of the watershed, covering low-intensity residential, high-intensity/commercial land, and areas currently being developed. Riparian buffer zones are nearly nonexistent (Figure 4) in some of the agricultural lands. Livestock also have unlimited access to streambanks in certain parts of the watershed, resulting in streambank trampling and severe erosion (Figure 4). Little contiguous forested tracts remain in the watershed.

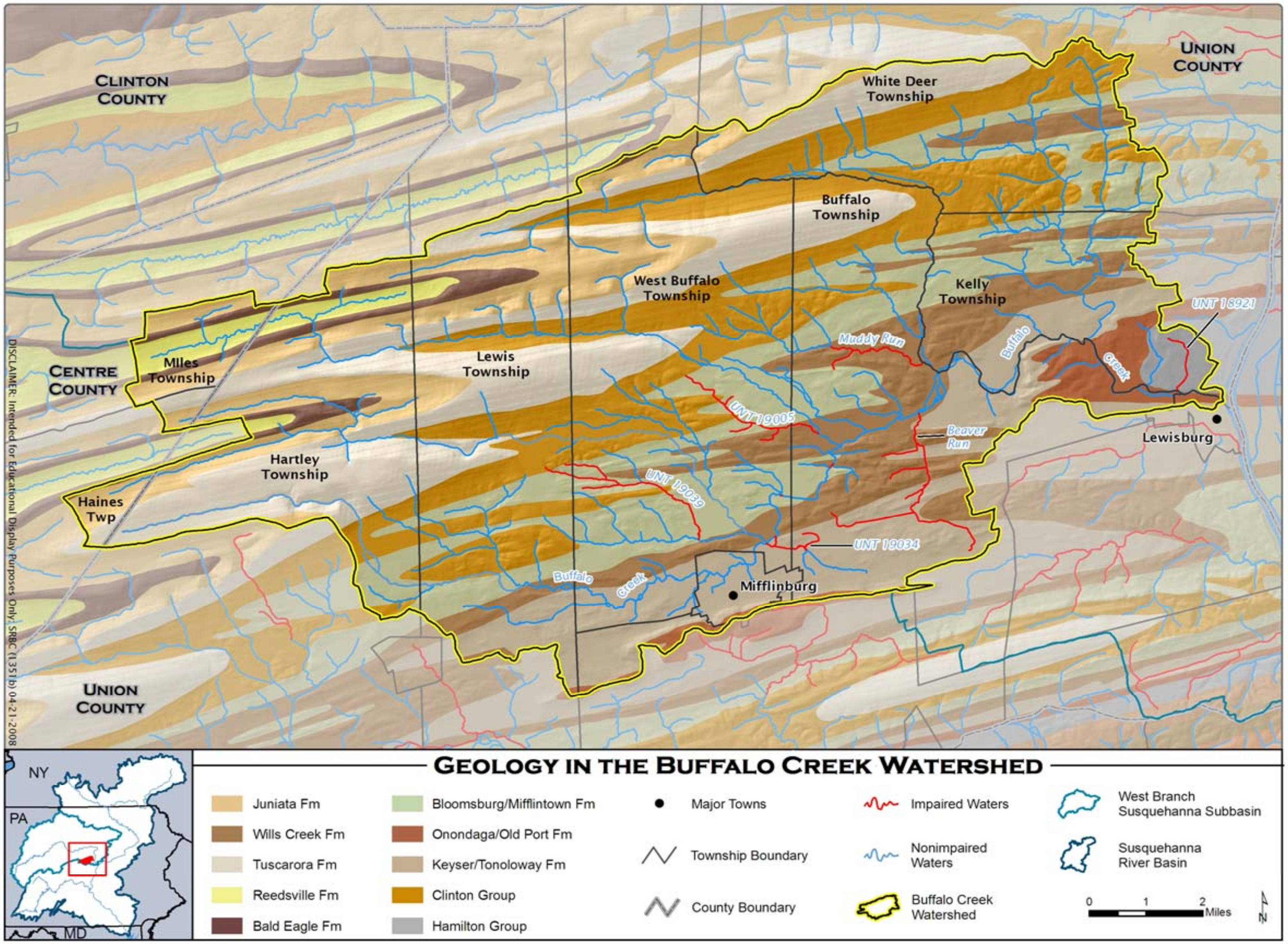

Figure 1. Geology Map of Buffalo Creek Watershed

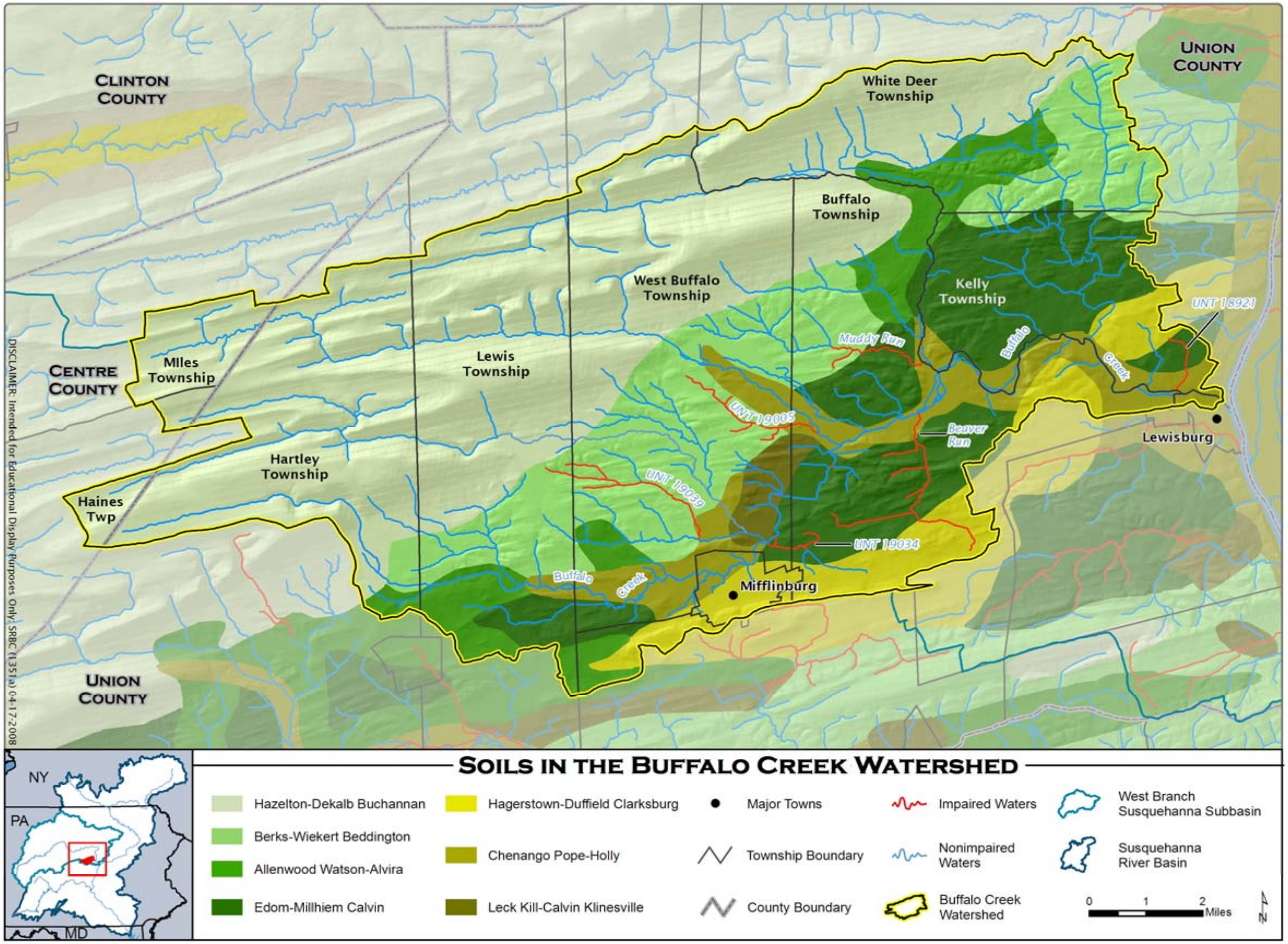

Figure 2. Soils Map of Buffalo Creek Watershed

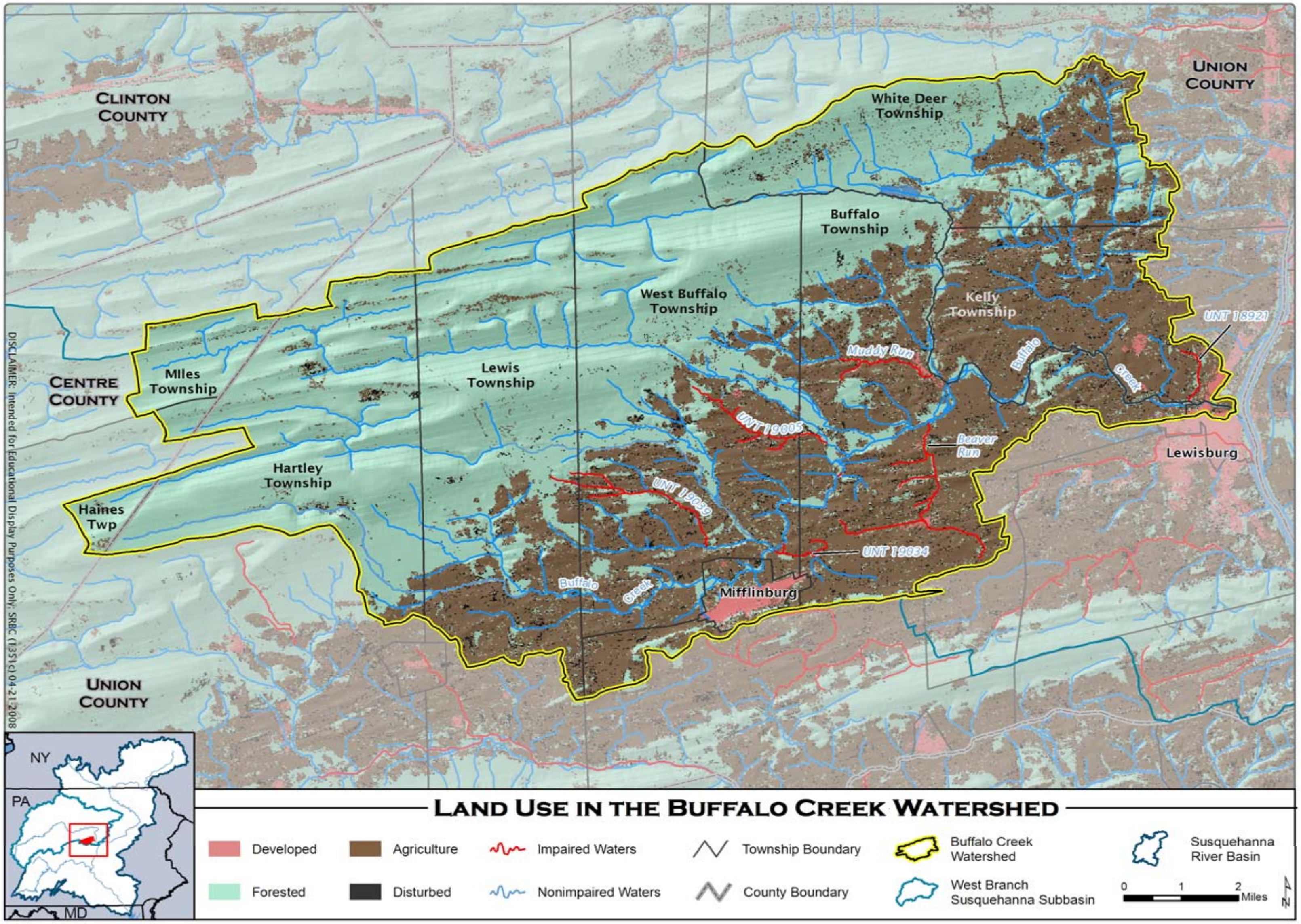

Figure 3. Land Use Map of Buffalo Creek Watershed

A

B

Figure 4. Evidence of Lack of Riparian Vegetation (A) and Streambank Erosion (B) in the Buffalo Creek Watershed

Surface Water Quality

Pennsylvania's 1998, 2002, and 2008 303(d) lists identified 33.48 miles of the Buffalo Creek Watershed as impaired by turbidity, suspended solids, and nutrients emanating from urban runoff and agricultural practices (Table 1).

Table 1. List of Impaired Stream Segments in Buffalo Creek Watershed

Segment ID	Year Listed	Stream Name	Stream Code	Source	Cause	Miles
1179	2002	UNT Buffalo Creek	18921	Small Residential Runoff	Nutrients	1.28
1159	2002	UNT Buffalo Creek	19034	Agriculture Grazing	Nutrients and Siltation	0.68
1159	2002	UNT Buffalo Creek	19035	Agriculture Grazing	Nutrients and Siltation	0.68
1025	2002	UNT Coal Run	19039	Agriculture Grazing	Nutrients and Siltation	3.54
1025	2002	UNT Coal Run	19041	Agriculture Grazing	Nutrients and Siltation	0.67
1025	2002	UNT Coal Run	19042	Agriculture Grazing	Nutrient and Siltation	0.89
8373	1998	Muddy Run	18966	Agriculture	Siltation	7.94
0932	2002	Muddy Run	18966	Agriculture Grazing	Siltation	2.03
0932	2002	UNT Muddy Run	18967	Agriculture Grazing	Siltation	0.56
14157	2008	UNT Beaver Run	18995	Agriculture	Siltation	0.76
14157	2008	UNT Beaver Run	18996	Agriculture	Siltation	0.72
14157	2008	UNT Beaver Run	18997	Agriculture	Siltation	0.07
64983	2008	UNT Beaver Run	64983	Agriculture	Siltation	1.68
1286	2002	UNT Rapid Run	19005	Agriculture Grazing	Nutrients and Siltation	2.96
1286	2002	UNT Rapid Run	19006	Agriculture Grazing	Nutrients and Siltation	0.48
1286	2002	UNT Rapid Run	19007	Agriculture Grazing	Nutrients and Siltation	0.45
1286	2002	UNT Rapid Run	19008	Agriculture Grazing	Nutrients and Siltation	0.22

In general, soil erosion is a major problem in the Buffalo Creek Watershed. Unrestricted access of livestock to streams results in trampled streambanks, excessive stream sedimentation, increased nutrient levels, and sparse streamside buffers and riparian vegetation. Large areas of row crops and use of conventional tillage, as well as unrestricted cattle access to streams, combine to leave the soil vulnerable to erosion. Many of the streams in the subbasin are extremely muddy for several days after summer thunderstorms. The resulting high sediment can make water unfit to drink, smother aquatic life and fish eggs, clog fish gills, and block sunlight into the creeks and rivers. Most highways and major roads in the subbasin are overcrowded and are being expanded and upgraded. Runoff from road construction also can be an additional, although temporary, source of stream sedimentation and increased nutrient levels.

APPROACH TO TMDL DEVELOPMENT

Pollutants & Sources

Nutrients and sediment have been identified as the pollutants causing designated use impairments in the Buffalo Creek Watershed TMDL, with the sources listed as agricultural and small residential activities. At present, there are no point source contributions within the segments addressed in these TMDLs.

As stated in previous sections, the land use is dominantly agriculture. Pasture and croplands extend right up to the streambanks with little to no riparian buffer zones present. Livestock have unlimited access to streambanks throughout most of the watershed. Based on visual observations, streambank erosion is severe in most reaches of the streams.

TMDL Endpoints

In an effort to address the sediment and nutrients problem found in the Buffalo Creek Watershed, a TMDL was developed to establish loading limits for sediment and nutrients. The TMDL is intended to address sediment and nutrient impairments from developed land uses that were first identified in Pennsylvania's 1998 303(d) list, as well as other nonpoint sources such as agriculture. The decision to use phosphorus load reductions to address nutrient enrichment is based on an understanding of the relationship between nitrogen, phosphorus, and organic enrichment in stream systems. Elevated nutrient loads from human activities (nitrogen and phosphorus in particular) can lead to increased productivity of aquatic plants and other organisms, resulting in the degradation of water quality conditions through the depletion of dissolved oxygen in the water column (Novotny and Olem, 1994; Hem, 1983). In aquatic ecosystems the quantities of trace elements are typically plentiful; however, nitrogen and phosphorus may be in short supply. The nutrient that is in the shortest supply is called the limiting nutrient because its relative quantity affects the rate of production (growth) of aquatic biomass. If the limiting nutrient load to a waterbody can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control the eutrophication processes in waterbodies, emphasis is placed on the limiting nutrient. However, this is not always the case. For example, if nitrogen is the limiting nutrient, it still may be more efficient to control phosphorus loads if the nitrogen originates from difficult to control sources, such as nitrates in groundwater.

In most freshwater systems, phosphorus is the limiting nutrient for aquatic growth. In some cases, however, the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of nitrogen to the amount of phosphorus is often used to make this determination (Thomann and Mueller, 1987). If the nitrogen/phosphorus (N/P) ratio is less than 10, nitrogen is limiting. If the N/P ratio is greater than 10, phosphorus is the limiting nutrient. For the Buffalo Creek watershed, the average N/P ratio is approximately 36, which indicates to phosphorus as the limiting nutrient. Controlling the phosphorus loading to the Buffalo Creek watershed will limit plant growth, thereby helping to eliminate use impairments currently being caused by excess nutrients.

Reference Watershed Approach

The TMDL developed for the Buffalo Creek Watershed addresses sediment and nutrients. Because neither Pennsylvania nor the U.S. Environmental Protection Agency (USEPA) has instream numerical water quality criteria for sediment and phosphorus, a method was developed to implement the applicable narrative criteria. The method for these types of TMDLs is termed the "Reference Watershed Approach." Meeting the water quality objectives specified for this TMDL will result in the impaired stream segment attaining its designated uses.

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

Selection of the Reference Watershed

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that the PADEP has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology/soils. Finally, the size of the reference watershed should be within 20-30 percent of the impaired watershed area. The search for a reference watershed for the Buffalo Creek Watershed to satisfy the above characteristics was done by means of a desktop screening using several GIS coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land cover/use grid, the Pennsylvania's streams database, and geologic rock types.

UNT 18925 was selected as the reference watershed for developing the Buffalo Creek Watershed TMDL. UNT 18925 is located just north of Kelly Point, in Union County, Pa. (Figure 5). The watershed is located in State Water Plan subbasin 10C, a tributary to the Little Buffalo Creek, and protected uses include aquatic life and recreation. The tributary is currently designated as a Cold Water Fishery (25 Pa. Code Chapter 93). Based on PADEP assessments, UNT 18925 is currently attaining its designated uses. The attainment of designated uses is based on sampling done by PADEP in 1997, as part of its State Surface Water Assessment Program.

Drainage area, location, and other physical characteristics of the impaired segments of the Buffalo Creek Watershed were compared to the UNT 18925 watershed (Table 2). Agricultural land is the dominant land use category in all the impaired segments of the Buffalo Creek Watershed (58-83 percent) and UNT 18925 (88 percent). The geology, soils, and precipitation in both are also similar (Table 2).

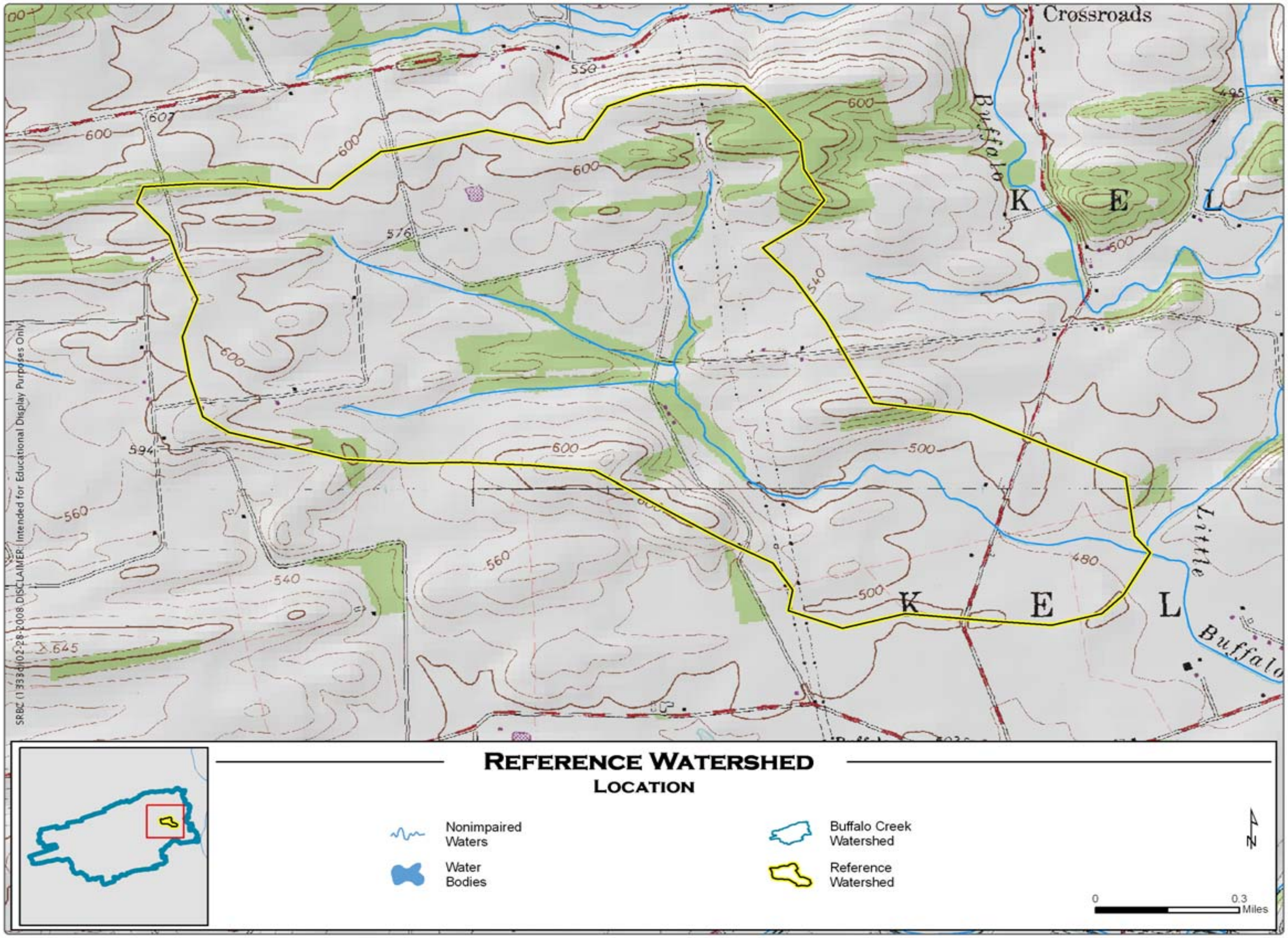

Figure 5. Location Map for Reference Watershed UNT 18925

Table 2. Comparison between Impaired Segments of Buffalo Creek and UNT 18925 Watershed

Attribute	Watershed	
	Impaired Segments*	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	0.47-4.55	1.25
Land Use	Agriculture (58.64-88.99%) Development (6.32-13.94%) Forested (0.00-34.31%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (5-50%) Bloomsburg and Mifflintown Formation (70-80%) Keyser and Tonoloway Formation (0-90%) Clinton Group (0-15%) Hamilton Group (0-100%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Berks-Weikert-Bedington (50-90%) Edom-Millheim-Calvin (45-100%) Chenango-Pope-Holly (5-40%) Leck Kill-Calvin-Klinesville (0-5%) Hagerstown-Duffield-Clarksburg (0-25%) Hazelton-Dekalb-Buchanan (0-2%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Berks-Weikert-Bedington A (0%) B (13%) C (52%) D (35%) Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%) Leck Kill-Calvin-Klinesville A (0%) B (32%) C (44%) D (24%) Hagerstown-Duffield-Clarksburg A (0%) B (36%) C (60%) D (4%) Hazelton-Dekalb-Buchanan A (2%) B (45%) C (53%) D (0%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)

Table 2. Comparison between Impaired Segments of Buffalo Creek and UNT 18925 Watersheds (continued)

K Factor	Berks-Weikert-Bedington (0.24) Edom-Millheim-Calvin (0.28) Chenango-Pope-Holly (0.30) Leck Kill-Calvin-Klinesville (0.23) Hagerstown-Duffield-Clarksburg (0.32) Hazelton-Dekalb-Buchanan (0.18)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	44.5-46.5	44.5
20-Yr. Ave. Runoff (in)	0.29-0.37	0.34

*Please refer to Attachment C for specific information on individual watershed.

WATERSHED ASSESSMENT AND MODELING

The TMDL for the impaired segments of the Buffalo Creek Watershed was developed using the ArcView Generalized Watershed Loading Function model (AVGWLF) as described in Attachment D. The AVGWLF model was used to establish existing loading conditions for the impaired segments of the Buffalo Creek Watershed and the UNT 18925 reference watershed. All modeling inputs have been attached to this TMDL as Attachments E and F. SRBC staff visited the watershed in the winter and spring of 2008. The field visits were conducted to get a better understanding of existing conditions that might influence the AVGWLF model. General observations of the individual watershed characteristics include:

UNT 18925 Watershed

- Reset P factor for cropland (0.52) and hay/pasture (0.52) land uses to 0.08 and transitional (0.80) to 0.13, while forested remained at 0.52. These changes were made to account for the pervasiveness of riparian buffer zones, streambank fencing, and stable streambanks.
- Analysis was completed with both offsite and onsite observations to justify the need for reductions in the P factor.
- C factors remained the same.

The AVGWLF model produced information on watershed size, land use, nutrients, and sediment loading. The nutrient and sediment loads represent an annual average over a 23-year period, from 1976 to 1998, and for the Buffalo Creek and UNT 18925 watersheds, respectively. This information was then used to calculate existing unit area loading rates for Muddy Run segment; Beaver Run; UNT 19039, 19034, 19005, and 18921 watersheds; and UNT 18925 reference watershed. Acreage, sediment, and phosphorus loading information for both the impaired watershed and the reference watershed are shown in Tables 3, 4, and 5, respectively.

Table 3. Land Use Comparisons in Acres

Land Use	UNT 18925	Muddy Run Seg.	UNT 18921	UNT 19005	UNT 19034	UNT 19039	Beaver Run
HAY/PAST	185.30	200.20	98.80	286.60	79.10	219.90	588.10
CROPLAND	516.40	323.70	252.00	467.00	170.50	375.60	1,887.90
FOREST	39.50	54.40	34.60	143.30	12.40	348.40	-
WETLAND	-	9.90	24.70	-	12.40	4.90	9.90
UNPAVED_RD	-	2.50	-	2.50	2.50	2.50	2.50
TRANSITION	56.80	39.50	19.80	76.60	19.80	64.20	12.40
LO_INT_DEV	-	24.70	22.20	7.40	2.50	-	281.70
HI_INT_DEV	-	-	24.70	-	-	-	-
TOTAL	798.00	654.90	476.80	995.80	299.20	1,015.50	2,782.50

Table 4. Existing Sediment Loads and Yields

Land use	UNT 18925 (lbs/day) (lbs/ac/day)	Muddy Run Seg. (lbs/day) (lbs/ac/day)	UNT 18921 (lbs/day) (lbs/ac/day)	UNT 19005 (lbs/day) (lbs/ac/day)	UNT 19034 (lbs/day) (lbs/ac/day)	UNT 19039 (lbs/day) (lbs/ac/day)	Beaver Run (lbs/day) (lbs/ac/day)
HAY/PAST	2.2329 0.0174	22.3562 0.1117	8.7671 0.0887	66.9589 0.2336	5.7534 0.0727	39.0685 0.1777	164.8767 0.2804
CROPLAND	200.4932 0.3883	519.1233 1.6037	345.6986 1.3718	1,517.7534 3.2500	161.4247 0.9468	510.8493 1.3601	5,983.7260 3.1695
FOREST	0.2740 0.0069	0.3288 0.0060	0.2192 0.0063	2.0274 0.0141	0.0547 0.0044	5.0411 0.0145	- -
WETLAND	- -	0.0548 0.0055	0.1096 0.0044	0.0548 0.0044	0.0547 0.0044	- -	0.0548 0.0055
UNPAVED_RD	- -	8.6027 3.4411	- -	12.9315 5.1726	3.1233 1.2493	8.4932 3.3973	11.1233 4.4493
TRANSITION	81.7534 1.4393	175.5068 4.4432	72.3288 3.6530	619.7808 8.0911	48.1644 2.4325	637.8630 9.9356	84.7671 6.8361
LO_INT_DEV	- -	8.2740 0.3350	1.5890 0.0716	1.5342 0.2073	0.1096 0.0438	- -	90.4110 0.3209
HI_INT_DEV	- -	- -	1.8082 0.0732	- -	- -	- -	- -
Streambank	84.8017 -	68.3842 -	33.1567 -	137.5635 -	23.7488 -	156.3932 -	468.3369 -
TOTAL	370.5551 0.4644	802.6308 1.2256	463.6773 0.9725	2,358.6045 2.3686	242.4336 0.8103	1,357.7082 1.3370	6,803.2958 2.4450

Table 5. Existing Phosphorus Loads and Yields

Land use	UNT 18925 (lbs/day) (lbs/ac/day)	UNT 18921 (lbs/day) (lbs/ac/day)	UNT 19005 (lbs/day) (lbs/ac/day)	UNT 19034 (lbs/day) (lbs/ac/day)	UNT 19039 (lbs/day) (lbs/ac/day)
HAY/PAST	0.0805 0.0004	0.0482 0.0005	0.1539 0.0005	0.0352 0.0004	0.1042 0.0005
CROPLAND	0.4879 0.0009	0.4276 0.0017	1.0841 0.0023	0.1901 0.0011	0.4324 0.0012
FOREST	0.0005 0.0000	0.0004 0.0000	0.0022 0.0000	0.0001 0.0000	0.0045 0.0000
WETLAND	- -	0.0007 0.0000	0.0004 0.0000	0.0004 0.0000	0.0001 0.0000
UNPAVED_RD	- -	- -	0.0085 0.0034	0.0035 0.0019	0.0049 0.0020
TRANSITION	0.0954 0.0017	0.0681 0.0034	0.3714 0.0048	0.0376 0.0019	0.2620 0.0041
LO_INT_DEV	- -	0.0000 0.0000	0.0000 0.0000	0.0000 0.0000	- -
HI_INT_DEV	- -	0.0001 0.0000	- -	- -	- -
Streambank	0.0019 0.0000	0.0007 0.0000	0.0030 0.0000	0.0005 0.0000	0.0035 0.0000
Groundwater	0.2335 0.0000	0.1162 0.0000	0.2826 0.0000	0.0743 0.0000	0.2663 0.0000
Point Source	- -	- -	- -	- -	- -
Septic Systems	0.0050 0.0000	0.0049 0.0000	0.0050 0.0000	0.0050 0.0000	0.0050 0.0000
TOTAL	0.9046 0.0011	0.6670 0.0014	1.9111 0.0019	0.3417 0.0011	1.0829 0.0011

TMDLS

The targeted TMDL value for the Buffalo Creek Watershed was established based on current loading rates for sediment and phosphorus in the UNT 18925 reference watershed. Biological assessments have determined that UNT 18925 is currently attaining its designated uses. Reducing the loading rate of sediment and phosphorus in the Buffalo Creek Watershed to levels equivalent to those in the reference watershed will provide conditions favorable for the reversal of current use impairments.

Background Pollutant Conditions

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

Targeted TMDLs

The targeted TMDL value for sediment and phosphorus was determined by multiplying the total area of the UNT 19039 watershed (1,015.5 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 6). The existing mean annual loading of sediment and phosphorus to UNT 19039 (1,357.7082 lbs/day and 1.0829 lbs/day, respectively) will need to be reduced by 65 percent and 0 percent, respectively, to meet the targeted TMDL of 471.5982 lbs/day and 1.1171 lbs/day, respectively.

Table 6. Targeted TMDL for the UNT 19039 Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for UNT 19039 (lbs/day)
Sediment	1,015.5	0.4644	471.5982
Phosphorus	1,015.5	0.0011	1.1171

The targeted TMDL value for sediment and phosphorus was determined by multiplying the total area of the UNT 19034 watershed (299.2 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 7). The existing mean annual loading of sediment and phosphorus to UNT 19034 (242.4337 lbs/day and 0.3417 lbs/day, respectively) will need to be reduced by 43 percent and 4 percent, respectively, to meet the targeted TMDL of 138.9485 lbs/day and 0.3291 lbs/day, respectively.

Table 7. Targeted TMDL for the UNT 19034 Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for UNT 19034 (lbs/day)
Sediment	299.2	0.4644	138.9485
Phosphorus	299.2	0.0011	0.3291

The targeted TMDL value for sediment and phosphorus was determined by multiplying the total area of the UNT 19005 watershed (995.8 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 8). The existing mean annual loading of sediment and phosphorus to UNT 19005 (2,358.6045 lbs/day and 1.9110 lbs/day, respectively) will need to be reduced by 80 percent and 43 percent, respectively, to meet the targeted TMDL of 462.45 lbs/day and 1.0954 lbs/day, respectively.

Table 8. Targeted TMDL for the UNT 19005 Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for UNT 19005 (lbs/day)
Sediment	995.8	0.4644	462.4500
Phosphorus	995.8	0.0011	1.0954

The targeted TMDL value for sediment and phosphorus was determined by multiplying the total area of the UNT 18921 watershed (476.8 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 9). The existing mean annual loading of sediment and phosphorus to UNT 18921 (463.6773 lbs/day and 0.6670 lbs/day, respectively) will need to be reduced by 53 percent and 21 percent, respectively, to meet the targeted TMDL of 221.4259 lbs/day and 0.5245 lbs/day, respectively.

Table 9. Targeted TMDL for the UNT 18921 Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for UNT 18921 (lbs/day)
Sediment	476.8	0.4644	221.4259
Phosphorus	476.8	0.0011	0.5245

The targeted TMDL value for sediment was determined by multiplying the total area of the Muddy Run segment watershed (654.9 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 10). The existing mean annual loading of sediment to UNT Muddy Run (802.6307 lbs/day) will need to be reduced by 62 percent to meet the targeted TMDL of 304.1356 lbs/day.

Table 10. Targeted TMDL for the Muddy Run Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for Muddy Run (lbs/day)
Sediment	654.9	0.4644	304.1356

The targeted TMDL value for sediment was determined by multiplying the total area of the Beaver Run segment watershed (2,782.5 acres) by the appropriate unit-area loading rate for the UNT 18925 reference watershed (Table 11). The existing mean annual loading of sediment to UNT Muddy Run (6,803.2958 lbs/day) will need to be reduced by 81 percent to meet the targeted TMDL of 1,292.1930 lbs/day.

Table 11. Targeted TMDL for the Beaver Run Watershed

Pollutant	Area (ac)	Unit Area Loading Rate UNT 18925 Reference Watershed (lbs/ac/day)	Targeted TMDL for Beaver Run (lbs/day)
Sediment	2,782.5	0.4644	1,292.1930

Targeted TMDL values were used as the basis for load allocations and reductions in the Buffalo Creek Watershed, using the following two equations:

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

where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (point sources)
LA = Load Allocation (nonpoint sources)
ALA = Adjusted Load Allocation
LNR = Loads not Reduced

Margin of Safety

The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDLs for sediment and phosphorus were reserved as the MOS. Using 10 percent of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of Muddy Run, Beaver Run, UNTs 19039, 19034, 19005, and 18921 watersheds. The MOS used for the sediment and phosphorus TMDLs is shown below.

UNT 19039:
MOS (sediment) = 471.598 lbs/day (TMDL) x 0.1 = 47.160 lbs/day
MOS (phosphorus) = 1.117 lbs/day (TMDL) x 0.1 = 0.112 lbs/day

UNT 19034:
MOS (sediment) = 138.948 lbs/day (TMDL) x 0.1 = 13.895 lbs/day
MOS (phosphorus) = 0.329 lbs/day (TMDL) x 0.1 = 0.033 lbs/day

UNT 19005:
MOS (sediment) = 462.450 lbs/day (TMDL) x 0.1 = 46.245 lbs/day
MOS (phosphorus) = 1.095 lbs/day (TMDL) x 0.1 = 0.110 lbs/day

UNT 18921:
MOS (sediment) = 221.426 lbs/day (TMDL) x 0.1 = 22.143 lbs/day
MOS (phosphorus) = 0.524 lbs/day (TMDL) x 0.1 = 0.052 lbs/day

Muddy Run segment:
MOS (sediment) = 304.136 lbs/day (TMDL) x 0.1 = 30.414 lbs/day

Beaver Run Watershed:
MOS (sediment) = 1,292.193 lbs/day (TMDL) x 0.1 = 129.219 lbs/day

Adjusted Load Allocation

The ALA is the actual portion of the LA distributed among those nonpoint sources receiving reductions. It is computed by subtracting those nonpoint source loads that are not being considered for reductions (loads not reduced or LNR) from the LA. Sediment reductions were made to the hay/pasture, cropland, developed areas (sum of LO_INT_DEV, HI_INT_DEV, UNPAVED ROADS, QUARRY, TRANSITION), and streambanks. Those land uses/sources for which existing loads were not reduced (FOREST, WETLANDS, Groundwater, and Septic Systems) were carried through at their existing loading values (Tables 12-17).

Table 12. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19039

	Phosphorus (lbs/day)	**Sediment (lbs/day)**
Load Allocation	1.0050	471.5980
Loads not Reduced	0.2759	5.0410
FOREST	0.0045	5.0410
WETLANDS	0.0001	0.0000
Groundwater	0.2663	0.0000
Septic Systems	0.0050	0.0000
Adjusted Load Allocation	0.7291	466.5570

Table 13. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19034

	Phosphorus (lbs/day)	**Sediment (lbs/day)**
Load Allocation	0.3290	138.9480
Loads not Reduced	0.0748	0.1096
FOREST	0.0001	0.0548
WETLANDS	0.0004	0.0548
Groundwater	0.0743	0.0000
Septic Systems	0.0000	0.0000
Adjusted Load Allocation	0.2542	138.8384

Table 14. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19005

	Phosphorus (lbs/day)	**Sediment (lbs/day)**
Load Allocation	1.0950	462.4500
Loads not Reduced	0.2852	2.0820
FOREST	0.0022	2.0270
WETLANDS	0.0004	0.0550
Groundwater	0.2826	0.0000
Septic Systems	0.0050	0.0000
Adjusted Load Allocation	0.8098	460.3680

Table 15. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 18921

	Phosphorus (lbs/day)	Sediment (lbs/day)
Load Allocation	0.5240	221.4260
Loads not Reduced	0.1222	0.3290
FOREST	0.0004	0.2190
WETLANDS	0.0007	0.1100
Groundwater	0.1162	0.0000
Septic Systems	0.0049	0.0000
Adjusted Load Allocation	0.4018	221.0970

Table 16. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Muddy Run Segment

	Sediment (lbs/day)
Load Allocation	304.1360
Loads not Reduced	0.3840
FOREST	0.3290
WETLANDS	0.0550
Groundwater	0.0000
Septic Systems	0.0000
Adjusted Load Allocation	303.7520

Table 17. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Beaver Run Watershed

	Sediment (lbs/day)
Load Allocation	1,292.1930
Loads not Reduced	0.0548
WETLANDS	0.0548
Groundwater	0.0000
Septic Systems	0.0000
Adjusted Load Allocation	1,292.1382

TMDLs

The sediment and phosphorus TMDLs established for the Muddy Run, Beaver Run, UNTs 19039, 19034, 19005, and 18921 watersheds consist of a LA, ALA, and MOS. The individual components of the TMDL are summarized in Tables 18-23.

Table 18. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19039

Component	Phosphorus (lbs/day)	Sediment (lbs/day)
TMDL (Total Maximum Daily Load)	1.1170	471.5980
MOS (Margin of Safety)	0.1117	47.1598
LA (Load Allocation)	1.0053	424.4382
LNR (Loads not Reduced)	0.2759	5.0410
ALA (Adjusted Load Allocation)	0.7294	419.3972

Table 19. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19034

Component	Phosphorus (lbs/day)	Sediment (lbs/day)
TMDL	0.3290	138.9480
MOS	0.0329	13.8948
LA	0.2961	125.0532
LNR	0.0748	0.1096
ALA	0.2213	124.9436

Table 20. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 19005

Component	Phosphorus (lbs/day)	Sediment (lbs/day)
TMDL	1.0950	462.4500
MOS	0.1095	46.2450
LA	0.9855	416.2050
LNR	0.2852	2.0820
ALA	0.7003	414.1230

Table 21. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for UNT 18921

Component	Phosphorus (lbs/day)	Sediment (lbs/day)
TMDL	0.5240	221.4260
MOS	0.0524	22.1426
LA	0.4716	199.2834
LNR	0.1222	0.3290
ALA	0.3494	198.9544

Table 22. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Muddy Run Segment

Component	Sediment (lbs/day)
TMDL	304.1360
MOS	30.4136
LA	273.7224
LNR	0.3840
ALA	273.3384

Table 23. Load Allocations, Loads not Reduced, and Adjusted Load Allocation for Beaver Run Watershed

Component	Sediment (lbs/day)
TMDL	1,292.1930
MOS	129.2193
LA	1,162.9737
LNR	0.0548
ALA	1,162.9189

CALCULATION OF SEDIMENT AND PHOSPHORUS LOAD REDUCTIONS

The ALA established in the previous section represents the rate of sediment load that is available for allocation between contributing sources in the Muddy Run segment, Beaver Run, UNTs 19039, 19034, 19005, and 18921 watersheds. The ALA for sediment and phosphorus was allocated between agriculture, developed areas, and streambanks. LA and reduction procedures were applied to the entire Muddy Run segment, Beaver Run, UNTs 19039, 19034, 19005, and 18921 watersheds using the Equal Marginal Percent Reduction (EMPR) allocation method (Attachment G). The LA and EMPR procedures were performed using MS Excel, and results are presented in Attachment H.

In order to meet the sediment and phosphorus TMDL, the load currently emanating from controllable sources must be reduced (Tables 18-23). This can be achieved through reductions in current sediment and phosphorus loadings from cropland, from hay/pasture, developed areas, and streambanks (Tables 24-29).

Table 24. Sediment and Phosphorus Load Allocations and Reductions for UNT 19039

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	219.90	0.1777	0.0720	39.0680	15.8423	59
Cropland	375.60	1.3601	0.4528	510.8490	170.0683	67
Developed	66.70	9.6905	2.5498	646.3560	170.0683	74
Streambanks	-	-	-	156.3930	63.4184	59
Total	-	-	-	1,352.6660	419.3974	69
Phosphorus						
Hay/Pasture	219.90	0.0005	0.0005	0.1042	0.1042	0
Cropland	375.60	0.0012	0.0012	0.4324	0.4324	0
Developed	66.70	0.0040	0.0040	0.2669	0.2669	0
Streambanks	-	-	-	0.0035	0.0035	0
Total	-	-	-	0.8070	0.8070	0

Table 25. Sediment and Phosphorus Load Allocations and Reductions for UNT 19034

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	79.10	0.0727	0.0441	5.7534	3.4922	39
Cropland	170.50	0.9468	0.4448	161.4247	75.8392	53
Developed	24.80	2.0725	1.2580	51.3973	31.1974	39
Streambanks	-	-	-	23.7488	14.4152	39
Total	-	-	-	242.3242	124.9440	48
Phosphorus						
Hay/Pasture	79.10	0.0004	0.0004	0.0352	0.0352	0
Cropland	170.50	0.0011	0.0011	0.1901	0.1901	0
Developed	24.80	0.0017	0.0017	0.0411	0.0411	0
Streambanks	-	-	-	0.0005	0.0005	0
Total	-	-	-	0.2669	0.2669	0

Table 26. Sediment and Phosphorus Load Allocations & Reductions for UNT 19005

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	286.60	0.2336	0.0937	66.9590	26.8495	60
Cropland	467.00	3.2500	0.3556	1,517.7530	166.0563	89
Developed	86.50	7.3323	1.9197	634.2470	166.0563	74
Streambanks	-	-	-	137.5630	55.1605	60
Total	-	-	-	2,356.5220	414.1226	82
Phosphorus						
Hay/Pasture	286.60	0.0005	0.0003	0.1539	0.0996	35
Cropland	467.00	0.0023	0.0014	1.0841	0.6360	41
Developed	86.50	0.0044	0.0028	0.3799	0.2457	35
Streambanks	-	-	-	0.0030	0.0019	35
Total	-	-	-	1.6209	0.9832	39

Table 27. Sediment and Phosphorus Load Allocations and Reductions for UNT 18921

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	98.80	0.1108	0.0696	8.7670	5.5092	37
Cropland	252.00	2.0276	0.7333	345.6990	125.0230	64
Developed	66.70	3.0535	1.9188	75.7260	47.5863	37
Streambanks	-	-	-	33.1570	20.8359	37
Total	-	-	-	463.3490	198.9543	57
Phosphorus						
Hay/Pasture	98.80	0.0005	0.0004	0.0482	0.0417	14
Cropland	252.00	0.0017	0.0015	0.4276	0.3697	14
Developed	66.70	0.0010	0.0009	0.0682	0.0590	14
Streambanks	-	-	-	0.0007	0.0006	14
Total	-	-	-	0.5447	0.4709	14

Table 28. Sediment Load Allocations and Reductions for Muddy Run Segment

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	200.20	0.1117	0.0549	22.3560	10.9814	51
Cropland	323.70	1.6037	0.4148	519.1230	134.2655	74
Developed	66.70	2.8843	1.4168	192.3840	94.5004	51
Streambanks	-	-	-	68.3840	33.5907	51
Total	-	-	-	802.2470	273.3380	66

Table 29. Sediment Load Allocations and Reductions for Beaver Run Watershed

Pollutant Source	Acres	Unit Area Loading Rate (lbs/ac/day)		Pollutant Loading (lbs/day)		% Reduction
		Current	Allowable	Current	Allowable (LA)	
Sediment						
Hay/Pasture	588.10	0.2804	0.1645	164.8767	96.7186	41
Cropland	1,887.90	3.1695	0.3613	5,983.7260	682.1817	89
Developed	296.60	0.6281	0.3685	186.3014	109.2866	41
Streambanks	-	-	-	468.3369	274.7319	41
Total	-	-	-	6,803.2410	1,162.9187	83

CONSIDERATION OF CRITICAL CONDITIONS

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

CONSIDERATION OF SEASONAL VARIATIONS

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

RECOMMENDATIONS FOR IMPLEMENTATION

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Buffalo Creek Watershed TMDL identifies the necessary overall load reductions for sediment and phosphorus currently causing use impairments and distributes those reduction goals to the appropriate nonpoint sources. Reaching the reduction goals established by this TMDL will only occur through Best Management Practices (BMPs). BMPs that would be helpful in lowering the amounts of sediment and phosphorus reaching Buffalo Creek include the following: streambank stabilization and fencing; riparian buffer strips; strip cropping; conservation tillage; stormwater retention wetlands; and heavy use area protection, among many others.

The Buffalo Creek watershed is one area where an enormous amount of restoration progress has been made prior to development of the TMDL. Many of the recommended BMPs mentioned in the previous paragraph have been implemented in various parts of the watershed already, and there are a number of ongoing efforts aimed at expanding BMP coverage. The Buffalo Creek Watershed Alliance (BCWA), with a membership ranging from local citizens to the local government and business groups, has been a primary proponent of these watershed restoration efforts.

Since 2002, BCWA has been involved in various restoration projects in the Buffalo Creek Watershed. They have spearheaded several riparian vegetation plantings along degraded stretches of streambank to decrease the amount of runoff and improve bank stabilization. In 2007, BCWA partnered with Union County Conservation District to hire an Agricultural Specialist to identify and inventory the extent of BMPs on agriculturally impaired segments of the Buffalo Creek Watershed. BCWA also maintains seven sampling sites along the Buffalo Creek mainstem to record water quality changes in the watershed.

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

By developing a sediment and phosphorus TMDL for the Buffalo Creek Watershed, PADEP continues to support design and implementation of restoration plans to correct current use impairments. PADEP welcomes local efforts to support watershed restoration plans. For more information about this TMDL, interested parties should contact the appropriate watershed manager in PADEP's Northcentral Regional Office (570-327-3636).

PUBLIC PARTICIPATION

A notice of availability for comments on the draft Buffalo Creek Watershed TMDL was published in the Pa. Bulletin on February 7, 2009 and *The Standard Journal* newspaper on February 24, 2009 to foster public comment on the allowable loads calculated. A public meeting was held on March 4, 2009, at the Bucknell University to discuss the proposed TMDL. The public participation process (which ended on April 23, 2009) was provided for the submittal of comments. Comments and responses are summarized in Attachment I.

Notice of final TMDL approval will be posted on the PADEP's web site.

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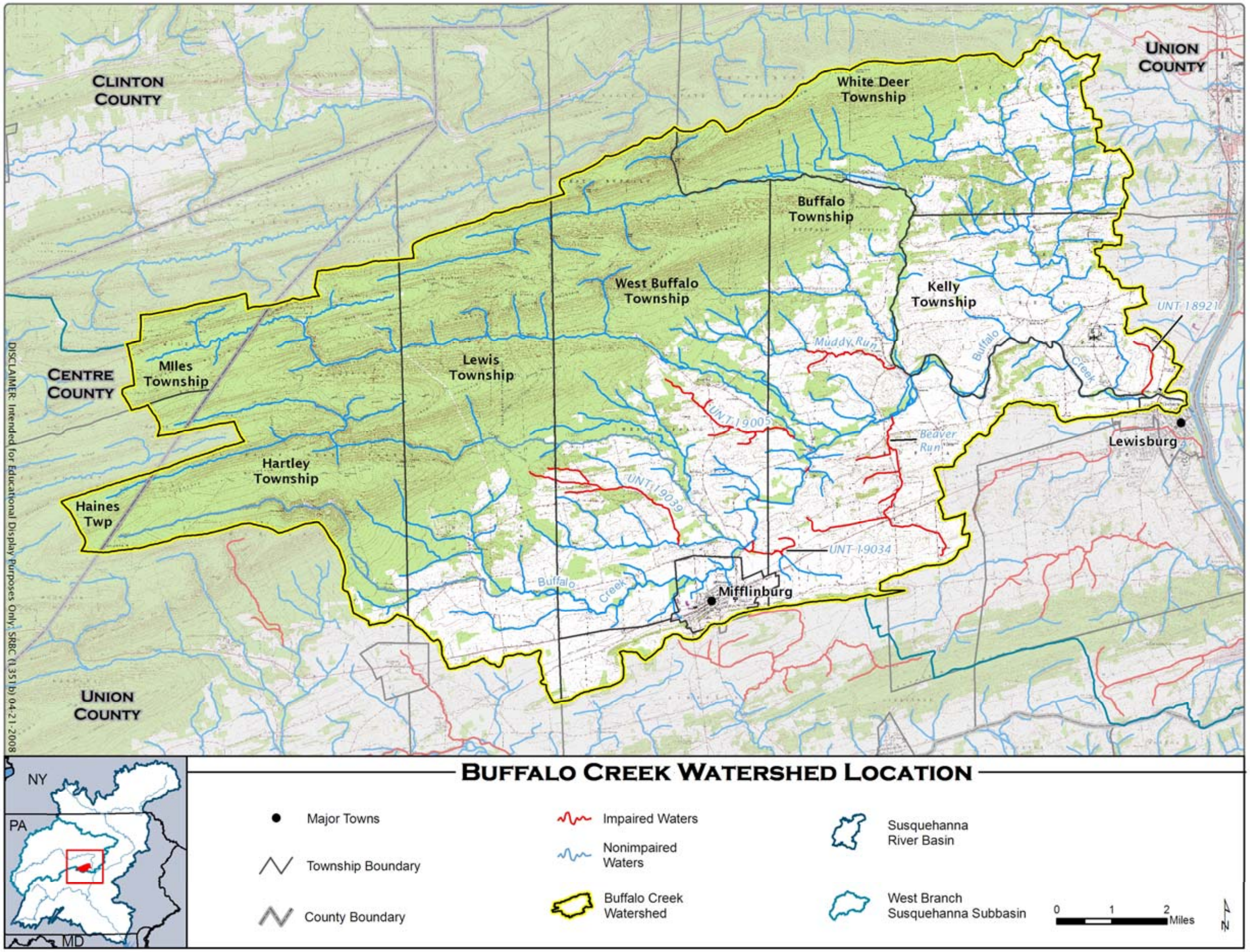
Hem, J.D. 1983. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water Supply Paper 1473.

Novotny, V. and H. Olem. 1994. Water Quality: Prevention, Identification, and Management of Diffuse Pollution. Van Nostrand Reinhold, N.Y.

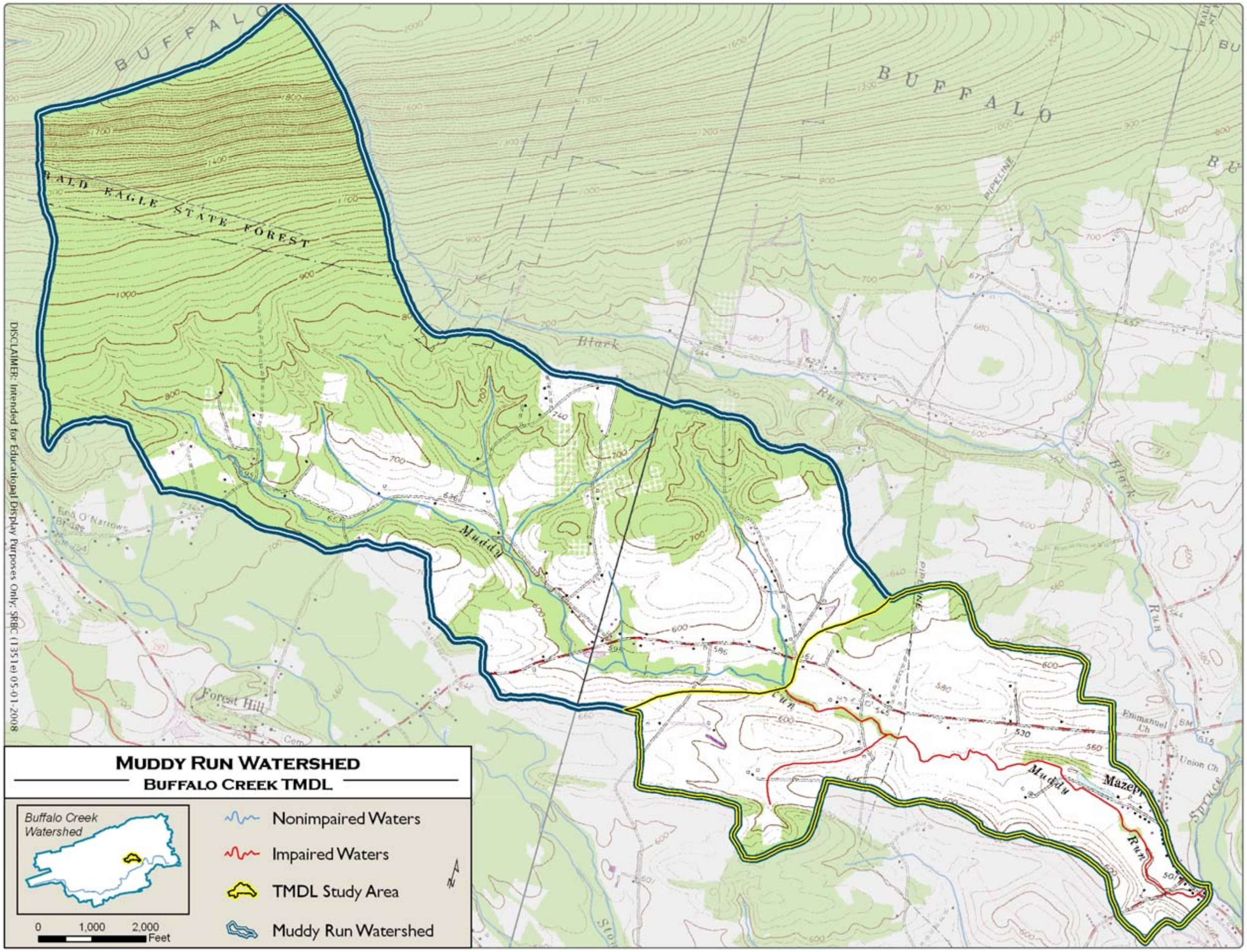
Thomann, R.V. and J.A. Mueller. 1987. Principles of Surface Water Quality Modeling and Control. Harper & Row, N.Y.

Attachment A

Buffalo Creek Watershed Impaired Waters



Buffalo Creek Watershed Location
Clinton County
Union County
Centre County
Union County
White Deer Township
Buffalo Township
West Buffalo Township
Kelly Township
Miles Township
Lewis Township
Hartley Township
Haines Twp
Mifflinburg
Lewisburg
Muddy Run
Buffalo Creek
Beaver Run
UNT 18921
UNT 19005
UNT 19039
UNT 19034
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC (1.351b) 04-21-2008
NY
PA
MD
Major Towns
Township Boundary
County Boundary
Impaired Waters
Nonimpaired Waters
Buffalo Creek Watershed
Susquehanna River Basin
West Branch Susquehanna Subbasin
0
1
2
Miles
N


MUDDY RUN WATERSHED
BUFFALO CREEK TMDL
Buffalo Creek Watershed
Nonimpaired Waters
Impaired Waters
TMDL Study Area
Muddy Run Watershed
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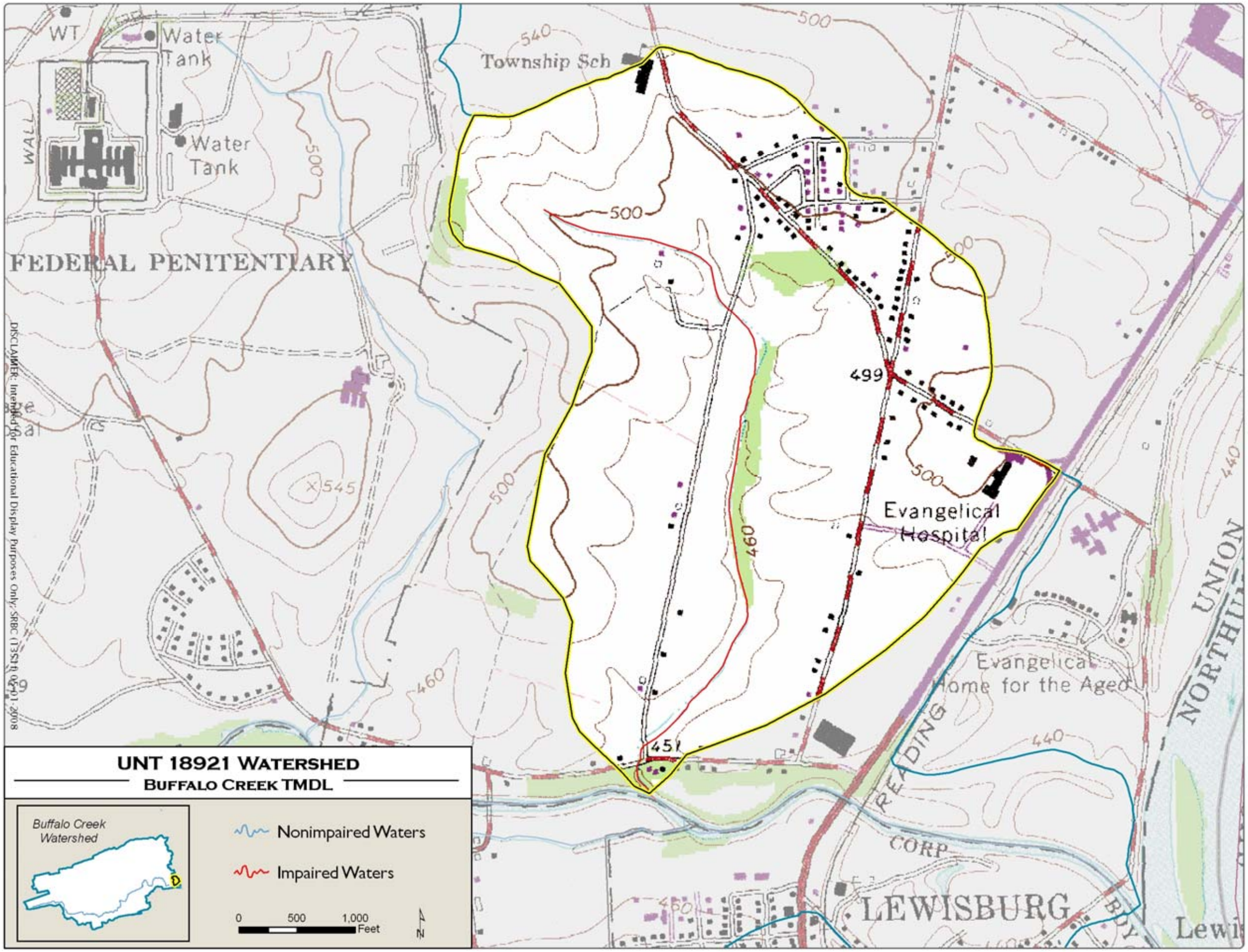
2,000
Feet
DISCLAIMER: Intended for Educational Display Purposes Only; SRBC (1351e) 05-01-2008
BUFFALO
BALD EAGLE STATE FOREST
Black Run
Muddy Run
Forest Hill
Mazeppa
Emmanuel Ch
Union Ch
PIPELINE


UNT 18921 Watershed
Buffalo Creek TMDL
Buffalo Creek Watershed
Nonimpaired Waters
Impaired Waters
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500
1,000
Feet
WT
Water Tank
Water Tank
WALL
FEDERAL PENITENTIARY
Township Sch
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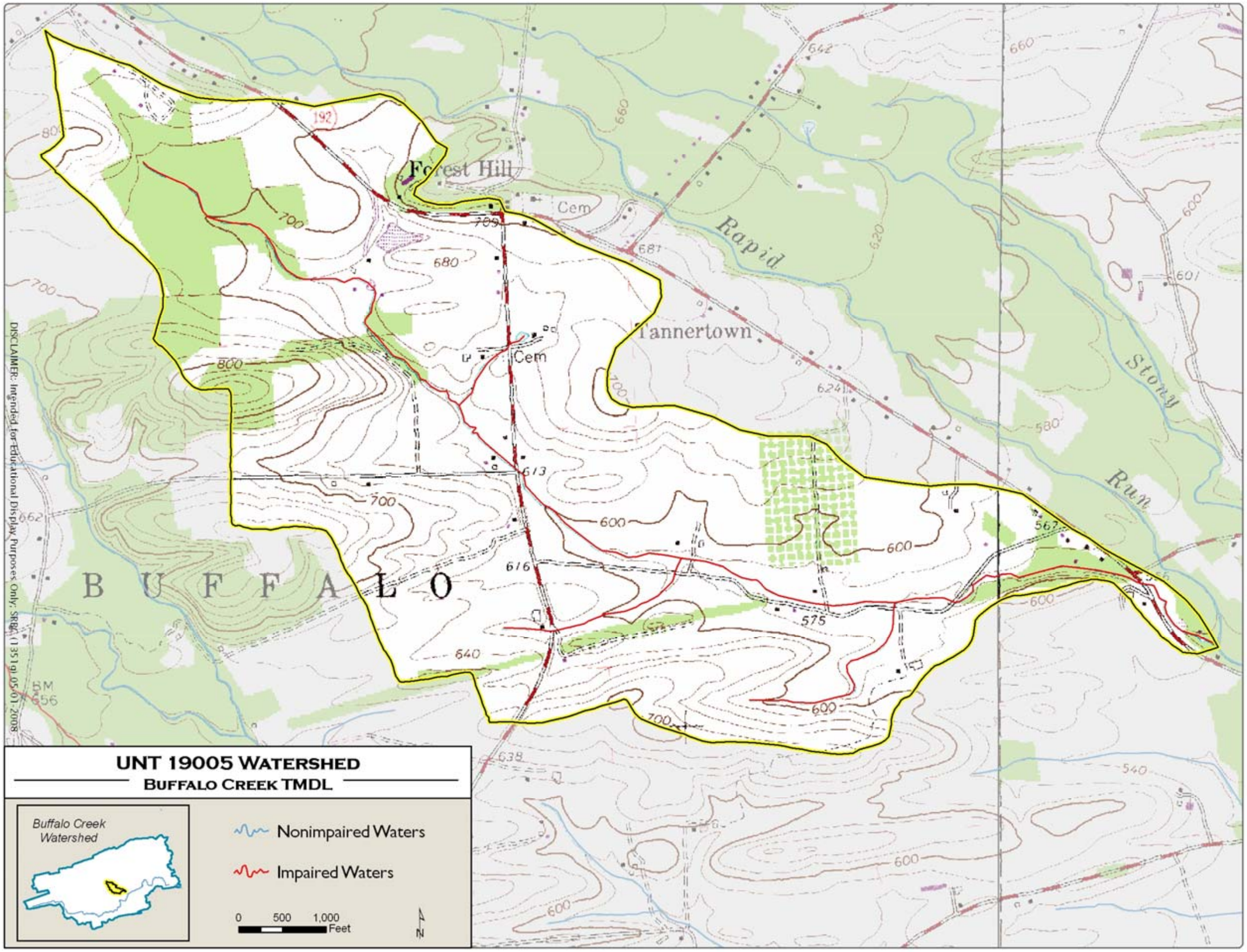
500
545
499
460
457
440
Evangelical Hospital
Evangelical Home for the Aged
READING
CORP
LEWISBURG
UNION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Buffalo Creek TMDL
Buffalo Creek Watershed
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Impaired Waters
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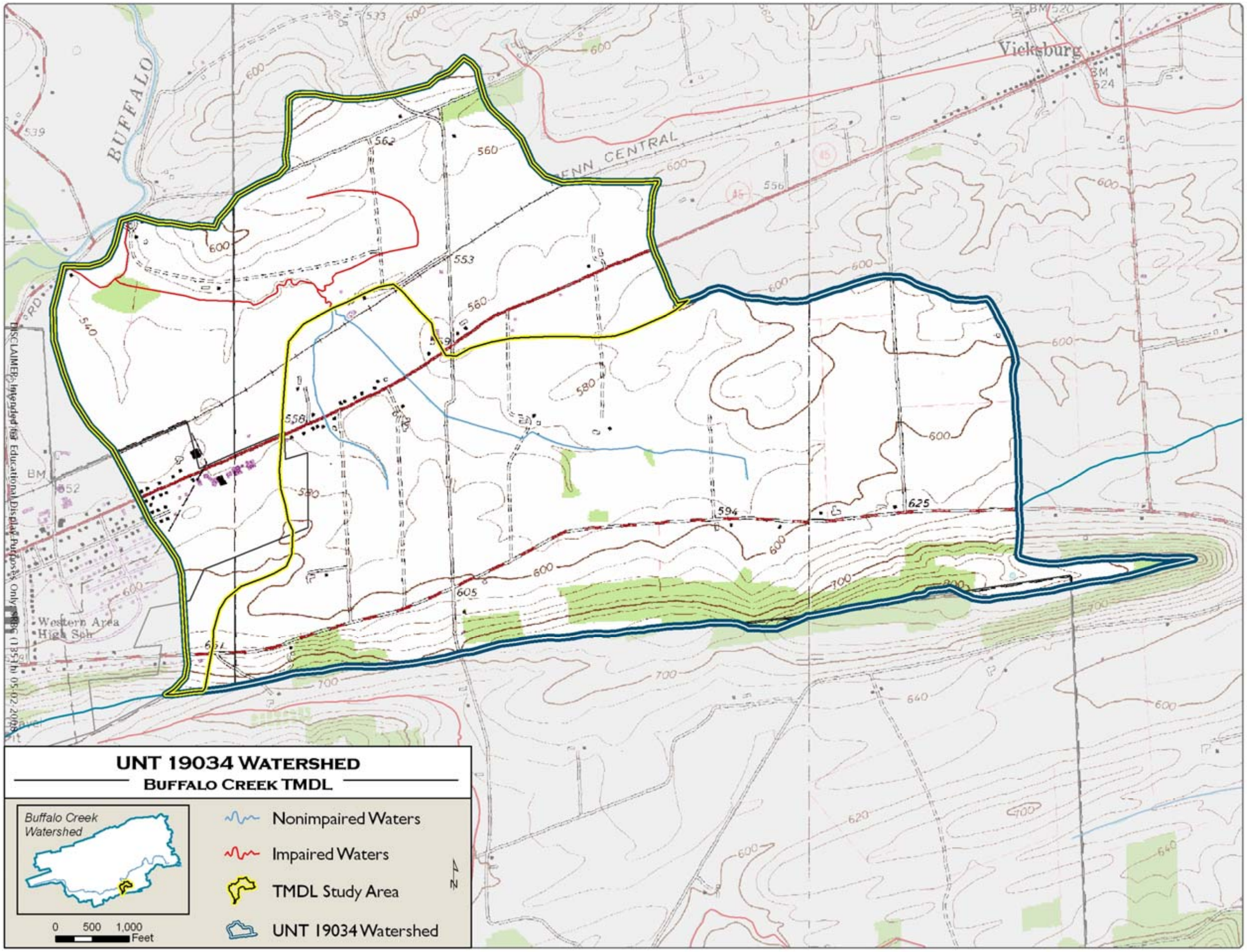
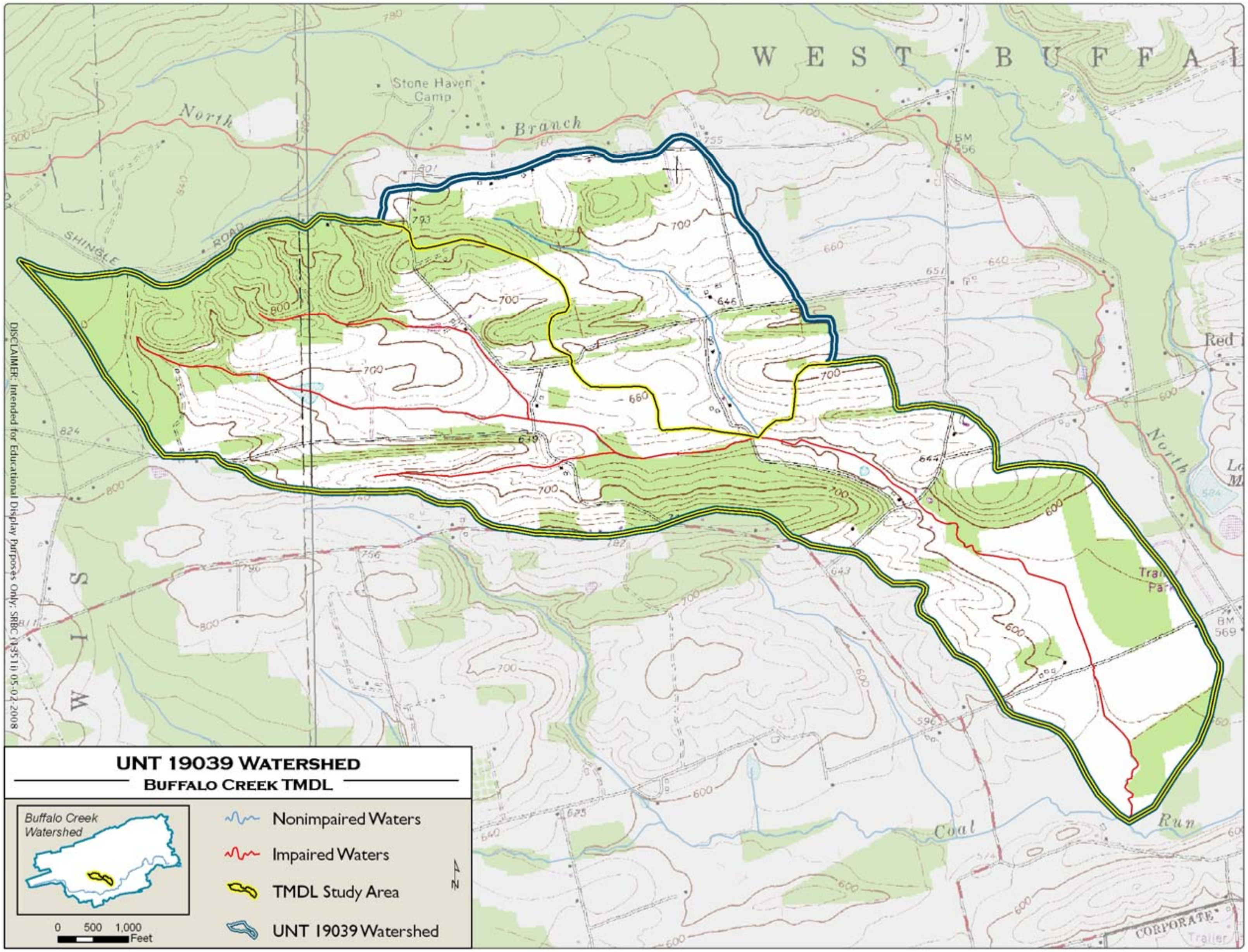
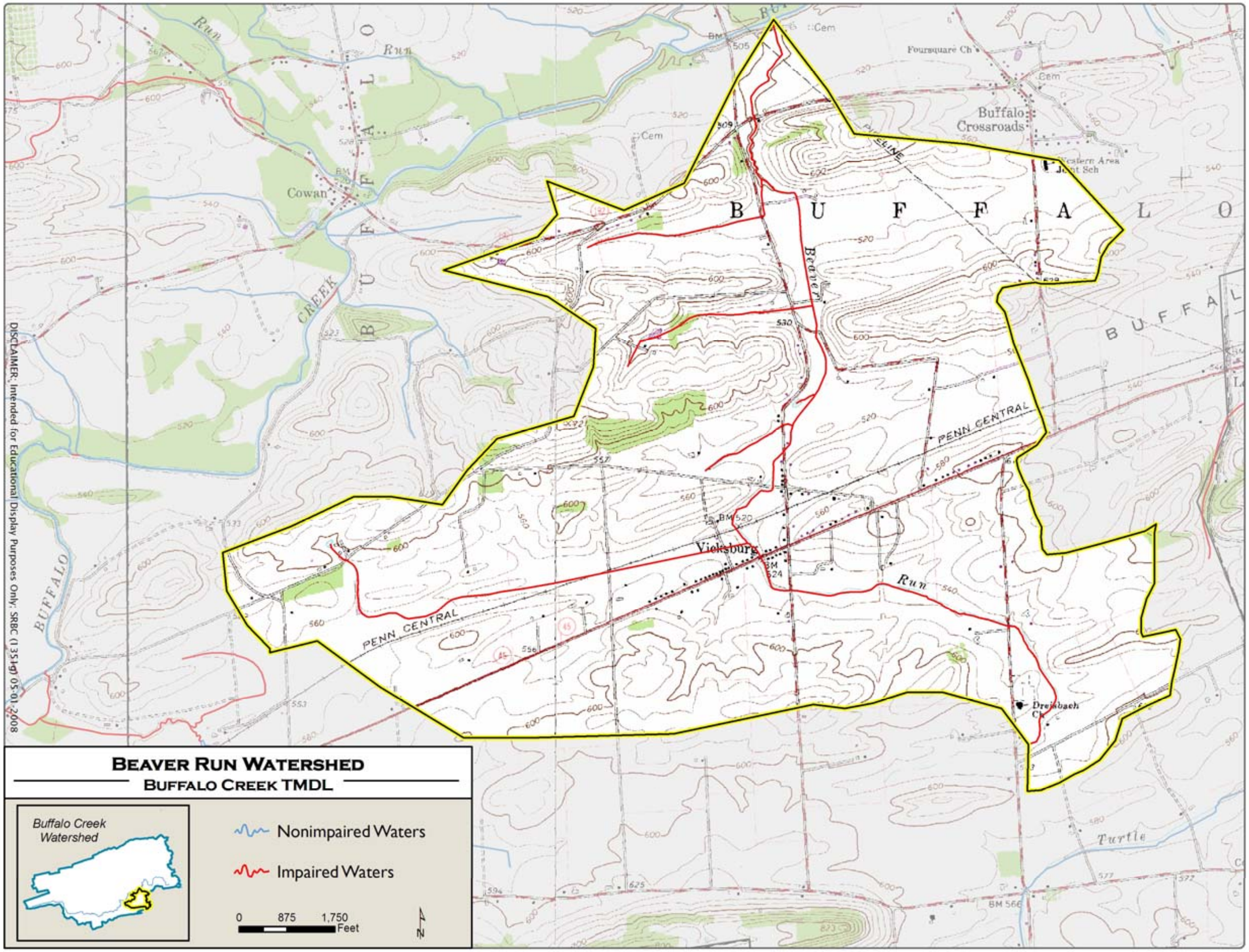
Cem
Tannertown
Rapid
Stony Run
BUFFALO
DISCLAIMER: Intended for Educational Display Purposes Only; SRBC (1351gl.05-01-2008)


UNT 19034 WATERSHED
BUFFALO CREEK TMDL
Buffalo Creek Watershed
Nonimpaired Waters
Impaired Waters
TMDL Study Area
UNT 19034 Watershed
0 500 1,000 Feet
Vicksburg
BUFFALO
PENN CENTRAL
Western Area High Sch


UNT 19039 WATERSHED
BUFFALO CREEK TMDL
Buffalo Creek Watershed
Nonimpaired Waters
Impaired Waters
TMDL Study Area
UNT 19039 Watershed
0 500 1,000 Feet
DISCLAIMER: Intended for Educational Display Purposes Only. SRBC 1351b 05-02-2008
W E S T B U F F A L
Stone Haven Camp
North Branch
SHINGLE ROAD
Coal Run
CORPORATE
Trailer


Beaver Run Watershed
Buffalo Creek TMDL
Buffalo Creek Watershed
Nonimpaired Waters
Impaired Waters
0 875 1,750 Feet
DISCLAIMER: Intended for Educational Display Purposes Only: SRBC (1351g) 05-01-2008
Vicksburg
Buffalo Crossroads
Cowan
Beaver Run
PENN CENTRAL
BUFFALO
Dreisbach Ch
Turtle
Western Area Joint Sch
Fourquare Ch

Attachment B

Information Sheet for the Buffalo Creek Watershed TMDL

What is being proposed?
Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the Buffalo Creek Watershed.

Who is proposing the plans? Why?
The Pennsylvania Department of Environmental Protection (PADEP) is proposing to submit the plans to the U.S. Environmental Protection Agency (USEPA) for review and approval as required by federal regulation. In 1995, USEPA was sued for not developing TMDLs when Pennsylvania failed to do so. PADEP has entered into an agreement with USEPA to develop TMDLs for certain specified waters over the next several years. This TMDL has been developed in compliance with the state/USEPA agreement.

What is a TMDL?
A TMDL sets a ceiling on the pollutant loads that can enter a waterbody so that it will meet water quality standards. The Clean Water Act requires states to list all waters that do not meet their water quality standards even after pollution controls required by law are in place. For these waters, the state must calculate how much of a substance can be put in the water without violating the standard, and then distribute that quantity to all the sources of the pollutant on that waterbody. A TMDL plan includes waste load allocations for point sources, load allocations for nonpoint sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to USEPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that USEPA must do so.

What is a water quality standard?
The Clean Water Act sets a national minimum goal that all waters be “fishable” and “swimmable.” To support this goal, states must adopt water quality standards. Water quality standards are state regulations that have two components. The first component is a designated use, such as “warm water fishes” or “recreation.” States must assign a use or several uses to each of their waters. The second component relates to the instream conditions necessary to protect the designated use(s). These conditions or “criteria” are physical, chemical, or biological characteristics such as temperature and minimum levels of dissolved oxygen, and maximum concentrations of toxic pollutants. It is the combination of the “designated use” and the “criteria” to support that use that make up a water quality standard. If any criteria are being exceeded, then the use is not being met and the water is said to be in violation of water quality standards.

What is the purpose of the plans?
The Buffalo Creek Watershed is impaired due to sediment and phosphorus emanating from urban runoff, as well as agricultural runoff and other nonpoint sources. The plans include a calculation of the loading for sediment that will correct the problem and meet water quality objectives.

Why was the Buffalo Creek Watershed selected for TMDL development?
In 1998, 2002 and 2008, PADEP listed segments of the Buffalo Creek Watershed under Section 303(d) of the federal Clean Water Act as impaired due to causes linked to sediment and phosphorus.

What pollutants do these TMDLs address?
The proposed plans provide calculations of the stream's total capacity to accept sediment and phosphorus.

Where do the pollutants come from?
The sediment and phosphorus related impairments in the Buffalo Creek Watershed come from nonpoint sources of pollution, primarily overland runoff from developed areas and agricultural lands, as well as from streambank erosion.

How was the TMDL developed?
PADEP used a reference watershed approach to estimate the necessary loading reduction of sediment that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a nonimpaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's Arcview-based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the nonimpaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading rates of the nonimpaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvania nor USEPA has instream numerical water quality criteria for sediment.

How much pollution is too much?
The allowable amount of pollution in a waterbody varies depending on several conditions. TMDLs are set to meet water quality standards at the critical flow condition. For a free flowing stream impacted by nonpoint source pollution loading of sediment, the TMDL is expressed as an annual loading. This accounts for pollution contributions over all streamflow conditions. PADEP established the water quality objectives for sediment by using the reference watershed approach. This approach assumes that the impairment is eliminated when the impaired watershed achieves loadings similar to the reference watershed. Reducing the current loading rates for sediment in the impaired watershed to the current loading rates in the reference watershed will result in meeting the water quality objectives.

How will the loading limits be met?
Best Management Practices (BMPs) will be encouraged throughout the watershed to achieve the necessary load reductions.

How can I get more information on the TMDL?
To request a copy of the full report, contact William Brown at (717) 783-2938 between 8:00 a.m. and 3:00 p.m., Monday through Friday. Mr. Brown also can be reached by mail at the Office of Water Management, PADEP, Rachel Carson State Office Building, 400 Market Street, Harrisburg, PA 17105 or by e-mail at wbrown@state.pa.us.

How can I comment on the proposal?

You may provide e-mail or written comments postmarked no later than April 23, 2009 to the above address.

Attachment C

Comparison between Impaired Segments and UNT 18925

Table C1. Comparison between UNT 19005 and UNT 18925 Watersheds

Attribute	Watershed	
	UNT 19005	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	1.56	1.25
Land Use	Agriculture (75.68%) Development (8.43%) Forested (14.39%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (15%) Bloomsburg and Mifflintown Formation (70%) Clinton Group (15%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Berks-Weikert-Bedington (85%) Chenango-Pope-Holly (10%) Leck Kill-Calvin-Klinesville (5%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Berks-Weikert-Bedington A (0%) B (13%) C (52%) D (35%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%) Leck Kill-Calvin-Klinesville A (0%) B (32%) C (44%) D (24%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Berks-Weikert-Bedington (0.24) Chenango-Pope-Holly (0.30) Leck Kill-Calvin-Klinesville (0.23)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	45.5	44.5
20-Yr. Ave. Runoff (in)	0.32	0.34

Table C2. Comparison between UNT 19039 and UNT 18925 Watersheds

Attribute	Watershed	
	UNT 19039	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	1.59	1.25
Land Use	Agriculture (58.64%) Development (6.32%) Forested (34.31%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (5%) Bloomsburg and Mifflintown Formation (80%) Clinton Group (15%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Berks-Weikert-Bedington (90%) Chenango-Pope-Holly (8%) Hazelton-Dekalb-Buchanan (2%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Berks-Weikert-Bedington A (0%) B (13%) C (52%) D (35%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%) Hazelton-Dekalb-Buchanan A (2%) B (45%) C (53%) D (0%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Berks-Weikert-Bedington (0.24) Chenango-Pope-Holly (0.30) Hazelton-Dekalb-Buchanan (0.18)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	45.5	44.5
20-Yr. Ave. Runoff (in)	0.29	0.34

Table C3. Comparison between Muddy Run Segment and UNT 18925 Watersheds

Attribute	Watershed	
	Muddy Run Segment	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	1.02	1.25
Land Use	Agriculture (80%) Development (8.31%) Forested (9.80%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (15%) Bloomsburg and Mifflintown Formation (85%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Berks-Weikert-Bedington (50%) Edom-Millheim-Calvin (45%) Chenango-Pope-Holly (5%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Berks-Weikert-Bedington A (0%) B (13%) C (52%) D (35%) Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Berks-Weikert-Bedington (0.24) Edom-Millheim-Calvin (0.28) Chenango-Pope-Holly (0.30)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	44.5	44.5
20-Yr. Ave. Runoff (in)	0.33	0.34

Table C4. Comparison between UNT 19034 and UNT 18925 Watersheds

Attribute	Watershed	
	UNT 19034	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	0.47	1.25
Land Use	Agriculture (83.43%) Development (7.46%) Forested (4.14%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (10%) Keyser and Tonoloway Formation (90%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Edom-Millheim-Calvin (100%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Edom-Millheim-Calvin (0.28)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	44.5	44.5
20-Yr. Ave. Runoff (in)	0.35	0.34

Table C5. Comparison between UNT 18921 and UNT 18925 Watersheds

	Watershed	
Attribute	**UNT 18921**	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	0.75	1.25
Land Use	Agriculture (73.57%) Development (13.94%) Forested (7.26%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Hamilton Group (100%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Edom-Millheim-Calvin (50%) Chenango-Pope-Holly (40%) Hagerstown-Duffield-Clarksburg (10%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%) Hagerstown-Duffield-Clarksburg A (0%) B (36%) C (60%) D (4%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Edom-Millheim-Calvin (0.28) Chenango-Pope-Holly (0.30) Hagerstown-Duffield-Clarksburg (0.32)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	44.5	44.5
20-Yr. Ave. Runoff (in)	0.37	0.34

Table C6. Comparison between Beaver Run and UNT 18925 Watersheds

	Watershed	
Attribute	**Beaver Run**	**UNT 18925**
Physiographic Province	Appalachian Mountain Section: Ridge and Valley (100%)	Appalachian Mountain Section: Ridge and Valley (100%)
Area (mi^2)	4.55	1.25
Land Use	Agriculture (88.99%) Development (10.57%) Forested (0.00%)	Agriculture (87.93%) Development (7.12%) Forested (4.95%)
Geology	Wills Creek Formation (50%) Keyser and Tonoloway Formation (50%)	Wills Creek Formation (55%) Bloomsburg and Mifflintown Formation (40%) Keyser and Tonoloway Formation (5%)
Soils	Edom-Millheim-Calvin (70%) Chenango-Pope-Holly (5%) Hagerstown-Duffield-Clarksburg (25%)	Edom-Millheim-Calvin (100%)
Dominant HSG	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%) Chenango-Pope-Holly A (26%) B (37%) C (20%) D (17%) Hagerstown-Duffield-Clarksburg A (0%) B (36%) C (60%) D (4%)	Edom-Millheim-Calvin A (0%) B (2%) C (90%) D (8%)
K Factor	Edom-Millheim-Calvin (0.28) Chenango-Pope-Holly (0.30) Hagerstown-Duffield-Clarksburg (0.32)	Edom-Millheim-Calvin (0.28)
20-Yr. Ave. Rainfall (in)	44.5	44.5
20-Yr. Ave. Runoff (in)	0.35	0.34

Attachment D

AVGWLF Model Overview & GIS-Based Derivation of Input Data

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

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

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

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

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

In using this interface, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land, and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT, and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background nitrogen and phosphorus concentrations and cropping practices. Complete GWLF-formatted weather files also are included for 80 weather stations around the state.

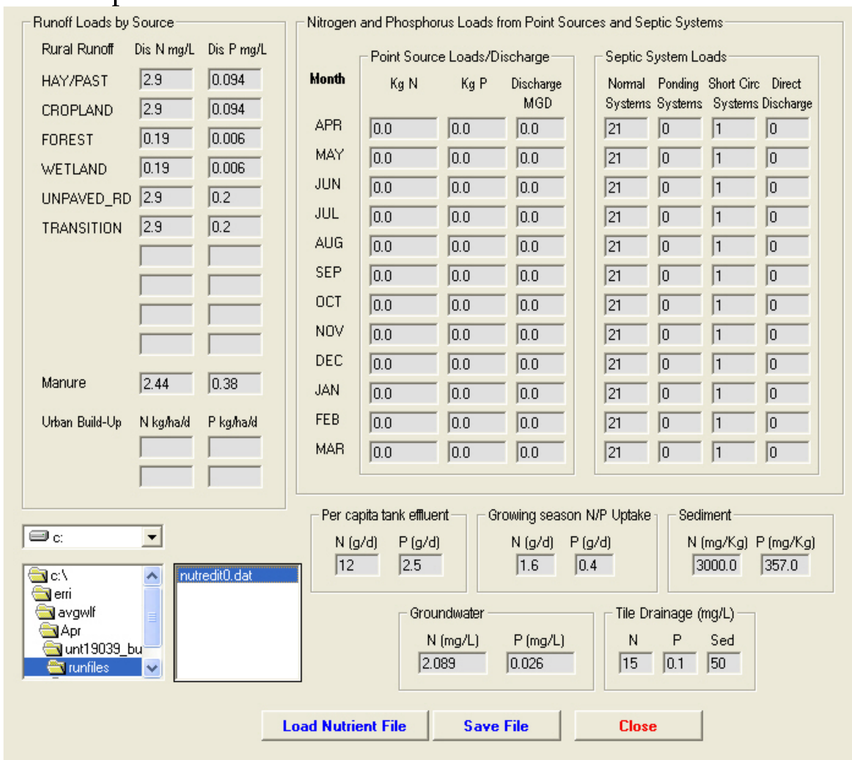
The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.

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

Attachment E

AVGWLF Model Inputs for the Buffalo Creek Watershed

UNT 19039 Nutrient Input File



Runoff Loads by Source

Rural Runoff	Dis N mg/L	Dis P mg/L
HAY/PAST	2.9	0.094
CROPLAND	2.9	0.094
FOREST	0.19	0.006
WETLAND	0.19	0.006
UNPAVED_RD	2.9	0.2
TRANSITION	2.9	0.2
Manure	2.44	0.38
Urban Build-Up	N kg/ha/d	P kg/ha/d

Nitrogen and Phosphorus Loads from Point Sources and Septic Systems

Month	Point Source Loads/Discharge: Kg N	Kg P	Discharge MGD	Septic System Loads: Normal Systems	Ponding Systems	Short Circ Systems	Direct Discharge
APR	0.0	0.0	0.0	21	0	1	0
MAY	0.0	0.0	0.0	21	0	1	0
JUN	0.0	0.0	0.0	21	0	1	0
JUL	0.0	0.0	0.0	21	0	1	0
AUG	0.0	0.0	0.0	21	0	1	0
SEP	0.0	0.0	0.0	21	0	1	0
OCT	0.0	0.0	0.0	21	0	1	0
NOV	0.0	0.0	0.0	21	0	1	0
DEC	0.0	0.0	0.0	21	0	1	0
JAN	0.0	0.0	0.0	21	0	1	0
FEB	0.0	0.0	0.0	21	0	1	0
MAR	0.0	0.0	0.0	21	0	1	0

Per capita tank effluent N (g/d)	P (g/d)	Growing season N/P Uptake N (g/d)	P (g/d)	Sediment N (mg/Kg)	P (mg/Kg)
12	2.5	1.6	0.4	3000.0	357.0

Groundwater N (mg/L)	P (mg/L)	Tile Drainage (mg/L) N	P	Sed
2.089	0.026	15	0.1	50

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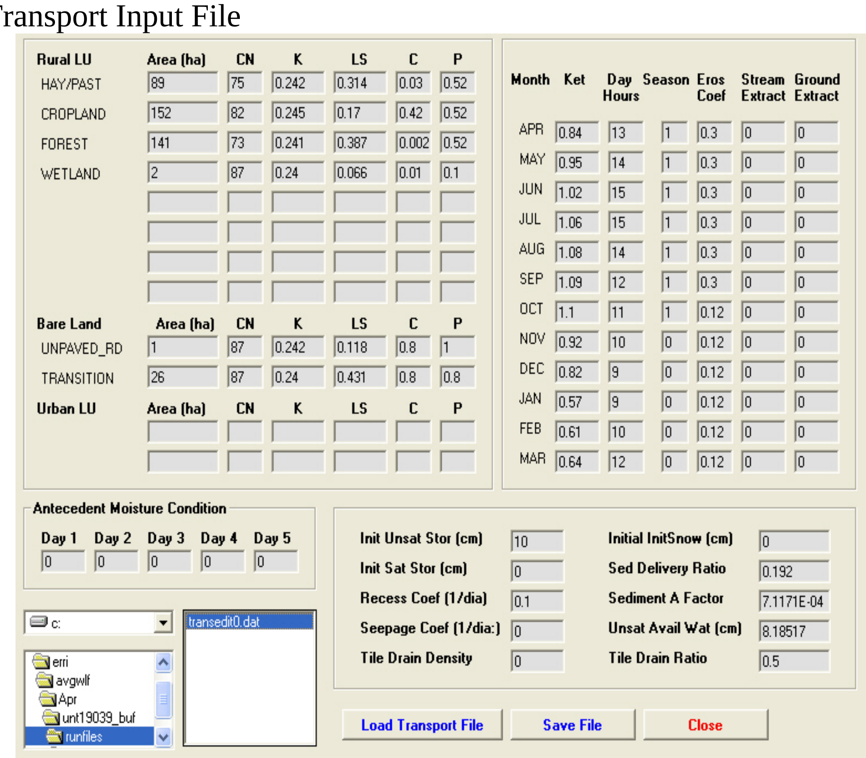
nutredit0.dat

Load Nutrient File | Save File | Close

UNT 19039 Transport Input File



Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	89	75	0.242	0.314	0.03	0.52
CROPLAND	152	82	0.245	0.17	0.42	0.52
FOREST	141	73	0.241	0.387	0.002	0.52
WETLAND	2	87	0.24	0.066	0.01	0.1
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
UNPAVED_RD	1	87	0.242	0.118	0.8	1
TRANSITION	26	87	0.24	0.431	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
APR	0.84	13	1	0.3	0	0
MAY	0.95	14	1	0.3	0	0
JUN	1.02	15	1	0.3	0	0
JUL	1.06	15	1	0.3	0	0
AUG	1.08	14	1	0.3	0	0
SEP	1.09	12	1	0.3	0	0
OCT	1.1	11	1	0.12	0	0
NOV	0.92	10	0	0.12	0	0
DEC	0.82	9	0	0.12	0	0
JAN	0.57	9	0	0.12	0	0
FEB	0.61	10	0	0.12	0	0
MAR	0.64	12	0	0.12	0	0

Antecedent Moisture Condition

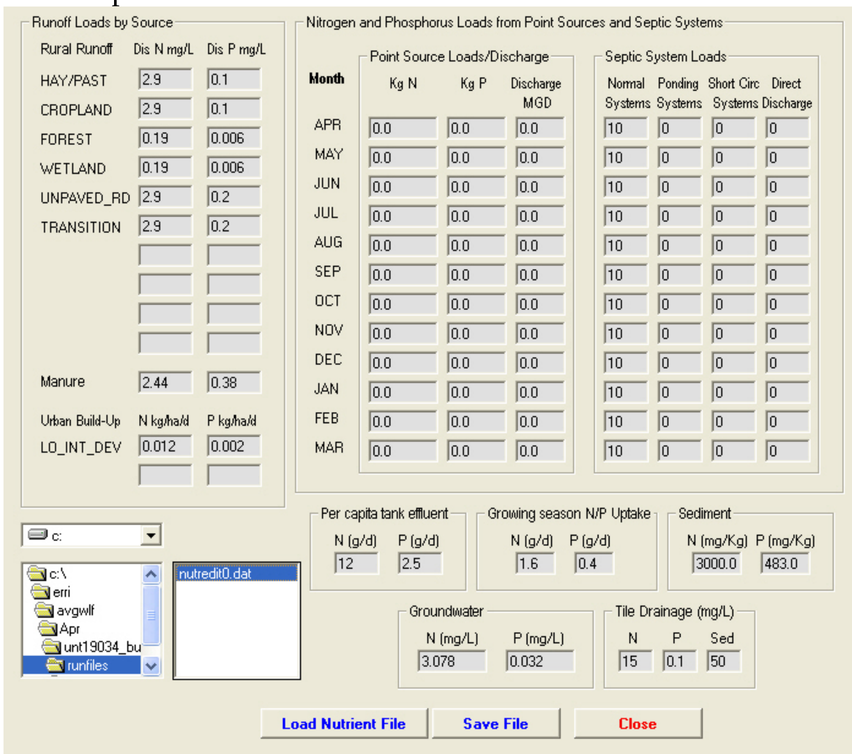
Day 1	Day 2	Day 3	Day 4	Day 5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial InitSnow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.192
Recess Coef (1/dia)	0.1	Sediment A Factor	7.1171E-04
Seepage Coef (1/dia:)	0	Unsat Avail Wat (cm)	8.18517
Tile Drain Density	0	Tile Drain Ratio	0.5

c:
erri
avgwlf
Apr
unt19039_buf
runfiles
transedit0.dat

Load Transport File | Save File | Close

UNT 19034 Nutrient Input File



Runoff Loads by Source

Rural Runoff	Dis N mg/L	Dis P mg/L
HAY/PAST	2.9	0.1
CROPLAND	2.9	0.1
FOREST	0.19	0.006
WETLAND	0.19	0.006
UNPAVED_RD	2.9	0.2
TRANSITION	2.9	0.2
Manure	2.44	0.38
Urban Build-Up	N kg/ha/d	P kg/ha/d
LO_INT_DEV	0.012	0.002

Nitrogen and Phosphorus Loads from Point Sources and Septic Systems

	Point Source Loads/Discharge			Septic System Loads			
Month	Kg N	Kg P	Discharge MGD	Normal Systems	Ponding Systems	Short Circ Systems	Direct Discharge
APR	0.0	0.0	0.0	10	0	0	0
MAY	0.0	0.0	0.0	10	0	0	0
JUN	0.0	0.0	0.0	10	0	0	0
JUL	0.0	0.0	0.0	10	0	0	0
AUG	0.0	0.0	0.0	10	0	0	0
SEP	0.0	0.0	0.0	10	0	0	0
OCT	0.0	0.0	0.0	10	0	0	0
NOV	0.0	0.0	0.0	10	0	0	0
DEC	0.0	0.0	0.0	10	0	0	0
JAN	0.0	0.0	0.0	10	0	0	0
FEB	0.0	0.0	0.0	10	0	0	0
MAR	0.0	0.0	0.0	10	0	0	0

Per capita tank effluent		Growing season N/P Uptake		Sediment	
N (g/d)	P (g/d)	N (g/d)	P (g/d)	N (mg/Kg)	P (mg/Kg)
12	2.5	1.6	0.4	3000.0	483.0

Groundwater		Tile Drainage (mg/L)		
N (mg/L)	P (mg/L)	N	P	Sed
3.078	0.032	15	0.1	50

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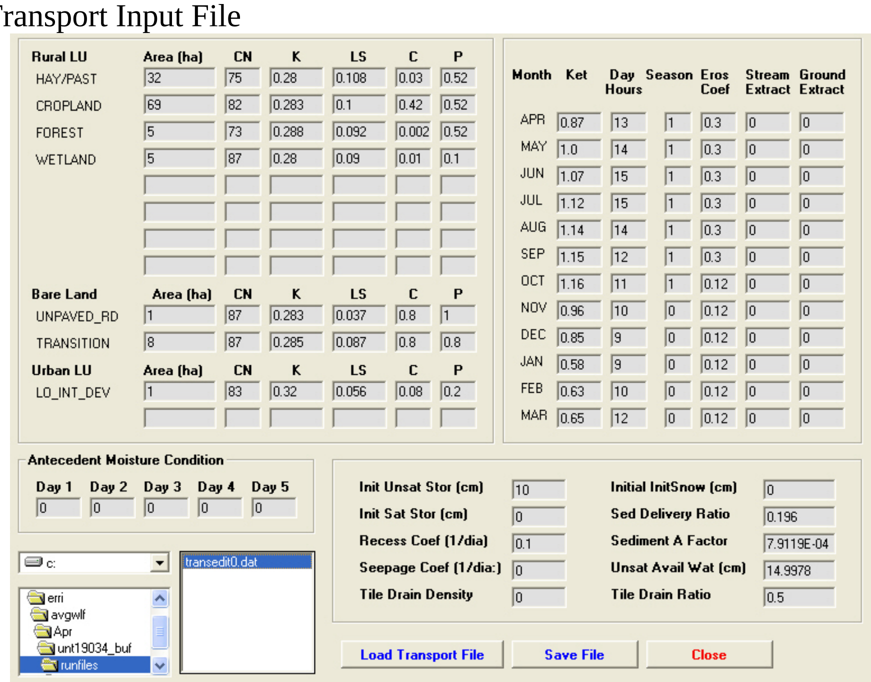
UNT 19034 Transport Input File



Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	32	75	0.28	0.108	0.03	0.52
CROPLAND	69	82	0.283	0.1	0.42	0.52
FOREST	5	73	0.288	0.092	0.002	0.52
WETLAND	5	87	0.28	0.09	0.01	0.1
Bare Land	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
UNPAVED_RD	1	87	0.283	0.037	0.8	1
TRANSITION	8	87	0.285	0.087	0.8	0.8
Urban LU	**Area (ha)**	**CN**	**K**	**LS**	**C**	**P**
LO_INT_DEV	1	83	0.32	0.056	0.08	0.2

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
APR	0.87	13	1	0.3	0	0
MAY	1.0	14	1	0.3	0	0
JUN	1.07	15	1	0.3	0	0
JUL	1.12	15	1	0.3	0	0
AUG	1.14	14	1	0.3	0	0
SEP	1.15	12	1	0.3	0	0
OCT	1.16	11	1	0.12	0	0
NOV	0.96	10	0	0.12	0	0
DEC	0.85	9	0	0.12	0	0
JAN	0.58	9	0	0.12	0	0
FEB	0.63	10	0	0.12	0	0
MAR	0.65	12	0	0.12	0	0

Antecedent Moisture Condition

Day 1	Day 2	Day 3	Day 4	Day 5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial InitSnow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.196
Recess Coef (1/dia)	0.1	Sediment A Factor	7.9119E-04
Seepage Coef (1/dia:)	0	Unsat Avail Wat (cm)	14.9978
Tile Drain Density	0	Tile Drain Ratio	0.5

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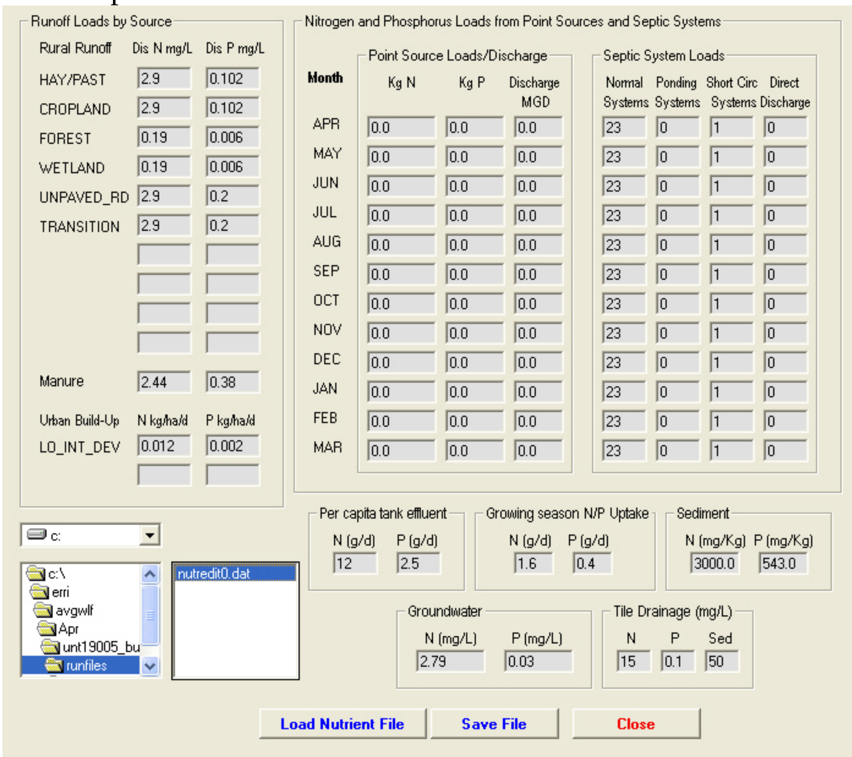
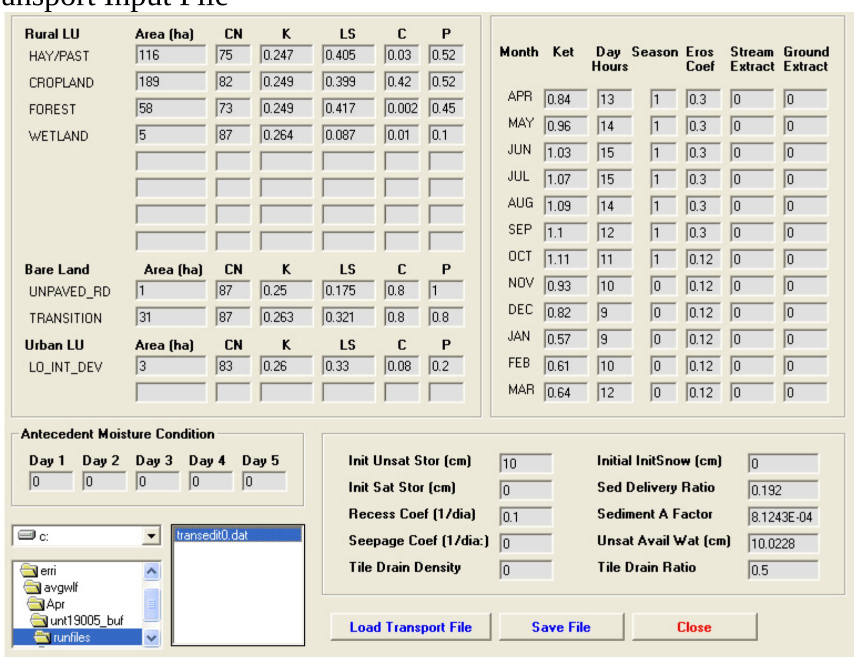
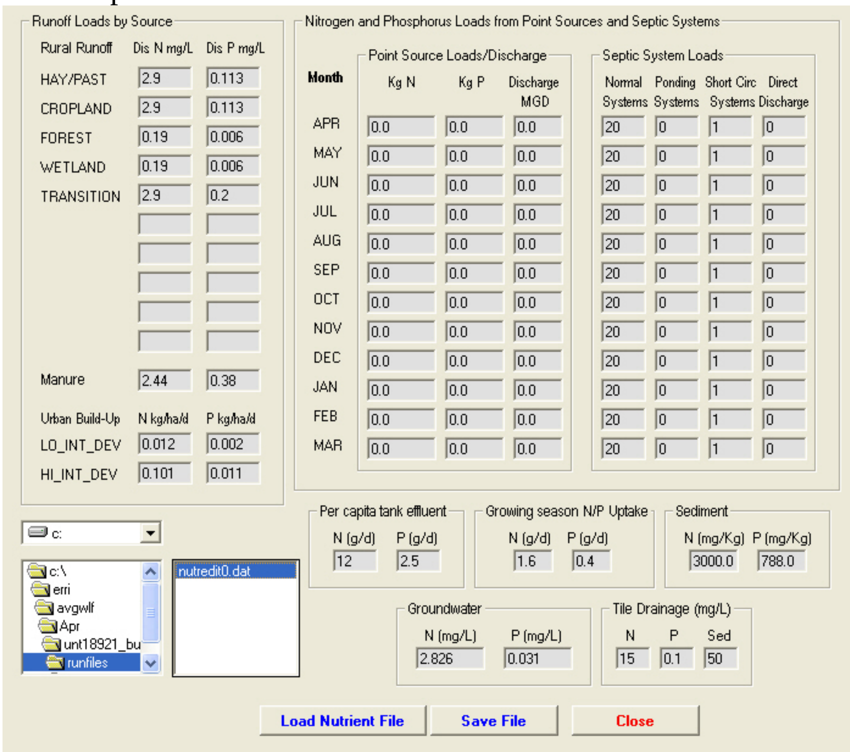
UNT 19005 Nutrient Input File



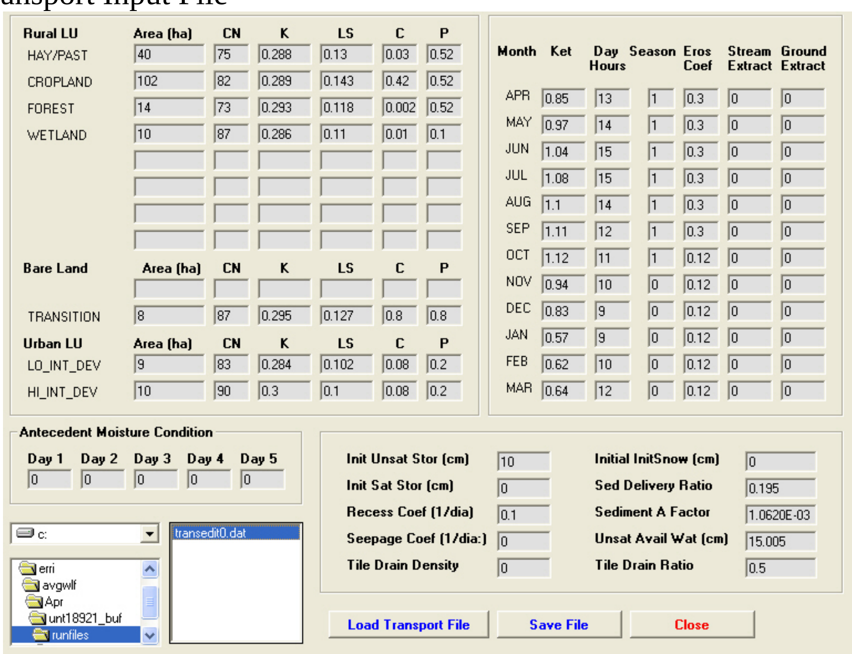
UNT 19005 Transport Input File



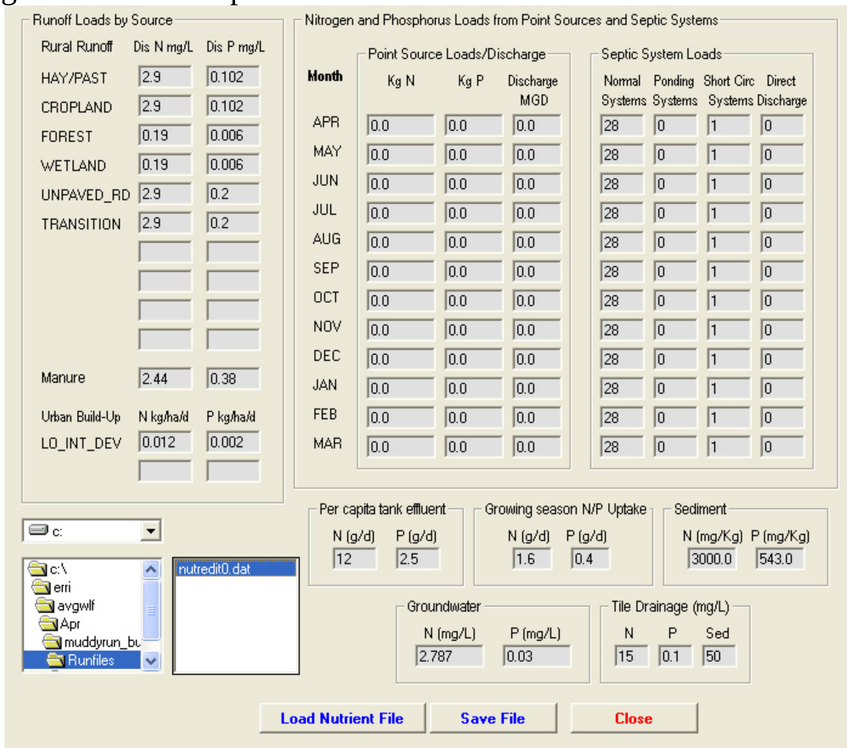
UNT 18921 Nutrient Input File



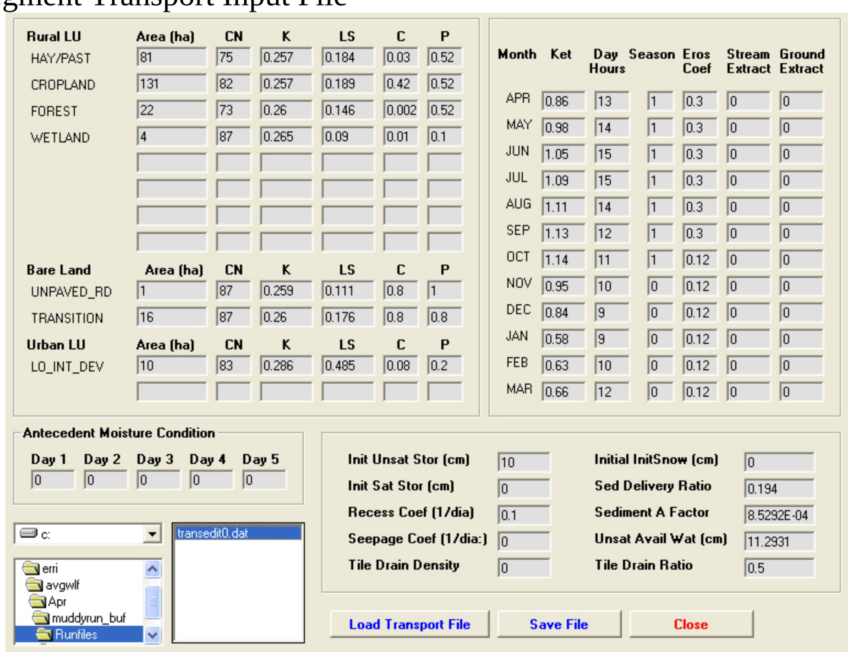
UNT 18921 Transport Input File



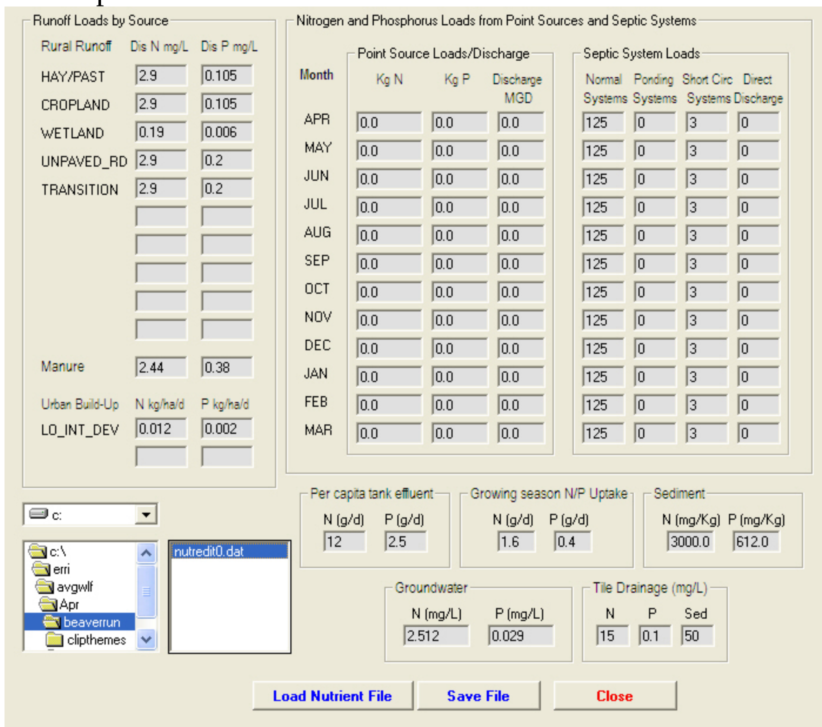
Muddy Run Segment Nutrient Input File



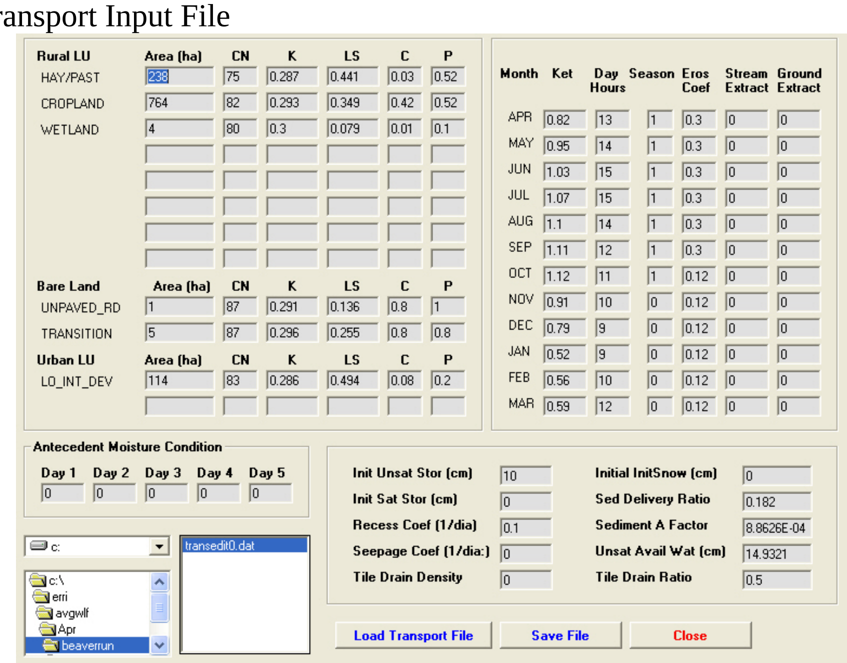
Muddy Run Segment Transport Input File



Beaver Run Nutrient Input File



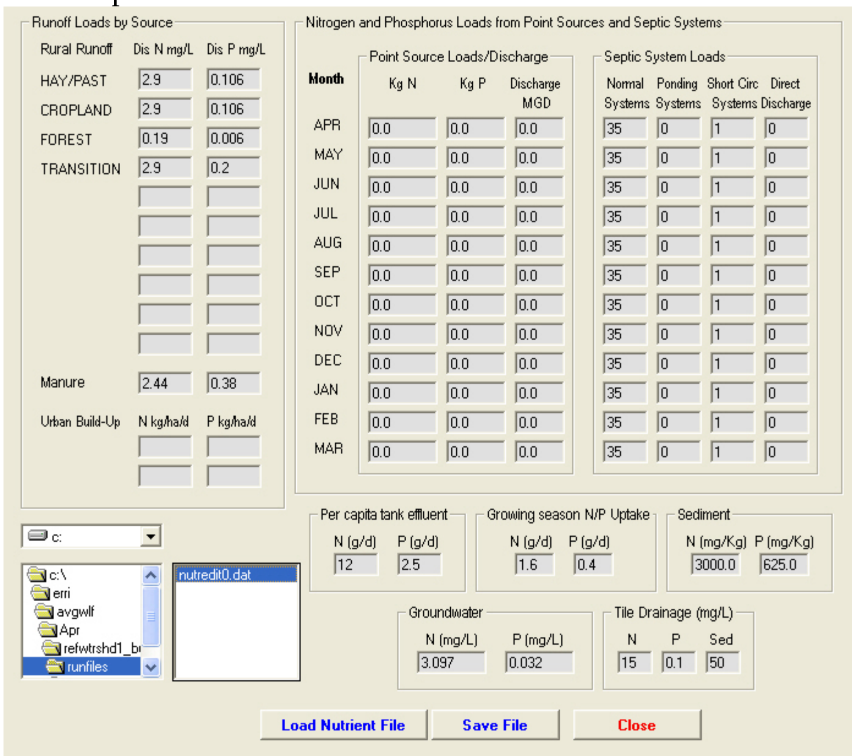
Beaver Run Transport Input File



Attachment F

AVGWLF Model Inputs for the UNT 18925 Reference Watershed

UNT 18925 Nutrient Input File



Runoff Loads by Source

Rural Runoff	Dis N mg/L	Dis P mg/L
HAY/PAST	2.9	0.106
CROPLAND	2.9	0.106
FOREST	0.19	0.006
TRANSITION	2.9	0.2
Manure	2.44	0.38

Urban Build-Up	N kg/ha/d	P kg/ha/d

Nitrogen and Phosphorus Loads from Point Sources and Septic Systems

Month	Point Source Loads/Discharge: Kg N	Kg P	Discharge MGD	Septic System Loads: Normal Systems	Ponding Systems	Short Circ Systems	Direct Discharge
APR	0.0	0.0	0.0	35	0	1	0
MAY	0.0	0.0	0.0	35	0	1	0
JUN	0.0	0.0	0.0	35	0	1	0
JUL	0.0	0.0	0.0	35	0	1	0
AUG	0.0	0.0	0.0	35	0	1	0
SEP	0.0	0.0	0.0	35	0	1	0
OCT	0.0	0.0	0.0	35	0	1	0
NOV	0.0	0.0	0.0	35	0	1	0
DEC	0.0	0.0	0.0	35	0	1	0
JAN	0.0	0.0	0.0	35	0	1	0
FEB	0.0	0.0	0.0	35	0	1	0
MAR	0.0	0.0	0.0	35	0	1	0

Per capita tank effluent: N (g/d) 12, P (g/d) 2.5

Growing season N/P Uptake: N (g/d) 1.6, P (g/d) 0.4

Sediment: N (mg/Kg) 3000.0, P (mg/Kg) 625.0

Groundwater: N (mg/L) 3.097, P (mg/L) 0.032

Tile Drainage (mg/L): N 15, P 0.1, Sed 50

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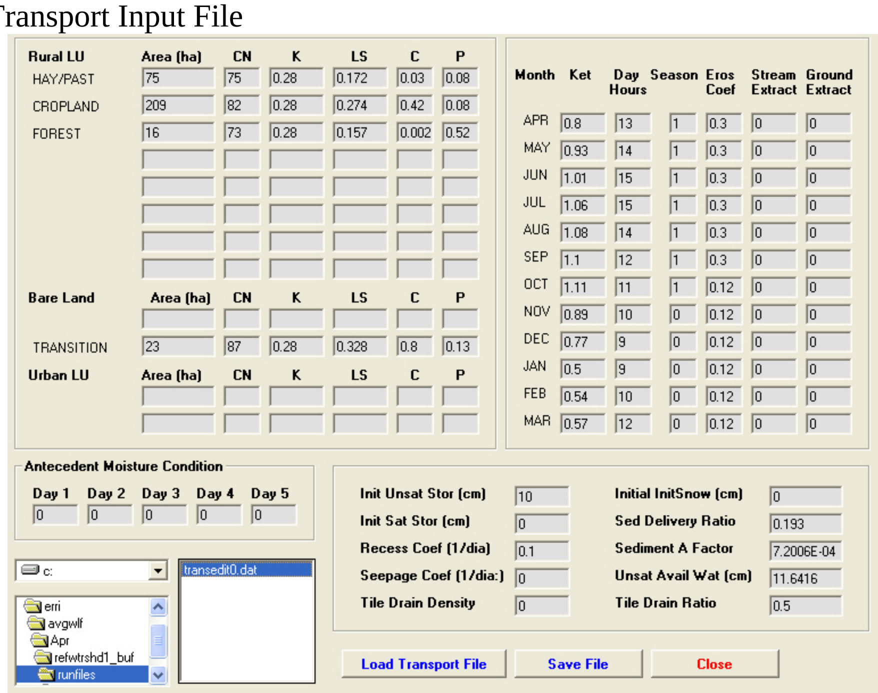
UNT 18925 Transport Input File



Rural LU	Area (ha)	CN	K	LS	C	P
HAY/PAST	75	75	0.28	0.172	0.03	0.08
CROPLAND	209	82	0.28	0.274	0.42	0.08
FOREST	16	73	0.28	0.157	0.002	0.52

Bare Land	Area (ha)	CN	K	LS	C	P
TRANSITION	23	87	0.28	0.328	0.8	0.13

Urban LU	Area (ha)	CN	K	LS	C	P

Month	Ket	Day Hours	Season	Eros Coef	Stream Extract	Ground Extract
APR	0.8	13	1	0.3	0	0
MAY	0.93	14	1	0.3	0	0
JUN	1.01	15	1	0.3	0	0
JUL	1.06	15	1	0.3	0	0
AUG	1.08	14	1	0.3	0	0
SEP	1.1	12	1	0.3	0	0
OCT	1.11	11	1	0.12	0	0
NOV	0.89	10	0	0.12	0	0
DEC	0.77	9	0	0.12	0	0
JAN	0.5	9	0	0.12	0	0
FEB	0.54	10	0	0.12	0	0
MAR	0.57	12	0	0.12	0	0

Antecedent Moisture Condition

Day 1	Day 2	Day 3	Day 4	Day 5
0	0	0	0	0

Init Unsat Stor (cm)	10	Initial InitSnow (cm)	0
Init Sat Stor (cm)	0	Sed Delivery Ratio	0.193
Recess Coef (1/dia)	0.1	Sediment A Factor	7.2006E-04
Seepage Coef (1/dia:)	0	Unsat Avail Wat (cm)	11.6416
Tile Drain Density	0	Tile Drain Ratio	0.5

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Attachment G

Equal Marginal Percent Reduction Method

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

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

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

3. Actual EMPR Process.

    a. Each land use/source load is compared with the total ALA to determine if any contributor would exceed the ALA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving waterbody. If the contributor exceeds the ALA, that contributor would be reduced to the ALA. If a contributor is less than the ALA, it is set at the existing load. This is the baseline portion of the EMPR.
    b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the ALA. If the ALA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

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

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

Attachment H

Equal Marginal Percent Reduction Calculations for the Buffalo Creek Watershed TMDL

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable							
	Load = loading rate in ref. * Acres in Impaired					419.397	419						
	471.598												
	SEDIMENT LOADING												
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction	
	Hay/Past.	39.068	1352.666	good	39	ADJUST	0.04	23.226	15.842	219.90	0.072	59%	
	Cropland	510.849		bad	419	615	0.41	249.329	170.068	375.60	0.453	67%	
	Developed	646.356		bad	419		0.41	249.329	170.068	66.70	2.550	74%	
	Streambank	156.393		good	156		0.15	92.975	63.418			59%	
	Total	1352.666			1034.25576		1.00		419.397				
Step 4:	All Ag. Loading Rate	0.31											
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.						
	Final Hay/Past. LA	219.90	0.072	15.842	0.178	39.068	59%						
	Final Cropland LA	375.60	0.453	170.068	1.360	510.849	67%						
	Developed	66.70	2.550	170.068	9.690	646.356	74%						
	Streambank			63.418		156.393	59%						
	Total			419.397		1352.666	69%						
	UNT 19039												

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					1.001	1					
	1.117											
	PHOSPHORUS LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	0.1042	0.807	good	0	quit	0.13	0.000	0.104	219.90	0.000	0%
	Cropland	0.4324		good	0	0	0.54	0.000	0.432	375.60	0.001	0%
	Developed	0.2669		good	0		0.33	0.000	0.267	66.70	0.004	0%
	Streambank	0.0035		good	0		0.00	0.000	0.004			0%
	Total	0.807			0.807		1.00		0.807			
Step 4:	All Ag. Loading Rate	0.00										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	219.90	0.000	0.104	0.000	0.104	0%					
	Final Cropland LA	375.60	0.001	0.432	0.001	0.432	0%					
	Developed	66.70	0.004	0.267	0.004	0.267	0%					
	Streambank			0.004		0.004	0%					
	Total			0.807		0.807	0%					
	UNT 19039											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable		
	Load = loading rate in ref. * Acres in Impaired					124.944	125	
	138.948							

SEDIMENT LOADING

Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	5.7534	242.3242	good	6	ADJUST	0.03	2.261	3.492	79.10	0.044	39%
	Cropland	161.4247		bad	125	81	0.61	49.105	75.839	170.50	0.445	53%
	Developed	51.3973		good	51		0.25	20.200	31.197	24.80	1.258	39%
	Streambank	23.7488		good	24		0.12	9.334	14.415			39%
	Total	242.3242			205.843532		1.00		124.944			

Step 4:	All Ag. Loading Rate	0.32

Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
	Final Hay/Past. LA	79.10	0.044	3.492	0.073	5.753	39%
	Final Cropland LA	170.50	0.445	75.839	0.947	161.425	53%
	Developed	24.80	1.258	31.197	2.072	51.397	39%
	Streambank			14.415		23.749	39%
	Total			124.944		242.324	48%

UNT 19034

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable	
	Load = loading rate in ref. * Acres in Impaired					0.296	0
	0.329						

PHOSPHORUS LOADING

		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
Step 3:												
	Hay/Past.	0.0352	0.2669	good	0	quit	0.13	0.000	0.035	79.10	0.000	0%
	Cropland	0.1901		good	0	0	0.71	0.000	0.190	170.50	0.001	0%
	Developed	0.0411		good	0		0.15	0.000	0.041	24.80	0.002	0%
	Streambank	0.0005		good	0		0.00	0.000	0.001			0%
	Total	0.2669			0.2669		1.00		0.267			

Step 4: All Ag. Loading Rate 0.00

		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
Step 5:							
	Final Hay/Past. LA	79.10	0.000	0.035	0.000	0.035	0%
	Final Cropland LA	170.50	0.001	0.190	0.001	0.190	0%
	Developed	24.80	0.002	0.041	0.002	0.041	0%
	Streambank			0.001		0.001	0%
	Total			0.267		0.267	0%

UNT 19034

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					414.123	414					
	462.450											
	SEDIMENT LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	66.9590	2356.522	good	67	ADJUST	0.06	40.110	26.849	286.60	0.094	60%
	Cropland	1517.7530		bad	414	619	0.40	248.066	166.056	467.00	0.356	89%
	Developed	634.2470		bad	414		0.40	248.066	166.056	86.50	1.920	74%
	Streambank	137.5630		good	138		0.13	82.403	55.160			60%
	Total	2356.5220			1032.767136		1.00		414.123			
Step 4:	All Ag. Loading Rate	0.26										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	286.60	0.094	26.849	0.234	66.959	60%					
	Final Cropland LA	467.00	0.356	166.056	3.250	1517.753	89%					
	Developed	86.50	1.920	166.056	7.332	634.247	74%					
	Streambank			55.160		137.563	60%					
	Total			414.123		2356.522	82%					
	UNT 19005											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					0.983	1					
	1.095											
	PHOSPHORUS LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	0.1539	1.6209	good	0	ADJUST	0.10	0.054	0.100	286.60	0.000	35%
	Cropland	1.0841		bad	1	1	0.65	0.347	0.636	467.00	0.001	41%
	Developed	0.3799		good	0		0.25	0.134	0.246	86.50	0.003	35%
	Streambank	0.0030		good	0		0.00	0.001	0.002			35%
	Total	1.6209			1.520042		1.00		0.983			
Step 4:	All Ag. Loading Rate	0.00										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	286.60	0.000	0.100	0.001	0.154	35%					
	Final Cropland LA	467.00	0.001	0.636	0.002	1.084	41%					
	Developed	86.50	0.003	0.246	0.004	0.380	35%					
	Streambank			0.002		0.003	35%					
	Total			0.983		1.621	39%					
	UNT 19005											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable	
	Load = loading rate in ref. * Acres in Impaired					198.954	199
	221.426						

SEDIMENT LOADING

Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	8.7670	463.349	good	9	ADJUST	0.03	3.258	5.509	79.10	0.070	37%
	Cropland	345.6990		bad	199	118	0.63	73.931	125.023	170.50	0.733	64%
	Developed	75.7260		good	76		0.24	28.140	47.586	24.80	1.919	37%
	Streambank	33.1570		good	33		0.10	12.321	20.836			37%
	Total	463.3490			316.604328		1.00		198.954			

Step 4:	All Ag. Loading Rate	0.52

Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.
	Final Hay/Past. LA	79.10	0.070	5.509	0.111	8.767	37%
	Final Cropland LA	170.50	0.733	125.023	2.028	345.699	64%
	Developed	24.80	1.919	47.586	3.053	75.726	37%
	Streambank			20.836		33.157	37%
	Total			198.954		463.349	57%

UNT 18921

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					0.471	0					
	0.524											
	PHOSPHORUS LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	0.0482	0.5447	good	0	ADJUST	0.09	0.007	0.042	98.80	0.000	14%
	Cropland	0.4276		good	0	0	0.79	0.058	0.370	252.00	0.001	14%
	Developed	0.0682		good	0		0.13	0.009	0.059	66.70	0.001	14%
	Streambank	0.0007		good	0		0.00	0.000	0.001			14%
	Total	0.5447			0.5447		1.00		0.471			
Step 4:	All Ag. Loading Rate	0.00										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	98.80	0.000	0.042	0.000	0.048	14%					
	Final Cropland LA	252.00	0.001	0.370	0.002	0.428	14%					
	Developed	66.70	0.001	0.059	0.001	0.068	14%					
	Streambank			0.001		0.001	14%					
	Total			0.471		0.545	14%					
	UNT 18921											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					273.338	273					
	304.136											
	SEDIMENT LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	22.3560	802.247	good	22	ADJUST	0.04	11.375	10.981	200.20	0.055	51%
	Cropland	519.1230		bad	273	283	0.49	139.072	134.266	323.70	0.415	74%
	Developed	192.3840		good	192		0.35	97.884	94.500	66.70	1.417	51%
	Streambank	68.3840		good	68		0.12	34.793	33.591			51%
	Total	802.2470			556.462004		1.00		273.338			
Step 4:	All Ag. Loading Rate	0.28										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	200.20	0.055	10.981	0.112	22.356	51%					
	Final Cropland LA	323.70	0.415	134.266	1.604	519.123	74%					
	Developed	66.70	1.417	94.500	2.884	192.384	51%					
	Streambank			33.591		68.384	51%					
	Total			273.338		802.247	66%					
	Muddy Run											

Step 1:	TMDL Total Load				Step 2:	Adjusted LA = (TMDL total load - MOS) - uncontrollable						
	Load = loading rate in ref. * Acres in Impaired					1162.919	1163					
	1292.193											
	SEDIMENT LOADING											
Step 3:		Non-MS4 Daily Average Load	Load Sum	Check	Initial Adjust	Recheck	% reduction allocation	Load Reduction	Initial LA	Acres	Allowable Loading Rate	% Reduction
	Hay/Past.	164.8767	6803.241	good	165	ADJUST	0.08	68.158	96.719	588.10	0.164	41%
	Cropland	5983.7260		bad	1163	820	0.59	480.737	682.182	1887.90	0.361	89%
	Developed	186.3014		good	186		0.09	77.015	109.287	296.60	0.368	41%
	Streambank	468.3369		good	468		0.24	193.605	274.732			41%
	Total	6803.2410			1982.4337		1.00		1162.919			
Step 4:	All Ag. Loading Rate	0.31										
Step 5:		Acres	Allowable (Target) Loading Rate	Final LA	Current Loading Rates	Current Load	% Red.					
	Final Hay/Past. LA	588.10	0.164	96.719	0.280	164.877	41%					
	Final Cropland LA	1887.90	0.361	682.182	3.170	5983.726	89%					
	Developed	296.60	0.368	109.287	0.628	186.301	41%					
	Streambank			274.732		468.337	41%					
	Total			1162.919		6803.241	83%					
	BEAVER RUN											

Attachment I

Comment & Response Document for the Buffalo Creek Watershed TMDL

COMMENTOR: Anonymous

Public Comments on Buffalo Creek Watershed TMDL of January 23, 2009

I attended the public meeting for the Draft presentation of the Buffalo Creek Watershed TMDL sponsored by the Buffalo Creek Watershed Alliance, DEP and SRBC and received a copy of the draft document.

The following are some of my comments divided into two types; 1) typos or other simple mistakes and 2) basic disagreements with the methodology or assumptions of the TMDL.

1) Typos or other simple mistakes

Comment: Page 1; Item 2. First line should be ….1998 303(d) list identifies 15.46 miles (not 40.94 miles). The last sentence is very unclear; specify that the numbers are max min values from particular sub watersheds.

Response: The changes to Item 2 on Page 1 have been corrected.

Comment: Page 2; Item 3. Mean "annual" sediments ….. are really "daily" as indicated by the units on the numbers. Assuming the required reductions come from Tables 24-29 the results should be sediment 48 to 83% and nutrients 0 to 39%.
Item 5, Tables, It is unbelievable that all sediment reductions are either 10 or 11% and all Phosphorus reductions are between 33 and 36%. It is probably because the "Current Loading" column is not taken from Table 4 and 5 "Existing … Loads and Yields" as it should be, but instead from TMDL Tables 18-23 where the two lines are clearly directly related.

Response: The changes to Item 3 on Page 2 were corrected.

Comment: Page 3; Item 6. Last sentence should be …ranged from 13.9 to 129.

Response: The changes to Item 6 on Page 3 have been corrected.

Comment: Page 4; line 6. Insert … County "to Eastern Union County", where it joins …..
Line 10 Lochiel and Linntown are not in the Buffalo Creek watershed.

Response: The changes to line 6 on Page 4 have been corrected.

Comment: Page 9; Line 1. …identifies 39.08 miles …. Should be either 40.94 miles from page 1. Item 2): or total of Table 1 "Miles" column (33.48 miles). I see no reason why all three should not be the same.

Response: The number 33.48 was used to replace the other values.

Comment: Page 11; Line 5. Clearly the area of the reference watershed is not within 20-30% of the area of the Beaver run watershed.

Response: There is a range in size for all the impaired watersheds. This reference watershed was used because it was best representation of all attributes among the impaired segments.

Comment: Page 15; Line 6. …visited "both" watersheds… I don't understand what "both" refers to. Final paragraph line 3, "respectively"?

Response: The word "both" was replaced with "the watershed".

Comment: Page 16; Table 3. The Beaver Run Forest area of "-" is way low, I own nearly 20 acres of forest with a nearby 5 -10 acres. Similarly the 282 acres of Lo_int_Dev seems too high.

Response: Based on the delineation of the areas of impairment, these are numbers that were generated by the Pennsylvania land use layer provided in the AVGWLF model.

Comment: Page 25; Line 1. …the "annual total" sediment… Should be …the "rate" of sediment…Line 2. Should include Beaver Run
Second Paragraph, Line 2. Should read (Tables 18-23).

Response: The requested changes have been added to the document.

Comment: Page 29; The PUBLIC PARTICIPATION section is wrong.

Response: The public participation section on page 29 is correct.

Comment: Page 42; Arrgh.

Response: It is standard to give 30-45 days for public review.

Comment: Page 51; Paragraph 3, Line 6, KLSCP seem not be used to calculate "changes" but rather "values". Also C and P don't seem to be independent variables.

Response: The requested changes have been added to the document.

Comment: Page 58. Lower file is misnamed it should be UNT 18921 Transport Input File.

Response: The lower file on page 58 now reads UNT 18921 Transport Input File.

Comment: 2) Basic disagreements with the methodology or assumptions of the TMDL

The use of significant figures in the report is very bad. Just because the spreadsheet will calculate a result with seven figures doesn't mean that all of them are significant since the base data has at most 3 or 4 significant figures. The larger number of figure is harder to understand and give a false sense of accuracy.

Nutrient loading should be included for Muddy Run and Beaver Run.

On the maps the watershed outlines are clearly visible but the "impaired sections" which are apparently used to calculate acres of particular "Land Use" are impossible to determine. For example in Table 3 the 54.4 acres of forest in the Muddy Run watershed makes no sense from the map or for considering the effluent sediments and nutrients of the sub watershed.

Page 10-11 TMDL Endpoints. The argument for using and controlling the Phosphorus load as opposed to Nitrogen seems to be only very local and disregards local variation of the N/P ratio and the concerns for excess nutrients in the Susquehanna River and the Bay. Given that the data and computer programs are available why not just do both N and P. What is the source for "N/P ratio is approximately 36"?

Page 15 Watershed Assessment and Modeling. The decision to reset P factors for cropland, hay/pasture, and transitional, drives the entire results of the report. A simple statement such as "Install pervasive riparian buffer zones, streambank fencing, and stabilize streambanks in the impaired watersheds as they are in the reference watershed" in the summary section would have eliminated the need for all of the confusing tables numbers and appendices.

Response: Since the Commonwealth changed from displaying annual loadings to daily loadings, it is has become inherently difficult to maintain consistency in significant figures when loadings are expressed in such small amounts.

Nutrient loading was not included for Muddy Run or Beaver Run because the 303(d) list at the time of the report writing.

The boundaries for the impaired sections of the subwatersheds in this report are outlined with a yellow and black line. The area inside these polygons was used to calculate land use distributions using AVGWLF.

Phosphorus is used in nutrient reduction when the nitrogen to phosphorous ratio is great than 10. When the nitrogen to phosphorous ratio is less than 10, nitrogen is used as the limiting parameter. The average nitrogen to phosphorous ratio is 36.

Adjusting C and P numbers is a way to fine tune the model (AVGWLF) and gain appropriate reductions in the reference watershed approach.