WATERSHED IMPLEMENTATION PLAN

MILL CREEK

Prepared by Lancaster County Conservation District

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Watershed Background

The Mill Creek watershed is located in Lancaster County, Pennsylvania. The watershed encompasses ten municipalities; East Earl, East Lampeter, Earl, Leacock, Pequea, Salisbury, Upper Leacock, and West Lampeter Townships, as well as New Holland Borough and the City of Lancaster. The Mill Creek Watershed drains 56.46 sq. miles or 36,134 acres of mostly agricultural land. There are 76.8 total stream miles in the Mill Creek watershed comprised of 38.9 miles of 1st order streams, 13.1 miles of 2nd order, 19.5 miles of 3rd order, and 5.3 miles of 4th order streams. The Mill Creek watershed is in sub-basin 07J and is included in HUC Area 2050306-Lower Susquehanna River, a Category I-FY99/2000 Priority watershed. Major tributaries of the Mill Creek watershed include Muddy Run, Groff Run, and Big Spring Run. The watershed can be broken down even further by dividing the Mill Creek proper into the "Upper" Mill Creek section (27.03 sq. miles) and "Lower" Mill Creek section (12.08 sq. miles) (this nomenclature is not on any official topographic maps but locals do use these boundaries to break the watershed down further). (Figure 1)

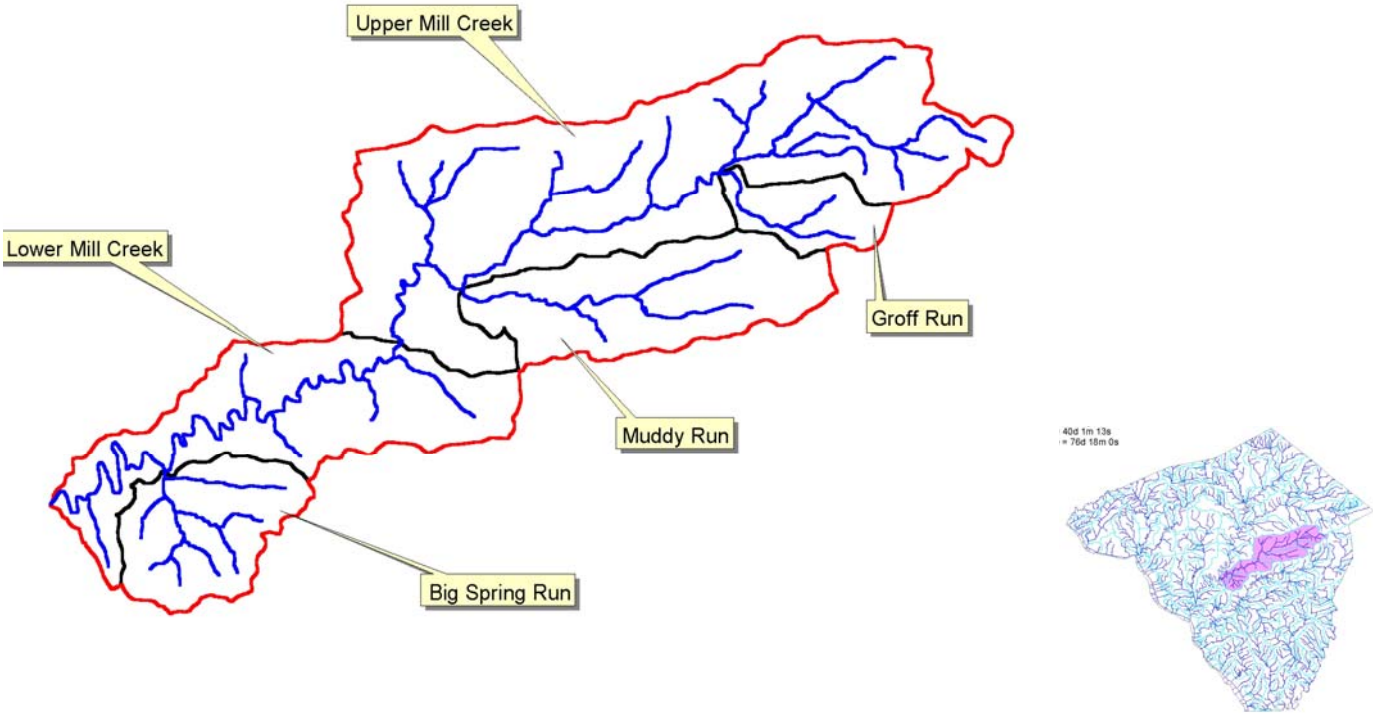


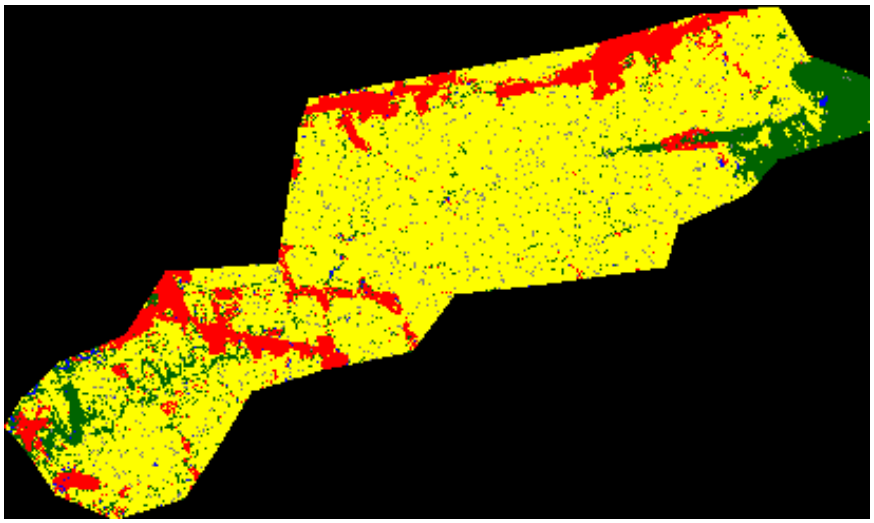
Figure 1: Map of Mill Creek Watershed and Sub-Watersheds

The Mill Creek Watershed flows in a Southwesterly direction originating from the Welsh Mountains. It then flows South around New Holland Borough, between Leola and Intercourse, North and West of Bird-in-Hand, North around Strasburg Borough, and South of the City of Lancaster before empting into the Conestoga River near New Danville. According to the Pennsylvania Department of environmental Protection there is a High Quality Cold Water Fisheries Section in the Mill Creek Watershed located on an unnamed tributary from the New Holland Reservoir (source to tail waters of reservoir). In addition, three major transportation arties cross the Mill Creek watershed and threaten the rural nature of the watershed, Routes 30, 340, and 23.

The highest point in the Mill Creek Watershed is an unnamed hill in the Welsh Mountains with an elevation of 1,100 ft. The lowest point occurs at the confluence of Mill Cr. with the Conestoga River at an elevation of 230 ft. Letort-Pequea-Conestoga and the Duffield-Hagertown soils account for 95% of the sols in the watershed. These soils are nearly level to steep, well-drained soils, undulating broad valleys, formed in residuum from limestone. The Clymer-Chester soils account for the remaining 5% in the watershed. These soils are nearly level to very steep, well-drained soils formed in residuum from sandstone, micaschist, and quartzite. The Clymer-Chester soils make up the area of the Welsh Mountains. In addition, 95% of the watershed is underlain with carbonate geology which has an increased risk of sinkhole formation.

Land use in the Mill Creek Watershed is comprised of 67.5% cropland (24,340 acres), 9.6% residential (3,470 acres), 7.9% woodland (2,857 acres), 7.2% commercial/industrial (2,390 acres), 3.2% open space (1,142 acres), 2.6% pastureland (947 acres), and 2.0% farmsteads (706 acres). (Figure 2) Old Order Amish and Mennonite families who follow traditional farming methods own many of the farms in the upper and mid reaches of the Mill Creek Watershed. One report on the Mill Creek Watershed claims it has some of the highest densities of dairy cows found anywhere in Pennsylvania. The watershed is subjected to a variety of non-point source pollutants including organic enrichment and siltation from agriculture, on-lot septic systems, stream bank erosion and lack of stabilization, and unrestricted cattle access along streams. It can also be observed that little to no riparian zone exists along the streams in the watershed. Other issues in the watershed include;

general lack of strip cropping and contour plowing, croplands and pastures extending right up to stream banks, and heavily grazed pastureland.



Map Legend

Red - Developed Areas
Green - Forested Tracts
Yellow - Agricultural Lands
Blue – Water Features

Figure 2: Land use within the Mill Creek Watershed

In addition, the majority of the stream banks along the Mill Creek are in dire need of stabilization measures. Most of the unstable reaches are due to the presence of livestock that have not been fenced out of the stream corridor. The rest of the unstable banks are due to the presence of numerous mills on the Mill Creek over the last 150-200 years. These mills had dams associated with them and would back up water and more importantly silt for the entire length of the creek behind the dam. As these dams were removed, because of fish migration measures and safety concerns, the sediment that was once buried underwater behind these dams is now exposed and today the new stream channel is cutting through this very alluvial material.

Impairment Listings

According to the Pennsylvania Department of Environmental Protection's (PA DEP) 303(d) list the following streams sections are impaired by agricultural practices and are in the greatest need of agricultural best management practices, such as; cattle exclusion, cropland terraces, contour farming, grass waterways, manure management, stream bank stabilization, and restoration of riparian buffers. Impaired sections include; Mill Creek (16.74 miles), 14 unnamed tributaries (17.22 miles), Big Spring Run and 6 unnamed tributaries (9.25 miles), Groff Run (4.08 miles), and Muddy Run and 2 unnamed tributaries (8.46 miles). (Table 1) In addition, Mill Creek has a point source discharge with high chloride content according to PA DEP's records. "A U.S. EPA biological study of agricultural areas in the Mid-Atlantic region stated that it was impossible to find healthy streams in the Limestone/Dolomite Lowlands Ecoregion of the Piedmont including Mill Creek due to poor farming practices in these watersheds for the past 100 years." Sampling benthic macroinvertebrates showed severe degradation in Lowland streams including Mill Creek. The most severely impaired sites were on tributaries, especially Muddy Run and unnamed tributaries. Main stem Mill Creek was in slightly better condition than its tributaries.

Table 1: Impairment Listings for the Mill Creek Watershed (DEP's Section 303(d)/305(b) Report)

Stream	**Stream Code**	**Drainage Area Square Miles**	**Miles Impaired**	**Miles Attained**	**Sources/Cause/ Comments**
Mill Creek	07957	56.4	16.74 main stem; 17.22 of 14 UNTs	9.84 main stem; 8.18 of 5 UNTs	Nutrients & siltation from AG/grazing & crops; Road runoff, Land development, One UNT-Industrial point source impairment
Groff Run & one UNT	07620	2.63	4.08		Nutrients & siltation from AG/grazing
Muddy Run	07613	8.84	5.6 main stem; 2.86 of 2 UNTs		Nutrients & siltation from AG/grazing
Big Spring Run	07599	5.80	2.21 main stem; 7.04 of 6 UNTs		Nutrients & siltation from AG

Past Studies

Several environmental studies have been done in the Mill Creek watershed over the years. Below is a summarization of those projects.

1. In 1991 the Bureau of Water Quality Management became involved with the *United States Dairy Association's (USDA) Water Quality Hydrologic Unit Project* in the Pequea-Mill Creek Watershed Basins. In this project specific riparian landowners agreed to allow the Pennsylvania Game Commission to fence Muddy Run and an unnamed tributary to prevent livestock from having full access to these stream sections. In 1992 the Southcentral Region Water Management Program was invited to participate in the project by performing aquatic biological investigations on the two streams every two years to determine if the fencing program was accomplishing its goal of improved habitat. Some of the comments from folks first involved in this project explain it all; "the benthic macroinvertebrate community was similar to the communities found in very stressed or degraded systems, analysis for water chemistry samples showed signs of severe impact, the water temperature increased 8 degrees in 6 hrs-this shows that despite the limestone spring influence the stream warms considerably in the summer because of a lack of riparian shading, the depth of the silt is considerable in some places-it is over one foot thick near the stream banks." Overall, the physical habitat was about as bad as one could imagine. This study's recommendation was stream bank fencing but also conceded that while fencing would certainly improve habitat over time, much more dramatic improvements would be realized if some stream restoration work (silt removal, channel modifications, riparian plantings, and/or bank stabilization) could be done in addition.

The results of this study showed that the riparian habitat along the upper two stations on Muddy Run did show improvement due to the installation of fencing and the resulting limited access of livestock. Stream banks were far more stable due to the establishment of vegetative cover. The lower Muddy Run site that was not fenced was typical of the majority of streams in Lancaster County, with cattle-trodden, eroding banks lacking good vegetative cover.

2. As part of the Pequea/Mill Creek National Monitoring Program project, under the direction of the United States Geological Service (USGS) and Natural Resource Conservation Service (NRCS), another project was conducted between 1993-1998 on *Trends in Surface-Water Quality during Implementation of Best Management Practices in Mill Creek and Muddy Run Basins, Lancaster County, Pennsylvania*. During the project about 12 to 15 miles out of 70 total stream miles in Mill Creek had been fenced and 50 manure storage facilities were installed. About 20% of the farms with stream bank fencing also implemented barnyard runoff controls. Most of the BMP's were installed in the Muddy Run portion of Mill Creek Watershed. Upstream of Muddy Run, 16 farms or 3.5 of 8 total stream miles were fenced. Five manure storage facilities were also installed in the Muddy Run basin.

Results indicated significant trends in reduction of nutrients and residue after installation of agricultural BMP's. The strongest trends were a greater than 50% reduction in concentrations of total and dissolved phosphorous (P) and residue in base flow in Mill Creek and Muddy Run. Storm flow samples showed a 31% reduction in total P concentrations in Mill Cr. and a 54% decrease in non-filterable residue in Muddy Run.

This USGS study indicated that stream bank fencing in connection with other BMP's such as stream crossings, manure storage, and rotational grazing is effective in reducing polluted runoff and improving water quality. They stated that many more BMP's were necessary to complete the restoration efforts already started. Additional improvements in water quality could be expected with installation of additional BMP's; however, "because of the magnitude of the problem achievement of water quality standards may not be observed for some time."

3. Between 1993 and 2001 the United States Geological Service, the Natural Resource Conservation Service, the Environmental Protection Agency, and the PA Department of Environmental Protection conducted the *Pequea and Mill Creek Watershed Section 319 National Monitoring Program Project*. The project was centered on Big Spring Run, a tributary to Mill Creek. The study reviewed the effects of two small watershed basins within the Big Spring Watershed. In one basin the partners implemented

stream bank fencing practices and in the other basin no BMP's were implemented. Surface and groundwater testing was conducted to study the effects of this very common BMP.

The results of this long-term study showed significant reductions in sediments, total Nitrogen, and total Phosphorous in the treatment basin. They were also able to show that groundwater flow paths affected water quality in an adjacent stream reach. Finally, the study showed improved habitat after fencing was completed and a healthier benthic community as well.

4. In July of 1998, Matthew Lisowski conducted an assessment of stream suitability for brown and brook trout in three southern Pennsylvania streams. The streams studied included Mill Creek and its tributary stream Big Spring Run. Mr. Lisowski was looking at stream temperature affects on the biota.

5. An ACT 167 plan was completed for the entire Mill Creek Watershed in 1998 by the Lancaster County Engineering Office. The plan outlined stormwater issues within the watershed and ways to reduce these concerns in the future.

6. In February of 2001, Tetra Tech, Inc. completed a Total Maximum Daily Load (TMDL) Plan for the Muddy Run Watershed. The plan comprised the entire 9 square mile Muddy Run watershed. (See below for more information on this document)

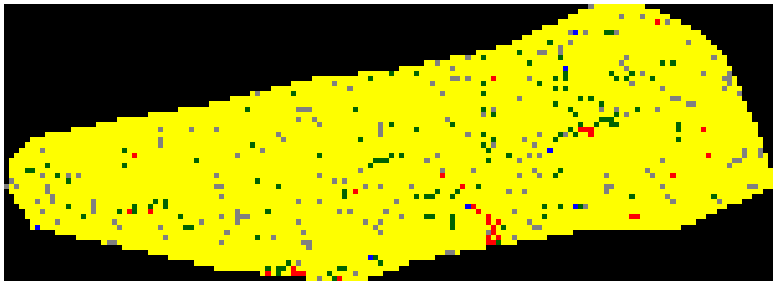
7. Finally, in 2004 another TMDL was developed for an unnamed tributary to Mill Creek in Upper Leacock Township. This plan covers a 3.4 square mile section of three unnamed tributaries and was created because of the 1996 listing of these particular sections of streams on DEP's 303(d). (See below for more information on this document)

Total Maximum Daily Loads

Two Total Maximum Daily Load (TMDL's) Plans were completed for two sub-watersheds within the Mill Creek Watershed. One was completed in February of 2001 on the Muddy Run tributary. This TMDL was subcontracted out by PA DEP to Tetra Tech, Inc. The remaining TMDL was completed in August of 2004 by the Susquehanna River Basin Commission on an Unnamed Tributary Stream (UNT) to Mill Creek. Both TMDL's are listed below with Load Reduction Requirements and other pertinent information. (Tables 2-5)

Muddy Run TMDL

The PA DEP listed 5.4 miles of streams (including 1.2 and 2.0 miles of Muddy Run listed for nutrients and suspended solids, respectively) on the 1996 303(d)/305(b) list. The TMDL developed covers a total of 3.2 miles of stream segments in the approximately 9 square mile Muddy Run watershed. The Muddy Run watershed is primarily in agricultural land use, with 98% in pasture/hay or cropland (47.1% cropland and 49.7% hay/pastureland). (Figure 3) Estimated population of Muddy Run watershed was 2,028 in 1995 and there were 583 households. 94% of the households use septic systems. Based on USGS water quality data estimated concentrations of nitrogen and phosphorous in groundwater in the watershed are 3.4mg/L and 0.024mg/L. In 1982 soil erosion rates in the Muddy Run watershed were over 10 tons per acre, almost double the state average.



Map Legend

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Figure 3: Land use within the Muddy Run Watershed

Table 2: The major components of the Muddy Run TMDL are summarized below:

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

Table 3: Load allocations for Muddy Run by land use/source:

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

Unnamed Tributary Stream (UNT) to Mill Creek TMDL

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

Table 4: The major components of the UNT Mill Creek TMDL are summarized below:

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

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

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

Problem Identification by Subwatershed

Big Spring Run:

The Big Spring Run drainage area is 3,712 acres or 5.8 square miles and is located in the Southwest corner of the Mill Creek Watershed. According to PA DEP's 303(d) list, 2.21 miles of the main stem of Big Spring Run are impaired and 7.04 miles of 6 unnamed tributary streams are impaired. The causes for this impairment are nutrients and siltation from agricultural sources. The Big Spring watershed has undergone substantial BMP implementation within the last 10 years. The majority of the BMP's installed over this time frame have included stream bank fencing, Conservation Reserve Enhancement Program (CREP) plantings, and barnyard controls/waste storage structures. Future projects within the watershed include additional stream bank fencing, riparian buffer establishment, stream stabilization, and cropland BMP's.

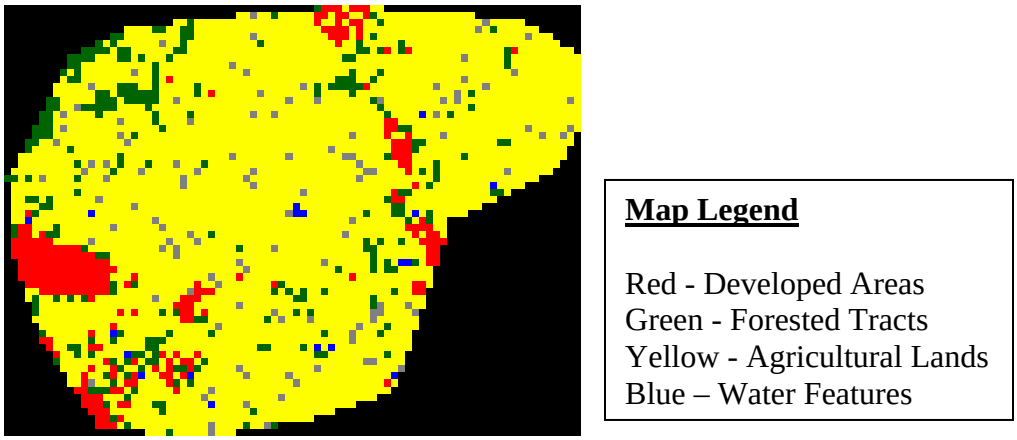

Figure 4: Land use within the Big Spring Run Watershed

Muddy Run:

The Muddy Run drainage area is 5,658 acres or 8.84 square miles and is located in the Southcentral part of the Mill Creek Watershed. Once again, according to PA DEP's 303(d) list, 5.6 miles of the main stem of Muddy Run are impaired and 2.86 miles of 2 unnamed tributary streams are impaired. The causes for this impairment are nutrients and siltation from agricultural & grazing sources. One comment PA DEP made during there assessment of Muddy Run was that it has "sediment-laden substrate, eroded banks, and excessive aquatic macrophyte growth due to high nutrient and sediment laden runoff from dairy farms." Since this assessment

and subsequent TMDL development substantial BMP's have been implemented throughout the watershed. The majority of this work consisted of stream bank fencing, cattle crossings, and riparian buffers. The work was carried out by NRCS, U.S. Fish and Wildlife Service (USFWS), and the Lancaster County Conservation District. Additional BMP's are needed throughout the watershed, such as, cropland BMP's, additional stream bank fencing measures, riparian buffer establishment, stream bank stabilization measures, barnyard runoff controls, and waste storage structures.

Groff Run:

The Groff Run drainage area is 1,683 acres or 2.63 square miles and is located in the Northeast part of the Mill Creek Watershed. According to PA DEP's 303(d) list, 4.08 miles of Groff Run are impaired. The causes of this impairment are nutrients and siltation from agricultural and grazing sources. Do date only minimal BMP work has been conducted in this watershed. Work that has been done includes stream bank fencing and barnyard and waste storage work. Additional BMP's in the form of riparian buffer establishment, stream bank restoration efforts, cropland BMP's, and additional stream bank fencing work needs to be accomplished.

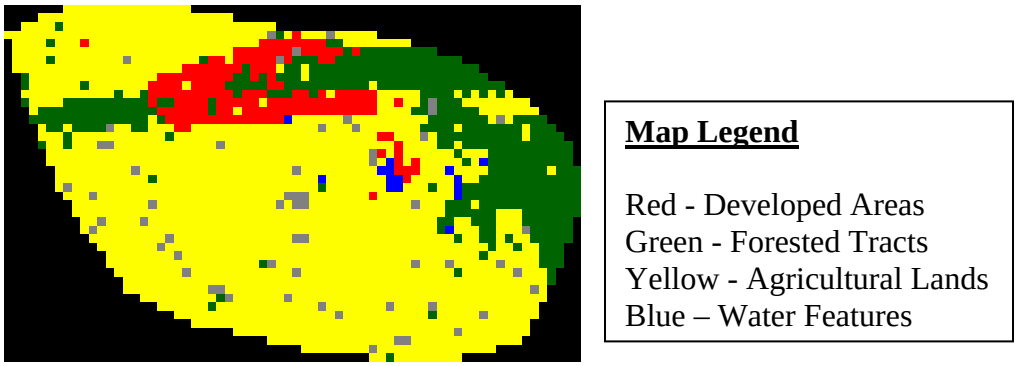

Figure 5: Land use within the Groff Run Watershed

Problem Identification

Sedimentation and Nutrient Loading:

The majority of the impairments in the Mill Creek Watershed stem from agricultural practices. There are roughly 500 farms in the Mill Creek Watershed, of which approximately 250 of these farms have a conservation plan developed for their operations. 125 of the 250 farms have a conservation plan that is current and actively followed according to research done by the Conservation District and NRCS. Nearly half of all conservation plans in the watershed are not fully implemented or totally up-to-date. The Conservation District works hard to make sure these plans are followed to the fullest but with the number of farms in Lancaster County, let alone in the Mill Creek Watershed, and the amount of staff devoted for just such tasks it is very difficult.

On the positive end a tremendous amount of effort has been directed toward agricultural producers in the Mill Creek Watershed from the Conservation District and NRCS. Most of this momentum was started by Frank Lucas from NRCS and District staff at our satellite office in Smoketown, the heart of the Mill Creek Watershed. As shown with past studies and projects, numerous BMP's have been implemented within the last 10-15 years in the watershed. The majority of these BMP's have involved stream bank fencing, agricultural waste storages, and barnyard controls. These efforts have been monumental considering that almost half of the watershed residents are plain sect farmers. The District and NRCS has made a conscience effort to work with one Amish farmer at a time in hopes that others will see the conservation measures and continue the effort on their property. Obviously this is not a fast process but results can be observed over the long haul.

Stream bank Stability:

Recently on going conservation efforts have spurred a new watershed association working within the Mill Creek Watershed, the Millcreek Preservation Association. One of the main focuses of this group, beside agricultural BMP implementation, has been stream bank stability of the many banks along the Mill Creek and its tributaries. The name of Mill Creek gives away a lot of the history of the watershed. Since the early 1800's

man has used Mill Creek for power generation. Dams of all shapes and sizes dotted the Mill Creek Watershed for more than two centuries. At one time there were more then 22 mill dams in the Mill Creek watershed, today 5 larger dams and 13 smaller water obstructions remain throughout the watershed. (Figure 6) The dams of today and years past have caused major bank stability issues along Mill Creek. When in operation the dams in essence raised the floodplain level of the stream to a higher then normal elevation because of backed up silt behind the dam. When the dam is removed this sediment, sometimes called legacy sediment, is once again free to move down through the watershed carving out deeply incised channels and raising floodplain elevations. Sequentially, stormflows now can not access the floodplains because of their heights and they erode fragile stream banks instead. This perpetual cycle causes tremendous amounts of stress on barely vegetated stream banks causing them to slump off into the channel to reach a stable point. This process will continue until the stream reaches an equilibrium point where it no longer “power washes” the stream banks. It has been the contention of the Conservation District and other folks in Lancaster County that the current TMDL and other load reduction models to not fully take the effects of stream bank erosion into account or allow for this estimate into the model. In Lancaster County and the Mill Creek Watershed stream bank erosion is a major non-point source pollutant.

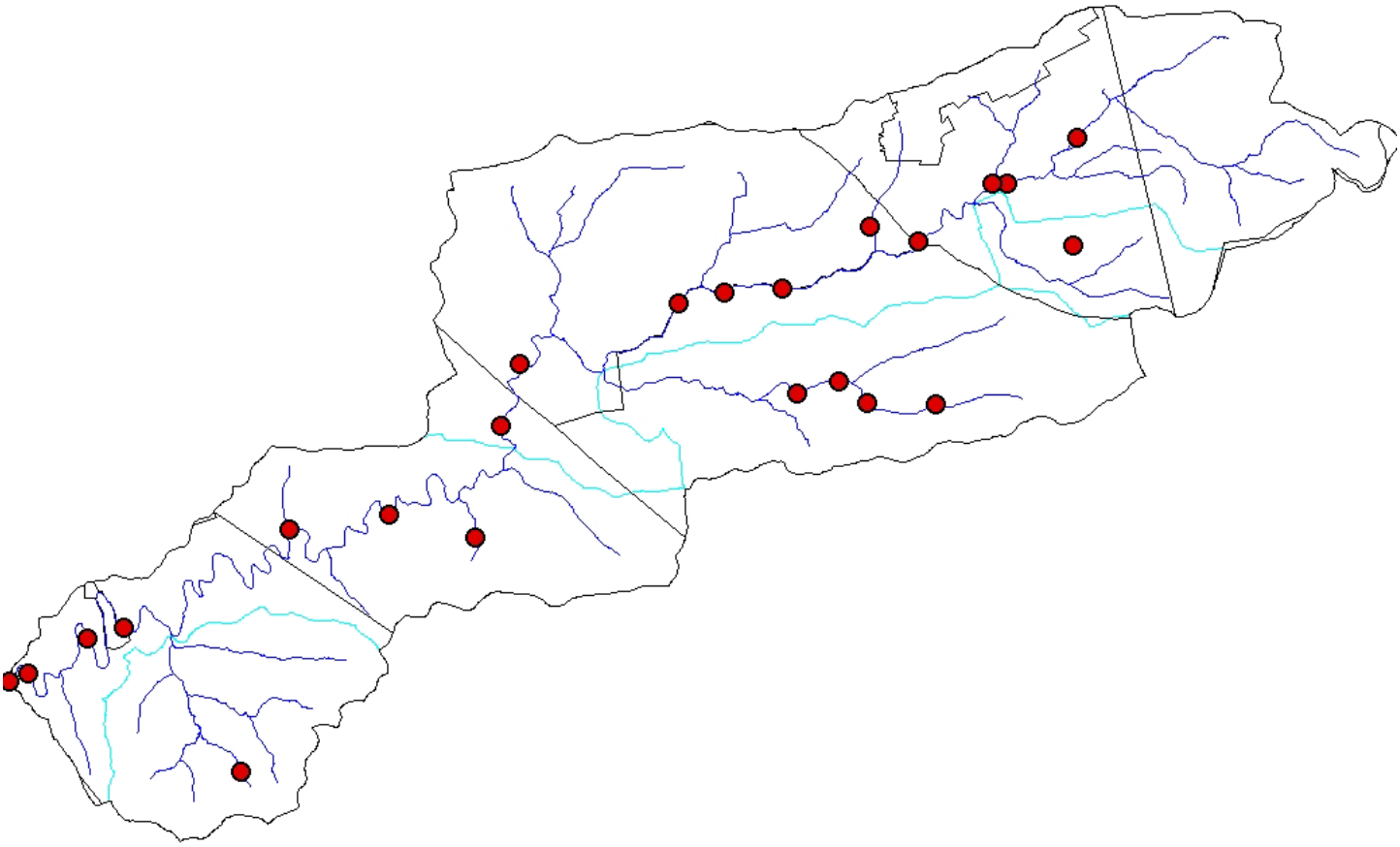

Figure 6: Map of dams or other water obstructions throughout the Mill Creek Watershed

Lack of Fish Habitat:

Another issue the local watershed association would like to see addressed would be the lack of fish habitat within the Mill Creek Watershed. The Conservation District and NRCS has realized the Amish and plain sect communities are concerned about the wildlife in and around the stream corridor. Many of the older farmers in the watershed remember going fishing on the Mill Creek and how great of an experience this was. Because of past agricultural issues and lack of unstable stream banks fish habitat has been depleted within the watershed. The watershed group with assistance from other agencies would like to reestablish a fish population in the watershed. Structures like mud sills, root wads, cross vanes, J-hooks, and deflectors, are all items the group would like to install throughout the watershed. The potential for Mill Creek and its tributaries is very promising considering the amount of small limestone spring sources all along the watershed. If BMP's were

put in place and stream banks were stabilized the natural springs of the watershed could create an awesome coldwater fishery in the future.

Development Pressure and Stormwater:

Probably one of the biggest threats to the watershed is increased development pressure. Because of the rural nature of the majority of the watershed a lot of open space has the potential to be developed in the coming decades. Growth should not be frowned upon as long it is managed smart growth that sets certain conservation and environmental standards. Stormwater influences can already be seen in the watershed due to increased impervious cover. Large shopping centers, restaurants, tourist destinations, and residential developments, have taken their toll in the mid to lower reaches of the watershed. Innovative stormwater practices will need to be implemented to lessen the impact of new develop in the watershed. As more farms are sold, development will progress outward into the countryside and stormwater and impervious cover will play a role in the overall watershed health. The key is to work with municipalities now to prevent further issues in the future. Municipal ordinances need to be reviewed and updated to promote livable high density communities that preserve open space and maximize the landscape.

Prioritization

Each project within this plan has been assigned a priority ranking. The ranking is meant to be a blueprint for those using this plan as to what projects should be addressed first. Each project is different in scope, cost, and the amount of load reduction relating to the project. Rankings were made by District staff, NRCS staff, and feedback from the Millcreek Preservation Association. The rankings are based on severity of pollution problem, proximity to stream, slope, complexity of project, and location in the watershed. Conservation District and NRCS staff have a tremendous amount of background on all projects and are probably the only reasonable folks to make these recommendations. A prioritization of 5 means this project can wait and is not an immediate concern, while a ranking of 1 means the problem needs to be addressed as soon as possible.

Obviously these rankings only suggest where to start, if a willing landowner steps forward and is ranked lower then another landowner not willing to work then common sense must take over. In addition, stormwater retro fits, though important, obviously cost much more then an agricultural BMP but both might provide the same benefit. Retro fits are more difficult to incorporate on the ground then a cropland practice so valued judgment by those using this plan will need to be taken.

BMP and Watershed Modeling

A number of tools and computer models were used to create this watershed plan. After all information for the Mill Creek Watershed was obtained through ground surveys, conservation plan reviews, and personal interviews, the data was entered into an ArcView Geographical Informational System (GIS). This allowed staff to map the watershed more accurately for planning purposes. We then entered our BMP data into a modeling tool created by Penn State University and PA DEP called the ArcView Non-Point Source Tool (AVNPS tool). This tool allowed us to enter past, present, and future BMP's throughout the watershed. (Figure 7) Next, working with Penn State University and PA DEP a scenario file for our 3 watersheds in the Mill Creek was created using the ArcView Generalization Watershed Loading Function (AVGWLF) model. The three watersheds we needed to analyze were the two TMDL watersheds, Muddy Run and the UNT Mill Creek, and the remaining Mill Creek Watershed. Because each TMDL completion or assessment date for the three watersheds was different three different scenarios needed to be created. Our ultimate goal was to obtain load reduction values in all of the watersheds for mainly sediment and phosphorous. Nitrogen was also calculated in our models to be comprehensive.

Once all of the above information was obtained a final modeling tool was used to calculate load reduction values. The modeling tool was the Pollution Reduction Impact Comparison Tool or PRedICT. This tool used the data that was gathered in the AVNPS tool and married it with the AVGWLF scenario file for that particular watershed giving us a load reduction value. Because past and future BMP's were put into the AVNPS tool, PRedICT is able to distinguish between what BMP's were put in prior to an assessment or TMDL date (Existing) and what are planned for the Future. All of this information is crucial for calculating load reduction values in the watershed.

Past Management Measures

Due to the size of the Mill Creek Watershed PA DEP had decided to assess parts of the watershed at various times over the last 8 years. The Muddy Run Watershed was assessed in September of 1998 (Table A) and its TMDL was completed in February 2001. The Unnamed Tributaries of Mill Creek with the TMDL developed for them was assessed in May of 2000 (Table B) and the TMDL was completed in August of 2004. The Big Spring Run Watershed was assessed in June and July of 2000 and the Groff Run Watershed was assessed in October of 1997. The rest of Mill Creek and its tributaries were assessed between September of 1998 and June of 2000 (Table C).

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

Table A: Existing/Future Planned BMP's in the Muddy Run Watershed

Agricultural Practices					
	Existing*	**Future**		**Existing***	**Future**
Row Crops BMP's					
Cropland Protection	231.7 ac	689.6 ac	Nutrient Management	414.4 ac	892.5 ac
Conservation Tillage	0	104.8 ac	Terraces/ Diversions	0	0
Stripcropping/ Contour Farming	5	325.0 ac			
Hay Pasture BMP's					
Grazing Land Management (Hay/Pasture)	24.0 ac	224.5 ac			
Other BMP's					
Waterway	600 ft & 1.5 ac	550 ft & 3.1 ac	Filter Strip	0	0
Barnyard Controls	5	20	Underground Outlet	0	0
Waste Facility	8	6	Field Borders	0	800 ft
Waste System	6	10			
Stream Bank BMP's					
Stream Miles w/ Vegetative Buffer Strip	0	7.0	Miles of Stream Bank Stabilized or Natural Channel Designed Projects	0.3	2.0
Stream Miles Fenced	1.5	7.0			

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

Table B: Existing/Future Planned BMP's in the UNT's Mill Creek Watershed

Agricultural Practices					
	Existing*	**Future**		**Existing***	**Future**
Row Crops BMP's					
Cropland Protection	0	83.3 ac	Nutrient Management	0	135.3 ac
Conservation Tillage	0	7.2 ac	Terraces/ Diversions	0	0
Stripcropping/ Contour Farming	0	0			
Hay Pasture BMP's					
Grazing Land Management (Hay/Pasture)	0	0			
Other BMP's					
Waterway	0	1.5 ac	Filter Strip	0	0
Barnyard Controls	0	4	Underground Outlet	0	0
Waste Facility	0	0	Field Borders	0	0
Waste System	0	2			
Stream Bank BMP's					
Stream Miles w/ Vegetative Buffer Strip	0.9	3.4	Miles of Stream Bank Stabilized or Natural Channel Designed Projects	0	1
Stream Miles Fenced	0.8	3.4			

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

Table C: Existing/Future Planned BMP's in the Mill Creek Watershed
(Not including Muddy Run & UNT Mill Creek Watersheds)

Agricultural Practices					
	Existing*	**Future**		**Existing***	**Future**
Row Crops BMP's					
Cropland Protection	569.2 ac	1,328.3 ac	Nutrient Management	1,243.2 ac	1,942.4 ac
Conservation Tillage	303.5 ac	427.5 ac	Terraces/ Diversions	3,112 ft	12,250 ft
Stripcropping/ Contour Farming	475.8 ac	816.7 ac			
Hay Pasture BMP's					
Grazing Land Management (Hay/Pasture)	115.5 ac	481.5 ac			
Other BMP's					
Waterway	1,600 ft & 4.6 ac	0 ft & 21.8 ac	Filter Strip	64.9 ac	1.3 ac
Barnyard Controls	14	42	Underground Outlet	250 ft	880 ft
Waste Facility	15	11	Field Borders	0	0.5 ac
Waste System	11	22			
Stream Bank BMP's					
Stream Miles w/ Vegetative Buffer Strip	0.3	24.0	Miles of Stream Bank Stabilized or Natural Channel Designed Projects	0.4	10.0
Stream Miles Fenced	3.4	18.5			
Urban Practices					
Hi Density BMP's					
Constructed Wetlands	0	30	Detention Basins	0	0
Stream Length	0	0	Stream Bank Stabilized	0	1,000 ft
Low Density BMP's					
Constructed Wetlands	0	0	Detention Basins	0	0
Stream Length	0	0	Stream Bank Stabilized	0	0
Other BMP's					
Impervious Reduction	0	40	Infiltration Practices	0	10
Filtering Practices	0	21	Erosion & Sedimentation Controls	0	1
Rooftop Runoff	0	15			

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

Current Management Measures

To date large amounts of work have been completed within the Mill Creek Watershed in order to improve overall water quality. The majority of this work has been on agricultural land and working with local farmers implementing agricultural BMP's. In fact, because a large section of the Amish community lives within the Mill Creek Watershed, the Lancaster County Conservation District and NRCS set up a satellite office in the Mill Creek Watershed in 1990. The office is used by local farmers as a clearinghouse of information and is within their watershed so access issues for horse and buggy traffic is not an issue.

As stated earlier, the Smoketown Office has overseen most of the implemented BMP's in the Mill Creek Watershed. The staff in this office has spent numerous years creating working relationships within the Mill Creek Watershed community and more specifically the Amish community. For this reason the Ag. BMP's that are proposed are the same ones that have been implemented in this watershed for over 2 decades. New innovated techniques take a lot longer to get establish in this very close knit community and usually need the assistance of a local leader to try them out first before others will accept them.

The Lancaster County Conservation District, NRCS, the PA Game Commission, and even the U.S. Fish and Wildlife Service biggest Ag. BMP projects in the watershed have been stream bank fencing. The fencing has been targeted on small sub-watershed within the Mill Creek basin or in very specific clusters throughout the watershed. Once one farmer saw how the fencing worked and they were convinced it would work on their property, they two would implement it. This is a slow and tedious process but it does get conservation work on the ground. Other BMP's that were incorporated include barnyard runoff controls, waste storage structures, waste storage systems, and nutrient management systems. Some field practices have been done in certain pockets throughout the watershed but this is the current goal for the watershed, more field practices implemented.

Once again, the proposed Ag. BMP's go hand-in-hand with the current on-the-ground Ag. BMP's. The community must feel comfortable with the BMP before others will participate. For this reason, stream bank fencing, riparian buffers, stream bank stabilization, barnyard controls, waste storage structures, and nutrient

management plans, are the majority of the proposed BMP's. Some field BMP's are recommended on those operations where a conservation plan has been developed and these are the practices recommended on the plan.

Technical and Financial Assistance for BMP's

Table 4: Cost estimate per BMP and maintenance plus potential funding sources

BMP	Design & Construction Cost	Annual Operations & Maintenance Cost*	Potential Sources of Funding
*Waste Storage System (312)	$40,000.00	$2,000.00	Growing Greener, Section 319 Program, & other sources
#Conservation Crop Rotation (328)	$5.00/acre	$0.25	Growing Greener, Section 319 Program, & other sources
#Residue Management, No-till (329A)	$15.00/acre	$0.75	Growing Greener, Section 319 Program, & other sources
#Contour Farming (330)	$7.50/acre	$0.38	Growing Greener, Section 319 Program, & other sources
#Cover Crop (340)	$18.50/acre	$0.93	Growing Greener, Section 319 Program, & other sources
#Residue Management, Seasonal (344)	$17.00/acre	$0.85	Growing Greener, Section 319 Program, & other sources
*Barnyard Runoff Control (357)	$18,000.00	$900.00	Growing Greener, Section 319 Program, & other sources
^Stream bank Fencing (382)	$2.00/ft	$0.10	Growing Greener, Section 319 Program, & other sources
#Field Borders (386)	$200.00/acre	$10.00	Growing Greener, Section 319 Program, & other sources
^Riparian Buffer (391)	$1.70/ft	$0.09	Growing Greener, Section 319 Program, & other sources
#Filter Strip (393)	$200.00/acre	$10.00	Growing Greener, Section 319 Program, & other sources
#Grassed Waterway (412)	$3,700.00/acre	$185.00	Growing Greener, Section 319 Program, & other sources
#Pasture/Hayland Planting (512)	$200.00/acre	$10.00	Growing Greener, Section 319 Program, & other sources
^Prescribed Grazing (528A)	$100.00/acre	$5.00	Growing Greener, Section 319 Program, & other sources
^Stream bank Stabilization (580)	$30.00/ft	$1.50	Growing Greener, Section 319 Program, & other sources
#Stripcropping, Contour (585)	$10.00/acre	$0.50	Growing Greener, Section 319 Program, & other sources
#Nutrient Management Plan (590)	$8.00/acre	$0.40	Growing Greener, Section 319 Program, & other sources
*Terraces (600)	$3.25/ft	$0.16	Growing Greener, Section 319 Program, & other sources

^Constructed Wetlands (656)	$10,000.00/ impervious acre	$500.00	Growing Greener, Section 319 Program, & other sources
Dam Removal	Varies from project to project depending on size, scope, and overall goal.		Growing Greener, Section 319 Program, & other sources
Impervious Surface Reduction	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Filtering Practices	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Rooftop Runoff Management	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
Infiltration Practices	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources
E & S Controls	Varies from project to project depending on size		Growing Greener, Section 319 Program, & other sources

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

Table 5: Past & Proposed Projects for Implementation

		Total	Acres/Feet	Installed	Acres/Feet	Proposed	Estimated	Total
Number	Rank	Acres	Treated	BMP's	Proposed	BMP's	Cost/Unit	Cost
1	1	83	68.2	Conservation Crop Rotation	68.2	Cover Crop	$ 18.50	$ 1,261.70
			24.5	Contour Farming	68.2	NMP	$ 8.00	$ 545.60
			800'	Grassed Waterway	1	Barnyard Control	$18,000.00	$ 18,000.00
			10	Prescribed Grazing	1	Waste Storage System	$40,000.00	$ 40,000.00
			43.7	Stripcropping, Contour	2600	Stream bank Fencing	$ 2.00	$ 5,200.00
			800'	Diversion	2600	Riparian Buffer	$ 1.70	$ 4,420.00
					2600	Stream bank Stabilization	$ 30.00	$ 78,000.00
2	3	28.3	450'	Diversion	23.2	Conservation Crop Rotation	$ 5.00	$ 116.00
			0.5	Grassed Waterway	23.1	Contour Farming	$ 7.50	$ 173.25
					23.2	Cover Crop	$ 18.50	$ 429.20
					23.1	Stripcropping, Contour	$ 10.00	$ 231.00
					27.1	NMP	$ 8.00	$ 216.80
					3.7	Pasture/Hayland Planting	$ 200.00	$ 740.00
3	2	59.7	1	Waste Storage Facility	45	Stripcropping, Contour	$ 10.00	$ 450.00
			1	Barnyard Control	4000	Riparian Buffer	$ 1.70	$ 6,800.00
4	2	27	13.1	Conservation Crop Rotation	13.1	Residue Management, No-Till	$ 15.00	$ 196.50
			13.1	Cover Crop	3600	Riparian Buffer (trib)	$ 1.70	$ 6,120.00
			13.1	Stripcropping, Contour	2400	Riparian Buffer	$ 1.70	$ 4,080.00
			1400'	Stream bank Fencing	2400	Stream bank Fencing	$ 2.00	$ 4,800.00
			200'	Stream bank Stabilization	2400	Stream bank Stabilization	$ 30.00	$ 72,000.00
5	2	90	490'	Stream bank Fencing	62.3	Conservation Crop Rotation	$ 5.00	$ 311.50
					48.7	Residue Management, Seasonal	$ 17.00	$ 827.90
					13.6	Residue Management, No-Till	$ 15.00	$ 204.00
					62.3	Cover Crop	$ 18.50	$ 1,152.55
					1	Grassed Waterway	$ 3,700.00	$ 3,700.00
					62.3	NMP	$ 8.00	$ 498.40
					9.6	Prescribed Grazing	$ 100.00	$ 960.00
					0.5	Field Borders	$ 200.00	$ 100.00
6	2	N/A			2000	Stream bank Fencing	$ 2.00	$ 4,000.00
					2000	Riparian Buffer	$ 1.70	$ 3,400.00
7	4	N/A			700	Riparian Buffer	$ 1.70	$ 1,190.00
						Small dam removal	varies	
8	3	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
9	3	N/A			2400	Riparian Buffer	$ 1.70	$ 4,080.00

					2400	Stream bank Stabilization	$ 30.00	$ 72,000.00
10	2	N/A			2400	Stream bank Fencing	$ 2.00	$ 4,800.00
					2400	Riparian Buffer	$ 1.70	$ 4,080.00
11	4	50			1	Barnyard Control	$18,000.00	$ 18,000.00
12	3	40			2000	Stream bank Fencing	$ 2.00	$ 4,000.00
					2000	Riparian Buffer	$ 1.70	$ 3,400.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					40	NMP	$ 8.00	$ 320.00
						Small dam removal	varies	
13	4	50			1	Barnyard Control	$18,000.00	$ 18,000.00
					3000	Riparian Buffer	$ 1.70	$ 5,100.00
14	3	N/A			1800	Riparian Buffer	$ 1.70	$ 3,060.00
15	3	N/A			2000	Riparian Buffer	$ 1.70	$ 3,400.00
16	3	N/A			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1600	Stream bank Fencing	$ 2.00	$ 3,200.00
17	3	N/A			550	Riparian Buffer	$ 1.70	$ 935.00
18	2	105			5200	Riparian Buffer (trib & mainstem)	$ 1.70	$ 8,840.00
					5200	Stream bank Fencing	$ 2.00	$ 10,400.00
					5200	Stream bank Stabilization	$ 30.00	$156,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					105	NMP	$ 8.00	$ 840.00
19	4	N/A			1800	Riparian Buffer	$ 1.70	$ 3,060.00
20	3	50			1800	Riparian Buffer	$ 1.70	$ 3,060.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
21	2	98			4400	Riparian Buffer (trib & mainstem)	$ 1.70	$ 7,480.00
					4400	Stream bank Fencing	$ 2.00	$ 8,800.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					98	NMP	$ 8.00	$ 784.00
						remove spring pond	varies	
22	2	N/A			1000	Riparian Buffer	$ 1.70	$ 1,700.00
					1000	Stream bank Fencing	$ 2.00	$ 2,000.00
23	3	N/A			2800	Stream bank Fencing	$ 2.00	$ 5,600.00
					2800	Riparian Buffer	$ 1.70	$ 4,760.00
					2800	Stream bank Stabilization	$ 30.00	$ 84,000.00
24	2	N/A			5400	Stream bank Fencing	$ 2.00	$ 10,800.00

					5400	Riparian Buffer	$ 1.70	$ 9,180.00
					5400	Stream bank Stabilization	$ 30.00	$162,000.00
25	4	N/A			4000	Riparian Buffer	$ 1.70	$ 6,800.00
					4000	Stream bank Stabilization	$ 30.00	$120,000.00
26	3	N/A			700	Riparian Buffer	$ 1.70	$ 1,190.00
27	1	38.4			13.1	Conservation Crop Rotation	$ 5.00	$ 65.50
					10.7	Pasture/Hayland Planting	$ 200.00	$ 2,140.00
28	3	N/A			1000	Riparian Buffer	$ 1.70	$ 1,700.00
29	2	N/A			1400	Riparian Buffer	$ 1.70	$ 2,380.00
					800	Stream bank Fencing	$ 2.00	$ 1,600.00
30	3	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
31	2	N/A			2600	Riparian Buffer	$ 1.70	$ 4,420.00
32	2	N/A			800	Riparian Buffer	$ 1.70	$ 1,360.00
33	3	N/A			2000	Riparian Buffer (N. branch)	$ 1.70	$ 3,400.00
					1300	Riparian Buffer (S. branch)	$ 1.70	$ 2,210.00
34	3	N/A			600	Riparian Buffer	$ 1.70	$ 1,020.00
35	5	N/A			10	Constructed Wetlands	$10,000.00	$100,000.00
36	3	N/A			1400	Riparian Buffer	$ 1.70	$ 2,380.00
					1400	Stream bank Fencing	$ 2.00	$ 2,800.00
37	3	N/A			1500	Riparian Buffer	$ 1.70	$ 2,550.00
					1500	Stream bank Fencing	$ 2.00	$ 3,000.00
38	4	N/A			3600	Riparian Buffer	$ 1.70	$ 6,120.00
					3600	Stream bank Fencing	$ 2.00	$ 7,200.00
39	4	N/A			4000	Riparian Buffer	$ 1.70	$ 6,800.00
					4000	Stream bank Fencing	$ 2.00	$ 8,000.00
40	4	N/A			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1600	Stream bank Fencing	$ 2.00	$ 3,200.00
41	4	50			1	Barnyard Control	$18,000.00	$ 18,000.00
42	4	64	1	Barnyard Control	10	Prescribed Grazing	$ 100.00	$ 1,000.00
			64	NMP	64	Cover Crop	$ 18.50	$ 1,184.00
			1	Waste Storage Facility	64	Stripcropping, Contour	$ 10.00	$ 640.00
			1	Waste Storage System				
43	3	50	15	Cover Crop	15	Stripcropping, Contour	$ 10.00	$ 150.00
			48.5	NMP				
			10	Residue Management, Seasonal				
			1	Barnyard Control				
			1	Waste Storage Facility				

			1	Waste Storage System				
44	3	45	34	Conservation Crop Rotation	34	Residue Management, Seasonal	$ 17.00	$ 578.00
			15	Cover Crop	1000	Riparian Buffer	$ 1.70	$ 1,700.00
			1	Grassed Waterway				
			24	Prescribed Grazing				
			34	Stripcropping, Contour				
			34	NMP				
45	3	98	1	Barnyard Control	1500	Stream bank Fencing	$ 2.00	$ 3,000.00
			80.2	Conservation Crop Rotation	1500	Riparian Buffer	$ 1.70	$ 2,550.00
			80.2	Cover Crop				
			1	Grassed Waterway				
			80.2	NMP				
			16	Prescribed Grazing				
			80.2	Residue Management, No-Till				
			66.9	Stripcropping, Field				
			1	Waste Storage Facility				
			1	Waste Storage System				
			250'	Stream bank Fencing (trib)				
			250'	Stream bank Stabilization (trib)				
46	2	17.5	13.5	NMP	13.5	Conservation Crop Rotation	$ 5.00	$ 67.50
					13.5	Cover Crop	$ 18.50	$ 249.75
					1	Waste Storage System	$40,000.00	$ 40,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
47	3	N/A			500	Riparian Buffer	$ 1.70	$ 850.00
48	2	N/A			2000	Riparian Buffer	$ 1.70	$ 3,400.00
					2000	Stream bank Stabilization	$ 30.00	$ 60,000.00
49	3	N/A			600	Riparian Buffer	$ 1.70	$ 1,020.00
					600	Stream bank Stabilization	$ 30.00	$ 18,000.00
50	1	N/A			3500	Riparian Buffer	$ 1.70	$ 5,950.00
					3500	Stream bank Stabilization	$ 30.00	$105,000.00
51	4	N/A			1000	Riparian Buffer	$ 1.70	$ 1,700.00
52	3	N/A			500	Stream bank Fencing	$ 2.00	$ 1,000.00
53	2	100			500	Riparian Buffer	$ 1.70	$ 850.00
					1500	Terraces	$ 3.25	$ 4,875.00
54	2	100			4000	Riparian Buffer	$ 1.70	$ 6,800.00
					4000	Stream bank Stabilization	$ 30.00	$120,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
55	1	N/A			1500	Riparian Buffer	$ 1.70	$ 2,550.00

					1500	Stream bank Stabilization	$ 30.00	$ 45,000.00
56	3	100			2000	Riparian Buffer	$ 1.70	$ 3,400.00
					0.1	Grassed Waterway	$ 3,700.00	$ 370.00
					1300	Terraces	$ 3.25	$ 4,225.00
57	1	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
58	2	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
59	1	65			1000	Riparian Buffer	$ 1.70	$ 1,700.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					65	NMP	$ 8.00	$ 520.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
					50	Contour Farming	$ 7.50	$ 375.00
					50	Conservation Crop Rotation	$ 5.00	$ 250.00
60	3	N/A			1500	Riparian Buffer	$ 1.70	$ 2,550.00
						Small dam removal	varies	
					2	Impervious Surface Reduction	varies	
					2	Filtering Practices	varies	
61	3	N/A			300	Riparian Buffer	$ 1.70	$ 510.00
62	1	N/A			2400	Riparian Buffer	$ 1.70	$ 4,080.00
					2000	Stream bank Stabilization	$ 30.00	$ 60,000.00
					15	Impervious Surface Reduction	varies	
					15	Filtering Practices	varies	
					15	Constructed Wetlands	$10,000.00	$150,000.00
					5	Rooftop Runoff Management	varies	
63	3	N/A			600	Riparian Buffer	$ 1.70	$ 1,020.00
					600	Stream bank Fencing	$ 2.00	$ 1,200.00
64	4	N/A			2500	Riparian Buffer	$ 1.70	$ 4,250.00
					2500	Stream bank Fencing	$ 2.00	$ 5,000.00
65	5	N/A			300	Riparian Buffer	$ 1.70	$ 510.00
					300	Stream bank Fencing	$ 2.00	$ 600.00
66	3	N/A			725	Stream bank Stabilization	$ 30.00	$ 21,750.00
					725	Riparian Buffer (trib)	$ 1.70	$ 1,232.50
					600	Riparian Buffer (mill)	$ 1.70	$ 1,020.00
67	1	30			1400	Riparian Buffer	$ 1.70	$ 2,380.00
					1400	Stream bank Fencing	$ 2.00	$ 2,800.00
					1	Barnyard Control	$18,000.00	$ 18,000.00

					1	Waste Storage System	$40,000.00	$ 40,000.00
					30	NMP	$ 8.00	$ 240.00
					1400	Stream bank Stabilization	$ 30.00	$ 42,000.00
68	1	45			3400	Riparian Buffer	$ 1.70	$ 5,780.00
					3400	Stream bank Fencing	$ 2.00	$ 6,800.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					45	NMP	$ 8.00	$ 360.00
					40	Stripcropping, Contour	$ 10.00	$ 400.00
69	3	N/A			900	Riparian Buffer	$ 1.70	$ 1,530.00
70	2	56			3600	Riparian Buffer	$ 1.70	$ 6,120.00
					3600	Stream bank Fencing	$ 2.00	$ 7,200.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					56	NMP	$ 8.00	$ 448.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
71	3	N/A			130	Riparian Buffer (around spring)	$ 1.70	$ 221.00
					130	Stream bank Fencing (around spring)	$ 2.00	$ 260.00
72	2	N/A			2000	Riparian Buffer	$ 1.70	$ 3,400.00
					2000	Stream bank Fencing	$ 2.00	$ 4,000.00
73	3	N/A			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1600	Stream bank Fencing	$ 2.00	$ 3,200.00
74	3	N/A			4400	Riparian Buffer	$ 1.70	$ 7,480.00
					4400	Stream bank Fencing	$ 2.00	$ 8,800.00
75	3	50			2000	Riparian Buffer	$ 1.70	$ 3,400.00
					2000	Stream bank Fencing	$ 2.00	$ 4,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
76	5	50			0.1	Grassed Waterway	$ 3,700.00	$ 370.00
77	4	N/A			3	Filtering Practices	varies	
					3	Impervious Surface Reduction	varies	
78	4	16			1500	Riparian Buffer	$ 1.70	$ 2,550.00
					1500	Stream bank Fencing	$ 2.00	$ 3,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					16	NMP	$ 8.00	$ 128.00
79	2	N/A			3000	Stream bank Stabilization	$ 30.00	$ 90,000.00
					3200	Riparian Buffer	$ 1.70	$ 5,440.00
						remove mill race	varies	

						remove dam or fish passage	varies	
80	3	50	1308'	Stream bank Fencing	1	Barnyard Control	$18,000.00	$ 18,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
81	4	66	1	Waste Storage Facility	50	Stripcropping, Contour	$ 10.00	$ 500.00
			66	NMP				
			1	Barnyard Control				
82	2	40	22	Conservation Crop Rotation	2000	Riparian Buffer	$ 1.70	$ 3,400.00
			40	NMP	1	Barnyard Control	$18,000.00	$ 18,000.00
			1	Waste Storage Facility	8	Prescribed Grazing	$ 100.00	$ 800.00
			1	Waste Storage System		Small Dam Removal	varies	
					22	Cover Crop	$ 18.50	$ 407.00
					22	Stripcropping, Contour	$ 10.00	$ 220.00
83	3	N/A	1066'	Stream bank Fencing	1066	Riparian Buffer	$ 1.70	$ 1,812.20
84	2	82.5	1	Barnyard Control	1	Filter Strip	$ 200.00	$ 200.00
			68.6	NMP	1800	Riparian Buffer	$ 1.70	$ 3,060.00
			1	Waste Storage Facility	1800	Stream bank Stabilization	$ 30.00	$ 54,000.00
			1	Waste Storage System				
			4483'	Stream bank Fencing				
			4200'	Stream bank Stabilization				
85	4	70	1	Barnyard Control	51.9	Conservation Crop Rotation	$ 5.00	$ 259.50
			51.9	NMP	3360	Riparian Buffer	$ 1.70	$ 5,712.00
			16	Prescribed Grazing				
			1	Waste Storage Facility				
			1	Waste Storage System				
			3360'	Stream bank Fencing				
			3360'	Stream bank Stabilization				
			51.9	Cover Crop				
			600'	Grassed Waterway				
86	4	73.8	1	Barnyard Control	65.9	Conservation Crop Rotation	$ 5.00	$ 329.50
			85'	Fence	65.9	Cover Crop	$ 18.50	$ 1,219.15
			1	Waste Storage Facility				
			1	Waste Storage System				
			65.9	NMP				
			5	Prescribed Grazing				
			3	Grassed Waterway				
87	3	53.6	2500'	Stream bank Fencing	48.9	Conservation Crop Rotation	$ 5.00	$ 244.50
					48.9	Cover Crop	$ 18.50	$ 904.65
					48.9	NMP	$ 8.00	$ 391.20

88	4	89.8	1	Barnyard Control	81.8	Conservation Crop Rotation	$ 5.00	$ 409.00
			1	Waste Storage Facility	81.8	Residue Management, Seasonal	$ 17.00	$ 1,390.60
			81.8	NMP	6	Prescribed Grazing	$ 100.00	$ 600.00
89	3	90	61.6	Cover Crop	61.6	Conservation Crop Rotation	$ 85.00	$ 5,236.00
			61.6	NMP	61.6	Contour Farming	$ 7.50	$ 462.00
			1	Barnyard Control				
			1	Waste Storage Facility				
90	3	60	1	Waste Storage Facility	49	Conservation Crop Rotation	$ 5.00	$ 245.00
			49	NMP	49	Cover Crop	$ 18.50	$ 906.50
					8.5	Prescribed Grazing	$ 100.00	$ 850.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
91	3	54	1	Barnyard Control	54	Contour Farming	$ 7.50	$ 405.00
			54	Conservation Crop Rotation	2000	Riparian Buffer	$ 1.70	$ 3,400.00
			5	Cover Crop				
			54	NMP				
			5	Residue Management, Seasonal				
			3216'	Stream bank Fencing (trib)				
92	2	50	1200'	Stream bank Fencing	1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					1200	Riparian Buffer	$ 1.70	$ 2,040.00
93	3	37	1	Barnyard Control	32	Conservation Crop Rotation	$ 5.00	$ 160.00
			1	Waste Storage Facility	32	Cover Crop	$ 18.50	$ 592.00
			32	NMP	32	Stripcropping, Contour	$ 10.00	$ 320.00
					4.5	Prescribed Grazing	$ 100.00	$ 450.00
94	2	70	70	NMP	1	Barnyard Control	$18,000.00	$ 18,000.00
			1	Waste Storage Facility	10	Prescribed Grazing	$ 100.00	$ 1,000.00
			1	Waste Storage System				
95	4	23			20.1	Conservation Crop Rotation	$ 5.00	$ 100.50
					20.1	Cover Crop	$ 18.50	$ 371.85
					20.1	NMP	$ 8.00	$ 160.80
					2.2	Pasture/Hayland Planting	$ 200.00	$ 440.00
96	3	87	0.5	Grassed Waterway	84	NMP	$ 8.00	$ 672.00
			3326'	Stream bank Fencing	72	Prescribed Grazing	$ 100.00	$ 7,200.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					3326	Riparian Buffer	$ 1.70	$ 5,654.20
97	3	71	3200'	Stream bank Fencing	59	Conservation Crop Rotation	$ 5.00	$ 295.00
					59	Cover Crop	$ 18.50	$ 1,091.50
					0.1	Grassed Waterway	$ 3,700.00	$ 370.00

					59	NMP	$ 8.00	$ 472.00
					11.5	Prescribed Grazing	$ 100.00	$ 1,150.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
98	3	50	1	Barnyard Control	10	Prescribed Grazing	$ 100.00	$ 1,000.00
			47	NMP	47	Cover Crop	$ 18.50	$ 869.50
			1	Waste Storage Facility				
			1	Waste Storage System				
99	4	68	2	Barnyard Control	50	Stripcropping, Contour	$ 10.00	$ 500.00
			1	Grassed Waterway	50	Conservation Crop Rotation	$ 5.00	$ 250.00
			66	NMP	50	Cover Crop	$ 18.50	$ 925.00
			1	Waste Storage Facility				
			1	Waste Storage System				
100	2	30	550'	Grassed Waterway	23	Conservation Crop Rotation	$ 5.00	$ 115.00
			800'	Field Borders	23	Residue Management, Seasonal	$ 17.00	$ 391.00
					23	NMP	$ 8.00	$ 184.00
					5	Prescribed Grazing	$ 100.00	$ 500.00
					1000	Stream bank Fencing	$ 2.00	$ 2,000.00
					2000	Riparian Buffer	$ 1.70	$ 3,400.00
					2000	Stream bank Stabilization	$ 30.00	$ 60,000.00
101	3	55.4	1360'	Stream bank Fencing	1360	Riparian Buffer	$ 1.70	$ 2,312.00
			55.4	Conservation Crop Rotation	1360	Stream bank Stabilization	$ 30.00	$ 40,800.00
			55.4	Cover Crop				
			55.4	Contour Farming				
102	1	50	1181'	Stream bank Fencing	1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					1181	Riparian Buffer	$ 1.70	$ 2,007.70
						Small Dam Removal	varies	
					50	NMP	$ 8.00	$ 400.00
					9	Prescribed Grazing	$ 100.00	$ 900.00
103	5	50			1	Grassed Waterway	$ 3,700.00	$ 3,700.00
104	3	50			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
105	4	N/A			3000	Riparian Buffer	$ 1.70	$ 5,100.00
106	3	50			1300	Riparian Buffer	$ 1.70	$ 2,210.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
107	1	50			2700	Riparian Buffer	$ 1.70	$ 4,590.00
					2700	Stream bank Fencing	$ 2.00	$ 5,400.00
					1	Waste Storage System	$40,000.00	$ 40,000.00

					50	NMP	$ 8.00	$ 400.00
108	3	50			2800	Riparian Buffer	$ 1.70	$ 4,760.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
109	3	50			1000	Riparian Buffer	$ 1.70	$ 1,700.00
					1000	Stream bank Fencing	$ 2.00	$ 2,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
110	4	50			1350	Riparian Buffer	$ 1.70	$ 2,295.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
						Small dam removal	varies	
111	2	90			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					90	NMP	$ 8.00	$ 720.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
112	2	N/A			2000	Riparian Buffer	$ 1.70	$ 3,400.00
						Eliminate spring blockage	varies	
113	3	61			1800	Riparian Buffer	$ 1.70	$ 3,060.00
					1800	Stream bank Fencing	$ 2.00	$ 3,600.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					61	NMP	$ 8.00	$ 488.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
114	3	N/A			400	Riparian Buffer	$ 1.70	$ 680.00
						Eliminate on-line pond	varies	
115	2	N/A			3000	Riparian Buffer	$ 1.70	$ 5,100.00
116	2	82			1600	Riparian Buffer	$ 1.70	$ 2,720.00
					1600	Stream bank Fencing	$ 2.00	$ 3,200.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					82	NMP	$ 8.00	$ 656.00
					1600	Stream bank Stabilization	$ 30.00	$ 48,000.00
117	3	50			2600	Riparian Buffer	$ 1.70	$ 4,420.00
					2600	Stream bank Fencing	$ 2.00	$ 5,200.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					2600	Stream bank Stabilization	$ 30.00	$ 78,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
118	5	50			1200	Riparian Buffer	$ 1.70	$ 2,040.00

					1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
119	4	N/A			3000	Riparian Buffer	$ 1.70	$ 5,100.00
120	5	N/A			3000	Riparian Buffer	$ 1.70	$ 5,100.00
121	3	N/A			3800	Riparian Buffer	$ 1.70	$ 6,460.00
122	2	50			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
123	3	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
124	4	N/A			500	Riparian Buffer	$ 1.70	$ 850.00
					500	Stream bank Fencing	$ 2.00	$ 1,000.00
125	2	66			1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					66	NMP	$ 8.00	$ 528.00
126	1	81.3	1	Grassed Waterway	2000	Terraces (2x1000')	$ 3.25	$ 6,500.00
			1790'	Stream bank Fencing				
			81	NMP				
			60	Stripcropping, Contour				
			60	Cover Crop				
127	3	68.8	715'	Fence	63	Conservation Crop Rotation	$ 5.00	$ 315.00
			63	NMP	63	Cover Crop	$ 18.50	$ 1,165.50
			7	Prescribed Grazing	63	Contour Farming	$ 7.50	$ 472.50
			1	Barnyard Control				
			1	Waste Storage Facility				
128	3	81.5	300'	Stream bank Fencing	5000	Stream bank Fencing	$ 2.00	$ 10,000.00
			2	Barnyard Control	5000	Riparian Buffer	$ 1.70	$ 8,500.00
			1	Waste Storage Facility	10	Prescribed Grazing	$ 100.00	$ 1,000.00
			1	Waste Storage System	1000	Stream bank Stabilization	$ 30.00	$ 30,000.00
			69.5	NMP				
129	1	50	1300'	Stream bank Fencing	800	Stream bank Fencing	$ 2.00	$ 1,600.00
			1	Waste Storage Facility	800	Riparian Buffer	$ 1.70	$ 1,360.00
			800'	Grassed Waterway	800	Stream bank Stabilization	$ 30.00	$ 24,000.00
			1	Barnyard Control				
			50	NMP				

130	4	77	3300'	Stream bank Fencing	20.7	Stripcropping, Contour	$ 10.00	$ 207.00
			3300'	Riparian Buffer	17	Pasture/Hayland Planting	$ 200.00	$ 3,400.00
			1	Barnyard Control	3300	Stream bank Stabilization	$ 30.00	$ 99,000.00
			57	Conservation Crop Rotation				
			57	Cover Crop				
			57	NMP				
			250'	Underground Outlet				
			1	Waste Storage Facility				
			1	Waste Storage System				
131	3	49.2	1	Waste Storage Facility	33.5	Conservation Crop Rotation	$ 5.00	$ 167.50
			1	Barnyard Control	33.5	Cover Crop	$ 18.50	$ 619.75
			33.5	NMP	14.7	Prescribed Grazing	$ 100.00	$ 1,470.00
			1	Waste Storage System				
132	3	50	1440'	Stream bank Fencing	10	Prescribed Grazing	$ 100.00	$ 1,000.00
133	3	65	955'	Stream bank Fencing	1	Barnyard Control	$18,000.00	$ 18,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
134	3	53			40.3	Conservation Crop Rotation	$ 5.00	$ 201.50
					40.3	Cover Crop	$ 18.50	$ 745.55
					1	Grassed Waterway	$ 3,700.00	$ 3,700.00
					0.5	Grassed Waterway	$ 3,700.00	$ 1,850.00
					40.3	NMP	$ 8.00	$ 322.40
					1300	Stream bank Fencing	$ 2.00	$ 2,600.00
					1300	Riparian Buffer	$ 1.70	$ 2,210.00
135	3	60	1	Barnyard Control	46	Conservation Crop Rotation	$ 5.00	$ 230.00
			46	NMP	30	Contour Farming	$ 7.50	$ 225.00
			1	Waste Storage Facility	46	Cover Crop	$ 18.50	$ 851.00
			1	Waste Storage System	16	Stripcropping, Contour	$ 10.00	$ 160.00
					10	Prescribed Grazing	$ 10.00	$ 100.00
136	1	42	1	Barnyard Control	3000	Stream bank Fencing	$ 2.00	$ 6,000.00
			40	NMP	3000	Riparian Buffer	$ 1.70	$ 5,100.00
			1	Waste Storage Facility	1500	Stream bank Stabilization	$ 30.00	$ 45,000.00
			1	Waste Storage System	10	Prescribed Grazing	$ 10.00	$ 100.00
						Large dam removal		
137	4	46.9	43	NMP	43	Conservation Crop Rotation	$ 5.00	$ 215.00
			1	Barnyard Control	40.1	Cover Crop	$ 18.50	$ 741.85
			1	Waste Storage System	7.2	Residue Management, No-Till	$ 15.00	$ 108.00
138	1	75.5	1	Barnyard Control	1192	Riparian Buffer	$ 1.70	$ 2,026.40
			57.8	Conservation Crop Rotation				

			28	Cover Crop				
			57.8	Contour Farming				
			59	NMP				
			11	Prescribed Grazing				
			1	Waste Storage Facility				
			1192'	Stream bank Fencing				
139	3	N/A	700'	Stream bank Fencing	1400	Riparian Buffer	$ 1.70	$ 2,380.00
					1400	Stream bank Stabilization	$ 30.00	$ 42,000.00
						historic dam, fish passage around	varies	
140	3	N/A	1547'	Stream bank Fencing	1547	Riparian Buffer	$ 1.70	$ 2,629.90
141	3	N/A	1512'	Stream bank Fencing	1512	Stream bank Stabilization	$ 30.00	$ 45,360.00
142	3	50	1	Barnyard Control	1000	Stream bank Fencing	$ 2.00	$ 2,000.00
			50	NMP				
			1	Waste Storage Facility				
143	3	N/A	550'	Stream bank Fencing	550	Stream bank Stabilization	$ 30.00	$ 16,500.00
144	4	50			1	Barnyard Control	$18,000.00	$ 18,000.00
145	3	N/A			1	Filtering Practices	varies	
					5	Impervious Surface Reduction	varies	
146	2	N/A			1	E & S Controls	varies	
147	1	N/A			700	Riparian Buffer	$ 1.70	$ 1,190.00
					700	Stream bank Stabilization	$ 30.00	$ 21,000.00
148	2	N/A			2400	Stream bank Fencing	$ 2.00	$ 4,800.00
					2400	Riparian Buffer	$ 1.70	$ 4,080.00
149	3	N/A			700	Riparian Buffer	$ 1.70	$ 1,190.00
150	3	50			1	Barnyard Control	$18,000.00	$ 18,000.00
					1600	Stream bank Fencing	$ 2.00	$ 3,200.00
					1600	Riparian Buffer	$ 1.70	$ 2,720.00
151	3	52			1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					52	NMP	$ 8.00	$ 416.00
					200	Riparian Buffer	$ 1.70	$ 340.00
					200	Stream bank Fencing	$ 2.00	$ 400.00
152	4	N/A			1400	Riparian Buffer	$ 1.70	$ 2,380.00
153	2	50			1	Barnyard Control	$18,000.00	$ 18,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
					500	Riparian Buffer	$ 1.70	$ 850.00
154	3	57			2000	Stream bank Fencing	$ 2.00	$ 4,000.00
					2000	Riparian Buffer	$ 1.70	$ 3,400.00

					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					57	NMP	$ 8.00	$ 456.00
155	3	N/A			3600	Stream bank Fencing	$ 2.00	$ 7,200.00
					3600	Riparian Buffer	$ 1.70	$ 6,120.00
156	4	N/A			1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Stabilization	$ 30.00	$ 36,000.00
157	3	63			1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					63	NMP	$ 8.00	$ 504.00
158	3	50			1	Barnyard Control	$18,000.00	$ 18,000.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
159	3	N/A			2400	Riparian Buffer	$ 1.70	$ 4,080.00
					2400	Stream bank Fencing	$ 2.00	$ 4,800.00
					2400	Stream bank Stabilization	$ 30.00	$ 72,000.00
160	3	N/A			1200	Riparian Buffer	$ 1.70	$ 2,040.00
					1200	Stream bank Fencing	$ 2.00	$ 2,400.00
						Small dam removal	varies	
161	4	50			2400	Riparian Buffer	$ 1.70	$ 4,080.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
162	3	100			8000	Riparian Buffer	$ 1.70	$ 13,600.00
					8000	Stream bank Fencing	$ 2.00	$ 16,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					100	NMP	$ 8.00	$ 800.00
163	3	50			3200	Riparian Buffer	$ 1.70	$ 5,440.00
					3200	Stream bank Fencing	$ 2.00	$ 6,400.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
164	4	66	50.9	Filter Strip	15.1	Contour Farming	$ 7.50	$ 113.25
			66	NMP	20	Cover Crop	$ 18.50	$ 370.00
			20	Residue Management, Mulch Till				
			20	Residue Management, No-Till				
			20	Residue Management, Seasonal				
165	4	202	165.5	Conservation Crop Rotation	2500	Stream bank Fencing	$ 2.00	$ 5,000.00
			7.3	Contour Farming	2500	Riparian Buffer	$ 1.70	$ 4,250.00
			173.3	Nutrient Management	2000	Stream bank Stabilization	$ 30.00	$ 60,000.00

			173.3	Residue Management, Mulch Till	20	Pasture/Hayland Planting	$ 200.00	$ 4,000.00
			165.5	Stripcropping, Contour				
166	5	66.5	66.5	Contour Farming	55.6	Conservation Cover	$ 18.50	$ 1,028.60
			14	Filter Strip	20.1	Residue Management, No-Till	$ 15.00	$ 301.50
			14	Prescribed Grazing	55.6	NMP	$ 8.00	$ 444.80
			66.5	Residue Management, Seasonal				
			2310'	Fence				
			2.5	Riparian Buffer				
167	3	124	93	NMP	1900	Stream bank Fencing	$ 2.00	$ 3,800.00
			40	Residue Management, No-Till	1900	Riparian Buffer	$ 1.70	$ 3,230.00
			20.8	Stripcropping, Contour	1900	Stream bank Stabilization	$ 30.00	$ 57,000.00
			1	Barnyard Runoff Control	24	Prescribed Grazing	$ 100.00	$ 2,400.00
			1	Waste Storage System	5	Waterway	$ 3,700.00	$ 18,500.00
			1	Waste Storage Facility	93	Conservation Crop Rotation	$ 5.00	$ 465.00
					93	Residue Management, Seasonal	$ 17.00	$ 1,581.00
168	2	86.4	1.6	Grassed Waterway	2650	Stream bank Stabilization	$ 30.00	$ 79,500.00
			3112'	Terrace	54.8	Conservation Crop Rotation	$ 5.00	$ 274.00
			2650'	Riparian Buffer	1.6	Pasture/Hayland Planting	$ 200.00	$ 320.00
			54.8	Contour Farming	54.8	Cover Crop	$ 18.50	$ 1,013.80
			54.8	NMP	54.8	Residue Management, No-Till	$ 15.00	$ 822.00
169	3	71.9	1	Waste Storage Facility	42.9	Conservation Crop Rotation	$ 5.00	$ 214.50
			7200'	Stream bank Fencing	42.9	Cover Crop	$ 18.50	$ 793.65
					0.6	Grassed Waterway	$ 3,700.00	$ 2,220.00
					42.9	Stripcropping, Contour	$ 10.00	$ 429.00
					42.9	NMP	$ 8.00	$ 343.20
					3106	Fence	$ 2.00	$ 6,212.00
					26	Pasture/Hayland Planting	$ 200.00	$ 5,200.00
170	4	55.2	25	Residue Management, No-Till	52.9	Prescribed Grazing	$ 100.00	$ 5,290.00
			52.9	NMP	1	Barnyard Runoff Control	$18,000.00	$ 18,000.00
			1	Waste Storage Facility	43.9	Pasture/Hayland Planting	$ 200.00	$ 8,780.00
			2600'	Stream bank Fencing				
171	5	8.3	0.5	Conservation Cover	6	Cover Crop	$ 18.50	$ 111.00
			6	Conservation Crop Rotation				
			2100'	Diversion				
			0.2	Grassed Waterway				
			350'	Subsurface Drain				
			5.8	Contour Farming				

			0.3	Filter Strip				
172	1	64	17	Residue Management, No-Till	1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					1200	Riparian Buffer	$ 1.70	$ 2,040.00
					0.3	Prescribed Grazing	$ 100.00	$ 30.00
					1	Barnyard Runoff Control	$18,000.00	$ 18,000.00
					39.1	Conservation Crop Rotation	$ 5.00	$ 195.50
					39.1	Cover Crop	$ 18.50	$ 723.35
					39.1	Residue Management, No-Till	$ 15.00	$ 586.50
					21.9	Pasture/Hayland Planting	$ 200.00	$ 4,380.00
					19.1	Contour Farming	$ 7.50	$ 143.25
173	5	52	16	Cover Crop	16	Stripcropping, Contour	$ 10.00	$ 160.00
			36	Prescribed Grazing	5	Grassed Waterway	$ 3,700.00	$ 18,500.00
					52	NMP	$ 8.00	$ 416.00
174	4	47.8	5.2	Conservation Cover	1350	Stream bank Stabilization	$ 30.00	$ 40,500.00
			37	NMP	850	Riparian Buffer	$ 1.70	$ 1,445.00
			3.2	Tree/Shrub Establishment				
			25.1	Conservation Crop Rotation				
			25.1	Residue Management, No-Till				
			25.1	Cover Crop				
			25.1	Residue Management, Seasonal				
			21	Stripcropping, Contour				
			2800'	Fence				
			1.7	Grassed Waterway				
			1	Waste Storage Facility				
			6.7	Prescribed Grazing				
175	5	146	61.7	Conservation Crop Rotation	61.7	Residue Management, No-Till	$ 15.00	$ 925.50
			61.7	Contour Farming				
			63.7	Cover Crop				
			61.7	NMP				
176	5	N/A			1000	Riparian Buffer	$ 1.70	$ 1,700.00
						Small Dam Removal	varies	
177	4	50	500	Stream bank Stabilization	5	Grassed Waterway	$ 3,700.00	$ 18,500.00
			800	Riparian Buffer				
178	3	46	30	NMP	3	Contour Farming	$ 7.50	$ 22.50
			30	Conservation Crop Rotation	3880	Riparian Buffer	$ 1.70	$ 6,596.00
			30	Residue Management, No-Till				
			3880'	Stream bank Fencing				
179	3	56.3			51.4	NMP	$ 8.00	$ 411.20

					51.4	Conservation Crop Rotation	$ 5.00	$ 257.00
					51.4	Contour Farming	$ 7.50	$ 385.50
					51.4	Cover Crop	$ 18.50	$ 950.90
					0.8	Grassed Waterway	$ 3,700.00	$ 2,960.00
					51.4	Residue Management, No-Till	$ 15.00	$ 771.00
					4100	Terrace	$ 3.25	$ 13,325.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
180	3	70.8	5234'	Stream bank Fencing	52.8	Conservation Crop Rotation	$ 5.00	$ 264.00
					52.8	Cover Crop	$ 18.50	$ 976.80
					0.6	Grassed Waterway	$ 3,700.00	$ 2,220.00
					52.8	Stripcropping, Contour	$ 10.00	$ 528.00
					52.8	NMP	$ 8.00	$ 422.40
					16.7	Pasture/Hayland Planting	$ 200.00	$ 3,340.00
181	5	N/A			250	Riparian Buffer	$ 1.70	$ 425.00
182	4	N/A			350	Riparian Buffer	$ 1.70	$ 595.00
					500	Stream bank Stabilization	$ 30.00	$ 15,000.00
						Bridge maintenance	varies	
183	3	N/A			800	Riparian Buffer	$ 1.70	$ 1,360.00
						Pond Issues	varies	
					5	Constructed Wetlands	$10,000.00	$ 50,000.00
					5	Impervious Surface Reduction	varies	
					5	Rooftop Runoff Management	varies	
184	2	N/A			900	Riparian Buffer	$ 1.70	$ 1,530.00
					900	Stream bank Stabilization	$ 30.00	$ 27,000.00
185	3	N/A			800	Riparian Buffer	$ 1.70	$ 1,360.00
						Small dam removal	varies	
186	3	N/A			600	Riparian Buffer	$ 1.70	$ 1,020.00
187	4	N/A			1300	Riparian Buffer	$ 1.70	$ 2,210.00
188	3	N/A			200	Riparian Buffer	$ 1.70	$ 340.00
189	3	N/A			1500	Riparian Buffer	$ 1.70	$ 2,550.00
					1500	Stream bank Fencing	$ 2.00	$ 3,000.00
190	4	N/A			2500	Riparian Buffer	$ 1.70	$ 4,250.00
					2500	Stream bank Fencing	$ 2.00	$ 5,000.00
191	4	N/A			800	Riparian Buffer	$ 1.70	$ 1,360.00
192	4	N/A			1200	Stream bank Fencing	$ 2.00	$ 2,400.00
					1200	Riparian Buffer	$ 1.70	$ 2,040.00
193	2	100			1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00

194	3	21			2100	Stream bank Stabilization	$ 30.00	$ 63,000.00
					2100	Stream bank Fencing	$ 2.00	$ 4,200.00
					2100	Riparian Buffer	$ 1.70	$ 3,570.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					21	NMP	$ 8.00	$ 168.00
195	4	N/A			2000	Riparian Buffer	$ 1.70	$ 3,400.00
196	3	N/A			200	Riparian Buffer	$ 1.70	$ 340.00
					200	Stream bank Stabilization	$ 30.00	$ 6,000.00
197	1	92			4000	Riparian Buffer	$ 1.70	$ 6,800.00
					4000	Stream bank Stabilization	$ 30.00	$120,000.00
					4000	Stream bank Fencing	$ 2.00	$ 8,000.00
					1	Barnyard Control	$18,000.00	$ 18,000.00
					1	Waste Storage System	$40,000.00	$ 40,000.00
					92	NMP	$ 8.00	$ 736.00
					10	Prescribed Grazing	$ 100.00	$ 1,000.00
						remove pond and dam	varies	
198	3	N/A			3000	Riparian Buffer	$ 1.70	$ 5,100.00
199	3	100			0.2	Grassed Waterway	$ 3,700.00	$ 740.00
200	5	N/A			10	Impervious Surface Reduction	varies	
					5	Rooftop Runoff Management	varies	
					10	Infiltration Practices	varies	

w-BMP's in the Muddy Run Watershed Green-BMP's in the UNT Mill Creek Watershed

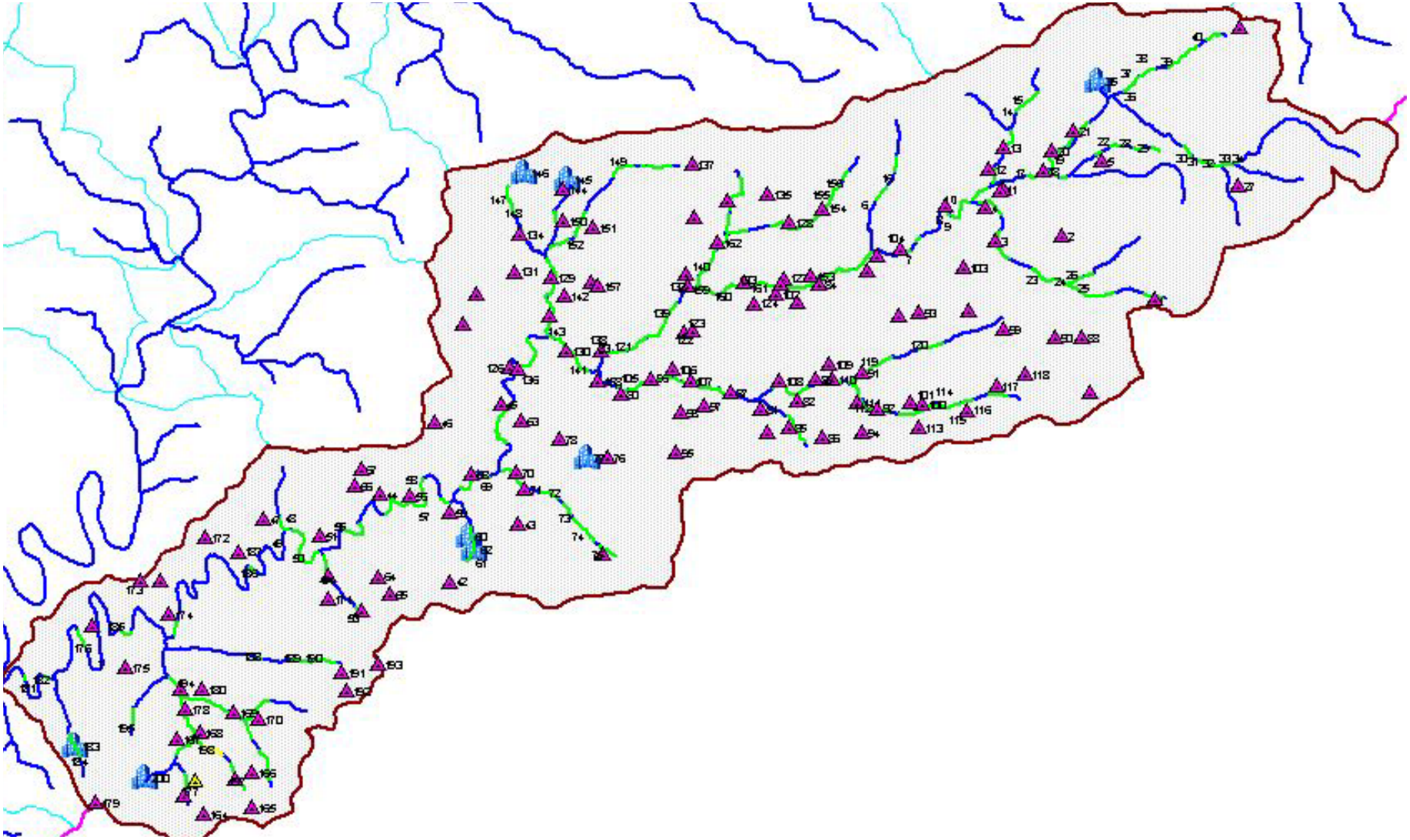

Figure 7: Map of prioritized Agricultural BMP's, existing and future, in the Mill Creek Watershed (due to over 200 sites the map & numbers are small)

Implementation Schedule

Numerous projects are currently in the planning stages for implementation in the Mill Creek Watershed. The projects are coming from the Conservation District and also the Millcreek Preservation Association. The projects the Conservation District is looking to complete within the next year or two are connected with an Agricultural BMP Section 319 Non-Point Source Pollution Prevention Program Grant. Once this Watershed Implementation Plan is approved projects which were stated in the original EPA 319 grant proposal will be looked at to see if work is still required. If there is a new landowner that is no longer willing to do work or if the project was completed with another funding source, this plan will be utilized to locate the next possible BMP location to target. These projects should be complete by 2007. In addition, the Millcreek Preservation Association has some funds to conduct stream bank fencing and riparian buffer establishment within the Mill Creek Watershed. Currently these funds are not allocated for specific projects but the plan that will be in place will assist the group in locating potential priority sites. Once again these projects should be completed by 2007/2008.

The Conservation District does realize that additional outreach will be needed to reach those in the watershed that have not undertaken any conservation practices to date. With the assistance of the Millcreek Preservation Association a concerted effort will be made to spread the word about the plan, BMP's, the TMDL, and cleaning up the Mill Creek Watershed. This educational aspect will take into account the plain sect community, the increasing development in the area, and the need to bridge the gap of these sometime conflicting styles. Working with municipalities in the watershed will be one way to connect the resources this plan can provide to the people that need it.

In 2007 proposals for the implementation of BMP's on 5 farms will be submitted. If funded, the projects will be completed in 2008-2009. Then in 2008 proposals for the implementation of BMP's on 10 farms will be submitted. If funded, the projects will be completed in 2009-2010. In 2009 proposals for the implementation of BMP's on 15 farms will be submitted. If funded, the projects will be completed in 2010-2011. This process will continue until TMDL load allocations can be met with BMP implementation.

The role of submitting these funding proposals will be a combination of entities from the Conservation District, the Millcreek Preservation Association, the Isaac Walton League of America, the Paradise Sportsmen Association, and others. The hope is that with a number of groups dividing up the workload that additional funding sources can be utilized and that projects can be completed in a more timely fashion. Obviously, all of these items are dependent on funding, weather, group stability, and other factors as well.

Model Predictions for Past, Current, and Proposed BMP's

Before results of the model runs are revealed the Lancaster County Conservation District feels it is important to state several issues that we noticed during the course of the modeling protocol.

First, several flaws or limitations are in the PRedICT model that could have far reaching consequences for this plan. Because of the vast amount of Ag. BMP's that are out there not all of them are listed in the PRedICT model. This is for a number of reasons, the BMP is not used often enough, no efficiency values for that BMP are available, the BMP is locally specific and not really needed in a general model, etc. We ran into this problem with agricultural waste systems, facilities, and barnyard control BMP's. All of these BMP's are vital for controlling nutrients in a watershed but they are not represented in the model thus there was no place to include there value. Also, these nutrient reduction BMP's have been a conservation practice the Conservation District and NRCS have really promoted because of all the excess nutrients in Lancaster County. Waste systems, facilities, and barnyard controls have really been embraced by the Plain Sect community because it not only controls nutrients on their operations but also frees up valuable time for the farmer instead of spreading every day. Although in the grand scheme of BMP's these practices might not seem vital compared to conventional cropland BMP's nutrient management in a small watershed like the Mill Creek is vital. (See Past Studies Section, *Trends in surface-Water Quality during Implementation of BMP's in Mill Creek and Muddy Run Basins, Lancaster County, PA*)

Next, we feel it only fair to state that the TMDL's, at least for the two subwatershed basins in the Mill Creek Watershed, are not as accurate as they could be. While preparing this plan significant flaws were

encountered in the TMDL process. For instance, in the Muddy Run TMDL stream bank erosion was not considered as a significant source of sediment and phosphorous impairment to the watershed, when in essence a vast majority of the issues in the watershed stem from this area. As discussed earlier, in the Piedmont area of Pennsylvania where rich alluvial soil is easily moved from one point to another, legacy sediment contained behind old mill dams is a major source of impairment. To not include this in a TMDL is saying it does not exist when in reality it should be one of the main components of the TMDL.

Finally, because the TMDL's in this particular watershed are not completely accurate certain BMP requirements were included in the PRedICT model that might be difficult to obtain. These requirements were needed to meet the lofty goals in the TMDL. Every effort will be made to obtain these BMP requirements, but because of the sheer volume of farms in the watershed and the amount of outreach that is needed for some of the TMDL requirements, achievability will be challenging.

Three PRedICT model runs were used for this plan, one for the Muddy Run Watershed (TMDL completed February 2001), one for the UNT Mill Creek Watershed (TMDL completed August 2004), and one for the remaining Mill Creek Watershed (no TMDL completed to date but assessed by PA DEP in 2000).

Muddy Run Watershed

For the Muddy Run Watershed several model runs were made with varying scenarios in order to reach TMDL load reductions. We quickly noticed that no matter what BMP's were proposed the TMDL reduction limits could not be reached for phosphorous. Even with 100% implemented BMP's on all farms in the watershed we were still short for reductions to phosphorous. This scenario pointed us in the idea that the TMDL may not be completely accurate. If we would convert all the agricultural land in the watershed to forest or wetland the phosphorous limit would be reached but it is not practical in a watershed where agriculture is the main economic stimulus for the residents. With these issues in mind a new scenario was created which obtained the sediment load reduction in the TMDL and came within 2,500 lbs of reaching the phosphorous load

reduction. We are not meeting the TMDL for one nutrient but we feel with agricultural waste systems, facilities, and barnyard controls not in the model this reduction limit can be meet.

Two other factors were tweaked in the PRedICT model to make it as accurate as possible for our scenario. First, the Agricultural Cost Editor for BMP's was modified to reflect cost estimates in Lancaster County. Cost for Grazing Land Management, Stream Bank Fencing, Stream Bank Stabilization, Vegetated Buffer Strips, and Nutrient Management were all increased to reflect current Lancaster County cost estimates. These prices will change with time but for the purpose of this plan they are as accurate as they can be. Also, the Agricultural BMP Load Reduction Efficiency Editor was modified slightly for certain BMP's to reflect efficiency values we felt were more accurate. These changes were not significant but only a few hundredths of a point. BMP efficiency's modified include the follow; cropland protection, conservation tillage, stripcropping/contour farming, nutrient management, grazing land management, vegetated buffer strips, stream bank fencing, and stream bank stabilization. Once again these changes were only minimal and should be achievable.

Results from our PRedICT model run call for an aggressive education and outreach program to implement the BMP's suggested. To reach TMDL load reduction levels the following goals will need to be reached in the roughly 135 farms in the Muddy Run Watershed.

- 35% of the farms will need to implement Conservation Cover Crop
- 10% will need to implement Conservation Tillage practices
- 50% will need to practice Stripcropping/Contour Farming
- 51% will need to have implemented Nutrient Management Plans
- 30% will need to have Grazing Land Management implemented
- Nearly 7 miles of Stream Bank Vegetation will need to be established
- 7 Miles of Stream Bank Fencing will need to erected
- And 2 miles of Stream Bank Stabilization will need to occur

These above goals are ambitious but with proper education and funding can be achieved. If additional residents hook up to city sewer systems or if the watershed starts to develop more these numbers will also change and new ideas will need to be researched to reach load reduction levels. The scenario run for the Muddy Run Watershed follows.

Mean Annual Load Data Editor

UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	6482058	23123	14118
Hay/Pasture	960998	3311	2496
High Density Urban	6828	2	78
Low Density Urban	10354	0	4
Unpaved Road	0	0	0
Other	300920	1908	543
STREAMBANK EROSION	468719	23	10
GROUNDWATER/SUBSURFACE		56111	425
POINT SOURCE DISCHARGE		126766	0
SEPTIC SYSTEMS		86	24
TOTAL	8229877	211330	17698
BASIN AREA	5619		

Agricultural Land BMP Scenario Editor

Acres			BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	2649	% Existing	7	0	0	0	0	21		0
		% Future	35	10	50	0	0	51		0
Hay/Pasture	2792	% Existing			0	0	0	21	1	0
		% Future			0	0	0	51	30	0

Agricultural Land on Slope > 3%	102	Acres	
Streams in Agricultural Areas	7.9	Miles	
Total Stream Length	8.6	Miles	

	Existing	Future
Stream Miles with Vegetated Buffer Strips	0	7
Stream Miles with Fencing	1.5	7
Stream Miles with Stabilization	.3	2
Unpaved Road Miles with E and S Controls	0	0

Urban Land BMP Scenario Editor

High Density Urban

Constructed Wetlands				Detention Basins			
Acres	62	% Existing	0			% Existing	21
% Impervious Surface	50	% Future	0			% Future	0
		Impervious Area Drained	0			Impervious Area Drained	0
% Drainage area Used	5	CW Area Drained	0	% Drainage area Used	3	CW Area Drained	0

Low Density Urban

Constructed Wetlands				Detention Basins			
Acres	42	% Existing	0			% Existing	0
% Impervious Surface	0	% Future	0			% Future	0
		Impervious Area Drained	0			Impervious Area Drained	0
% Drainage area Used	3	CW Area Drained	0	% Drainage area Used	2	CW Area Drained	0

Vegetated Stream Buffers				
			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0
Stream miles in low density urban areas	0	Stream miles in low density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0

Septic Systems BMP Scenario Editor

Septic Systems and Point Source Discharge Scenario Editor				
		Normal Systems		Short Circuit Systems
Number of persons on septic Systems	Existing	538		13
	Future	538		13
Septic systems converted by treatment type %	Secondary	0	Tertiary	0
Number of persons on public sewers	Existing	50	Future	0
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	100	0	7
	Future	100	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Agriculture and Urban BMP Load Reduction Efficiency Editor

Agricultural BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
BMP 1	0.25	0.40	0.40
BMP 2	0.50	0.40	0.65
BMP 3	0.25	0.45	0.45
BMP 4	0.87	0.45	0.90
BMP 5	0.87	0.77	0.90
BMP 6	0.70	0.30	
BMP 7	0.45	0.35	0.15
BMP 8	0.44	0.42	0.71
Vegetated Buffer Strips	0.65	0.55	0.60
Stream bank Fencing	0.60	0.80	0.80
Stream bank Stabilization	0.40	0.80	0.80
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55

Urban BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
Constructed Wetlands	0.53	0.51	0.88
Detention Basins	0.40	0.51	0.93

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of septic systems to secondary treatment plant	0.14	0.10
Conversion of septic systems to tertiary treatment plant	0.56	0.60
Conversion of primary treatment to secondary treatment	0.14	0.10
Conversion of primary treatment to tertiary treatment	0.56	0.60
Conversion of secondary treatment to tertiary treatment	0.42	0.50

BMP Cost Editor

Agricultural Cost Editor	
Conservation Tillage (per acre)	$30.00
Cropland Protection (per acre)	$25.00
Grazing land management (per acre)	$250.00
Stream bank Fencing (per acre)	$10.00
Stream bank fencing (per mile)	$10,000.00
Stream bank stabilization (per foot)	$30.00
Vegetated buffer strip (per mile)	$8,500.00
Terraces and Diversions (per acre)	$170.00
Nutrient Management (per acre)	$8.00
Ag to Wetland Conversion (per acre)	$25,000.00
Unpaved Roads (per foot)	$5.58
Ag to Forest Conversion (per acre)	$3,000.00
Urban Cost Editor	
Constructed wetlands (per acre)	$10,146.00
Detention basins (per acre)	$19,457.00
Septic System and Point Source Upgrades	
Conversion of septic systems to centralized sewage treatment (per home)	$15,000.00
Conversion from primary to secondary sewage treatment (per capita)	$250.00
Conversion from primary to tertiary sewage treatment (per capita)	$300.00
Conversion from secondary to tertiary sewage treatment (per capita)	$150.00

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row crops	6482058	23123	14118
Hay/pasture	960998	3311	2496
High density urban	6828	2	78
Low density urban	10354	0	4
Unpaved roads	0	0	0
Other	300920	1908	543
STREAMBANK EROSION	468719	23	10
GROUNDWATER/SUBSURFACE		56111	425
POINT SOURCE DISCHARGE		126766	0
SEPTIC SYSTEMS		86	24
TOTALS	**8229877**	**211330**	**17698**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total Phosphorus (lbs)
Row crops	1815468.54820253	1815468.54820253	4103.27428443038
Hay/pasture	919194.587	2274.342455	2040.81696
High density urban	6828	2	78
Low density urban	10354	0	4
Unpaved roads	0	0	0
Other	300920	1908	543
STREAMBANK EROSION	154786.274418605	12.3558139534884	3.30232558139535
GROUNDWATER/SUBSURFACE		55843.2978177032	425
POINT SOURCE DISCHARGE		126766	0
SEPTIC SYSTEMS		86	24
TOTALS	**3207551.40962114**	**192740.380861657**	**7221.39357001177**
PERCENT REDUCTIONS	61.0	8.8	59.2
TOTAL SCENARIO COST	$1,022,773.40		
Ag BMP Cost (%)	25.0		
WW upgrade cost (%)	0.0		
Urban BMP cost (%)	0.0		
Stream protection cost (%)	75.0		
Unpaved road protection cost (%)	0		

UNT Mill Creek Watershed

Similar to the Muddy Run Watershed model two factors were tweaked in the PRedICT model for the UNT Mill Creek scenario to make it as accurate as possible for our scenario. First, the Agricultural Cost Editor for BMP's was modified to reflect cost estimates in Lancaster County. Cost for Grazing Land Management, Stream Bank Fencing, Stream Bank Stabilization, Vegetated Buffer Strips, and Nutrient Management were all increased to reflect current Lancaster County cost estimates. These prices will change with time. Also, the Agricultural BMP Load Reduction Efficiency Editor was modified slightly for certain BMP's to reflect efficiency values we felt were more accurate. These changes were not significant but only a few hundredths of a point. BMP efficiency's modified include the follow; cropland protection, conservation tillage, stripcropping/contour farming, nutrient management, grazing land management, vegetated buffer strips, stream bank fencing, and stream bank stabilization. Once again these changes were only minimal and should be achievable.

Results from our UNT Mill Creek Watershed PRedICT model run once again call for an aggressive education and outreach program to implement the BMP suggested. To reach TMDL load reduction levels the following goals will need to be reached in the roughly 35 farms in the UNT Mill Creek Watershed.

- 10% of the farms will need to implement Conservation Cover Crop
- 60% will need to implement Conservation Tillage practices
- 30% will need to practice Stripcropping/Contour Farming
- 30% will need to have implemented Nutrient Management Plans
- 30% will need to have Grazing Land Management implemented
- Will need to establish Stream Bank Vegetation on the entire 3.4 miles of stream
- Will need to establish Stream Bank Fencing on the entire 3.4 miles of stream
- And at least 1 mile of Stream Bank Stabilization will need to occur

These above goals are ambitious but with proper education and funding can be achieved. The fencing and vegetation BMP's will most challenging but to-date a large portion of this work has been accomplish or is in the process. If this small watershed starts to develop these numbers will change and new ideas will need to be researched to reach load reduction levels. The scenario run for the UNT Mill Creek Watershed follows.

Mean Annual Load Data Editor

UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	739949	7706	1153
Hay/Pasture	71343	1086	166
High Density Urban	0	0	0
Low Density Urban	32312	3	37
Unpaved Road	0	0	0
Other	62117	446	78
STREAMBANK EROSION	224807	10	5
GROUNDWATER/SUBSURFACE		19165	217
POINT SOURCE DISCHARGE		16535	0
SEPTIC SYSTEMS		29	11
TOTAL	1130528	44980	1667
BASIN AREA	2365		

Agricultural Land BMP Scenario Editor

Acres			BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	976	% Existing	0	0	0	0	0	4		0
		% Future	10	60	30	0	0	30		0
Hay/Pasture	366	% Existing			0	0	0	4	0	0
		% Future			0	0	0	30	30	0

Agricultural Land on Slope > 3%	0	Acres	
Streams in Agricultural Areas	3.4	Miles	
Total Stream Length	4.1	Miles	

	Existing	Future
Stream Miles with Vegetated Buffer Strips	.9	3.4
Stream Miles with Fencing	.8	3.4
Stream Miles with Stabilization	0	1
Unpaved Road Miles with E and S Controls	0	0

Urban Land BMP Scenario Editor

High Density Urban

Constructed Wetlands				Detention Basins			
Acres	0	% Existing	0			% Existing	4
% Impervious Surface	50	% Future	0			% Future	0
		Impervious Area Drained	0			Impervious Area Drained	0
% Drainage area Used	5	CW Area Drained	0	% Drainage area Used	3	CW Area Drained	0

Low Density Urban

Constructed Wetlands				Detention Basins			
Acres	217	% Existing	0			% Existing	0
% Impervious Surface	0	% Future	0			% Future	0
		Impervious Area Drained	0			Impervious Area Drained	0
% Drainage area Used	3	CW Area Drained	0	% Drainage area Used	2	CW Area Drained	0

Vegetated Stream Buffers				
			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0
Stream miles in low density urban areas	0	Stream miles in low density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0

Septic Systems BMP Scenario Editor

Septic Systems and Point Source Discharge Scenario Editor				
		Normal Systems		Short Circuit Systems
Number of persons on septic Systems	Existing	108		6
	Future	108		6
Septic systems converted by treatment type %	Secondary	0	Tertiary	0
Number of persons on public sewers	Existing	410	Future	0
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	100	0	3.4
	Future	100	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Agriculture and Urban BMP Load Reduction Efficiency Editor

Agricultural BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
BMP 1	0.25	0.40	0.40
BMP 2	0.50	0.40	0.65
BMP 3	0.25	0.45	0.45
BMP 4	0.87	0.45	0.90
BMP 5	0.87	0.77	0.90
BMP 6	0.70	0.30	
BMP 7	0.45	0.35	0.15
BMP 8	0.44	0.42	0.71
Vegetated Buffer Strips	0.65	0.55	0.60
Stream bank Fencing	0.60	0.80	0.80
Stream bank Stabilization	0.40	0.80	0.80
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55

Urban BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
Constructed Wetlands	0.53	0.51	0.88
Detention Basins	0.40	0.51	0.93

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of septic systems to secondary treatment plant	0.14	0.10
Conversion of septic systems to tertiary treatment plant	0.56	0.60
Conversion of primary treatment to secondary treatment	0.14	0.10
Conversion of primary treatment to tertiary treatment	0.56	0.60
Conversion of secondary treatment to tertiary treatment	0.42	0.50

BMP Cost Editor

Agricultural Cost Editor	
Conservation Tillage (per acre)	$30.00
Cropland Protection (per acre)	$25.00
Grazing land management (per acre)	$250.00
Stream bank Fencing (per acre)	$10.00
Stream bank fencing (per mile)	$10,000.00
Stream bank stabilization (per foot)	$30.00
Vegetated buffer strip (per mile)	$8,500.00
Terraces and Diversions (per acre)	$170.00
Nutrient Management (per acre)	$8.00
Ag to Wetland Conversion (per acre)	$25,000.00
Unpaved Roads (per foot)	$5.58
Ag to Forest Conversion (per acre)	$3,000.00
Urban Cost Editor	
Constructed wetlands (per acre)	$10,146.00
Detention basins (per acre)	$19,457.00
Septic System and Point Source Upgrades	
Conversion of septic systems to centralized sewage treatment (per home)	$15,000.00
Conversion from primary to secondary sewage treatment (per capita)	$250.00
Conversion from primary to tertiary sewage treatment (per capita)	$300.00
Conversion from secondary to tertiary sewage treatment (per capita)	$150.00

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row crops	739949	7706	1153
Hay/pasture	71343	1086	166
High density urban	0	0	0
Low density urban	32312	3	37
Unpaved roads	0	0	0
Other	62117	446	78
STREAMBANK EROSION	224807	10	5
GROUNDWATER/SUBSURFACE		19165	217
POINT SOURCE DISCHARGE		16535	0
SEPTIC SYSTEMS		29	11
TOTALS	**1130528**	**44980**	**1667**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total Phosphorus (lbs)
Row crops	179872.896617647	179872.896617647	370.392517720588
Hay/pasture	68132.565	768.42102	136.98154
High density urban	0	0	0
Low density urban	32312	3	37
Unpaved roads	0	0	0
Other	62117	446	78
STREAMBANK EROSION	66893.7902439024	5.21951219512195	1.48780487804878
GROUNDWATER/SUBSURFACE		19126.8617033651	217
POINT SOURCE DISCHARGE		16535	0
SEPTIC SYSTEMS		29	11
TOTALS	**409328.251861549**	**38887.9834179132**	**851.861862598637**
PERCENT REDUCTIONS	63.8	13.5	48.9
TOTAL SCENARIO COST	$464,477.36		
Ag BMP Cost (%)	11.4		
WW upgrade cost (%)	0.0		
Urban BMP cost (%)	0.0		
Stream protection cost (%)	88.6		
Unpaved road protection cost (%)	0		

Remaining Mill Creek Watershed

Because no TMDL was set for the remaining part of the Mill Creek Watershed the BMP's slated for this scenario are slightly more achievable. This does not mean attention will not be put forth toward this larger watershed, because this watershed is key to the overall objective of the plan. Load reduction goals for this scenario came from the Millcreek Preservation Association and its members. Volunteers of the group had specific ideas and targets they would like to focus on in the future so there ideas and input was used to create the goals for the larger Mill Creek Watershed plan. This larger watershed scenario will give the Millcreek Preservation Association something to tackle for years to come and provide directions for the future.

To stay consistent with the previous two scenario models once again two factors were tweaked in the PRedICT model to make it as accurate as possible. First, the Agricultural Cost Editor for BMP's was modified to reflect cost estimates in Lancaster County. Cost for Grazing Land Management, Stream Bank Fencing, Stream Bank Stabilization, Vegetated Buffer Strips, and Nutrient Management were all increased to reflect current Lancaster County cost estimates. These prices will change over time. Also, the Agricultural BMP Load Reduction Efficiency Editor was modified slightly for certain BMP's to reflect efficiency values we felt were more accurate. These changes were not significant but only a few hundredths of a point. BMP efficiency's modified include the follow; cropland protection, conservation tillage, stripcropping/contour farming, nutrient management, grazing land management, vegetated buffer strips, stream bank fencing, and stream bank stabilization. Once again these changes were only minimal and should be achievable.

Results from our remaining Mill Creek Watershed PRedICT model run calls for a less aggressive education and outreach program to implement the BMP's suggested. The reason for this less aggressive approach is two reasons. First, the shear size of the Mill Creek Watershed dictates that more precise projects with greater load reductions need to be completed to get the best "bank for the buck" approach. Second, because the Millcreek Preservation Association will be the lead organization implementing this plan, something that was manageable for a small volunteer nonprofit group made more sense then an overly aggressive plan that had no chance of every being implemented. In this scenario less projects with larger load reductions makes

sense. To reach load reduction levels the following goals will need to be reached in the remaining Mill Creek Watershed.

- 10% of the farms will need to implement Conservation Cover Crop
- 10% will need to implement Conservation Tillage practices
- 10% will need to practice Stripcropping/Contour Farming
- 20% will need to have implemented Nutrient Management Plans
- 10% will need to have Grazing Land Management implemented
- Nearly 24 miles of Stream Bank Vegetation will need to be established
- 18.5 Miles of Stream Bank Fencing will need to erected
- And 10 miles of Stream Bank Stabilization will need to occur

These above goals are ambitious but with proper education and funding can be achieved. If this large watershed starts to develop significantly in the coming years these numbers will change and new ideas will need to be researched to reach load reduction levels. The scenario run for the remaining Mill Creek Watershed follows.

Mean Annual Load Data Editor

UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row Crops	12491310	261480	45223
Hay/Pasture	262325	43234	5720
High Density Urban	18340	4634	514
Low Density Urban	53146	1117	149
Unpaved Road	2	14	2.81904462217036
Other	1697730	12827	2703
STREAMBANK EROSION	14140855	707	311
GROUNDWATER/SUBSURFACE		233203	2417
POINT SOURCE DISCHARGE		859619	271
SEPTIC SYSTEMS		686	251
TOTAL	28663708	1417521	57562
BASIN AREA	35860		

Agricultural Land BMP Scenario Editor

Acres			BMP1	BMP2	BMP3	BMP4	BMP5	BMP6	BMP7	BMP8
Row Crops	20705	% Existing	3	2	2	0	0	6		0
		% Future	10	10	10	0	0	20		0
Hay/Pasture	6192	% Existing			0	0	0	6	2	0
		% Future			0	0	0	20	10	0

Agricultural Land on Slope > 3%	1676	Acres	
Streams in Agricultural Areas	55.7	Miles	
Total Stream Length	75.6	Miles	

	Existing	Future
Stream Miles with Vegetated Buffer Strips	.3	24
Stream Miles with Fencing	3.4	18.5
Stream Miles with Stabilization	.4	10
Unpaved Road Miles with E and S Controls	0	0

Urban Land BMP Scenario Editor

High Density Urban

Constructed Wetlands				Detention Basins			
Acres	1408	% Existing	0			% Existing	6
% Impervious Surface	50	% Future	2			% Future	0
		Impervious Area Drained	14.1			Impervious Area Drained	0
% Drainage area Used	5	CW Area Drained	1.4	% Drainage area Used	3	CW Area Drained	0

Low Density Urban

Constructed Wetlands				Detention Basins			
Acres	2051	% Existing	0			% Existing	0
% Impervious Surface	0	% Future	0			% Future	0
		Impervious Area Drained	0			Impervious Area Drained	0
% Drainage area Used	3	CW Area Drained	0	% Drainage area Used	2	CW Area Drained	0

Vegetated Stream Buffers

			Existing	Future
Stream miles in high density urban areas	0	Stream miles in high density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0
Stream miles in low density urban areas	3	Stream miles in low density urban areas w/buffers	0	0
		Stream bank Stabilization	0	0

Septic Systems BMP Scenario Editor

Septic Systems and Point Source Discharge Scenario Editor				
		Normal Systems		Short Circuit Systems
Number of persons on septic Systems	Existing	2829		134
	Future	2829		134
Septic systems converted by treatment type %	Secondary	0	Tertiary	0
Number of persons on public sewers	Existing	6295	Future	0
		Primary	Secondary	Tertiary
Distribution of pollutant discharge by treatment type %	Existing	100	0	18.5
	Future	0	0	0
		Primary to Secondary	Primary to Tertiary	Secondary to Tertiary
Distribution of treatment upgrades %		0	0	0

Agriculture and Urban BMP Load Reduction Efficiency Editor

Agricultural BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
BMP 1	0.25	0.40	0.40
BMP 2	0.50	0.40	0.65
BMP 3	0.25	0.45	0.45
BMP 4	0.87	0.45	0.90
BMP 5	0.87	0.77	0.90
BMP 6	0.70	0.30	
BMP 7	0.45	0.35	0.15
BMP 8	0.44	0.42	0.71
Vegetated Buffer Strips	0.65	0.55	0.60
Stream bank Fencing	0.60	0.80	0.80
Stream bank Stabilization	0.40	0.80	0.80
Unpaved Roads (lbs/ft)	0.02	0.0035	2.55

Urban BMP Load Reduction Efficiency Editor			
BMP Type	Nitrogen	Phosphorus	Sediment
Constructed Wetlands	0.53	0.51	0.88
Detention Basins	0.40	0.51	0.93

Wastewater BMP Load Reduction Efficiency Editor

	Nitrogen	Phosphorus
Conversion of septic systems to secondary treatment plant	0.14	0.10
Conversion of septic systems to tertiary treatment plant	0.56	0.60
Conversion of primary treatment to secondary treatment	0.14	0.10
Conversion of primary treatment to tertiary treatment	0.56	0.60
Conversion of secondary treatment to tertiary treatment	0.42	0.50

BMP Cost Editor

Agricultural Cost Editor	
Conservation Tillage (per acre)	$30.00
Cropland Protection (per acre)	$25.00
Grazing land management (per acre)	$250.00
Stream bank Fencing (per acre)	$10.00
Stream bank fencing (per mile)	$10,000.00
Stream bank stabilization (per foot)	$30.00
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Ag to Forest Conversion (per acre)	$3,000.00
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Conversion from primary to tertiary sewage treatment (per capita)	$300.00
Conversion from secondary to tertiary sewage treatment (per capita)	$150.00

Estimated Load Reductions

	Existing (lbs)		
UPLAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total P (lbs)
Row crops	12491310	261480	45223
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High density urban	18340	4634	514
Low density urban	53146	1117	149
Unpaved roads	2	14	2.81904462217036
Other	1697730	12827	2703
STREAMBANK EROSION	14140855	707	311
GROUNDWATER/SUBSURFACE		233203	2417
POINT SOURCE DISCHARGE		859619	271
SEPTIC SYSTEMS		686	251
TOTALS	**28663708**	**1417521**	**57562**

	Future (lbs)		
LAND EROSION/RUNOFF	Total Sed (lbs)	Total N (lbs)	Total Phosphorus (lbs)
Row crops	8223255.87610772	8223255.87610772	29999.2131333472
Hay/pasture	259177.1	37593.173552	5326.32672
High density urban	18017.216	4584.8796	508.7572
Low density urban	53146	1117	149
Unpaved roads	2	14	2.81904462217036
Other	1697730	12827	2703
STREAMBANK EROSION	10444779.6719577	586.361111111111	229.712169312169
GROUNDWATER/SUBSURFACE		232855.649918272	2417
POINT SOURCE DISCHARGE		859619	271
SEPTIC SYSTEMS		686	251
TOTALS	**20696105.8640654**	**1307270.01576445**	**41855.0092226594**
PERCENT REDUCTIONS	27.8	7.8	27.29
TOTAL SCENARIO COST	$4,145,692.99		
Ag BMP Cost (%)	6.2		
WW upgrade cost (%)	0.0		
Urban BMP cost (%)	3.5		
Stream protection cost (%)	90.4		
Unpaved road protection cost (%)	0		

Public Information and Participation

Public notice of this Watershed Implementation Plan has all ready been underway by the Conservation District and the Millcreek Preservation Association. Several articles have been published in the watershed group's newsletter that is sent to over 300 residents. The majority of the newsletters are sent to the Amish and Mennonite community. For those not in the Plain Sect community the District will conduct a Public Meeting at one of the municipalities in the watershed to unveil the plan and explain the idea behind the project. Our anticipation is that word of this plan will be spread through the watershed group and their contacts, through the newsletter, through municipal newsletters, and local contacts made from the Conservation District and NRCS staff. In addition each spring the watershed group conducts a Fishing Derby for local kids in the watershed and this event could be tied into an educational and outreach program for the adults on BMP's and conservation measures.

Water Quality Monitoring and Evaluation

Evaluation of nutrient and sediment load reductions is not an exact science. This is especially true in Pennsylvania where no State Water Quality Standards currently exist for sediments and nutrients. But the Conservation District with help from the PA DEP, the Millcreek Preservation Association, and the Lancaster County Chapter of the Senior Environmental Corps (SEC) will attempt to create a water monitoring study design for this plan. One study design document is all ready in use by the SEC volunteers and could be modified for this plan. The District will attempt to sample sediments and nutrients following BMP implementation with the assistance of the groups mentioned above. Macroinvertebrate sampling will also be done to validate the chemical sampling. Because of the shear size and scope of the watershed significant changes in the larger watershed may not be seen at first. On small tributary streams where quantification can be made easier, the end results might be seen sooner but once again because of the vast amount of agricultural production in the watershed small conservation measures might be lost in the bigger picture. Thus the

continued effort to provide education and outreach to the masses will be key in making sure all in the watershed know they are a vital part of the "healing process" of the watershed.

Monitoring efforts will focus on key parameters like dissolved oxygen, total suspended solids, turbidity, nitrates, phosphates, temperature, macroinvertebrates, and physical habitat assessments. These parameters are being sampled currently by SEC volunteers on a monthly basis and could be expanded to assist with this project. The majority of the monitoring sites for this project will focus on public property's that are easily accessible, locations above and below BMP projects, and possibly PA DEP's assessment points. At this time monitoring points have not been targeted because projects have not awarded. Once a project is awarded monitoring points will be established prior to any work to gather monitoring data. These sites will be monitored for 1 year prior to work and 2 years after work is completed. Public access points will be monitored monthly continuously because of accessibility. By combing project monitoring points and long-term sites we should be able to gather water quality data that will show improvements overtime.

In addition, computer modeling of the installed BMP's should be continued to account for load reductions. Two models that could be used for this are the Pollution Reduction Impact Comparison Tool (PRedICT) and/or the Spreadsheet Tool for the Estimation of Pollutant Loads (STEPL). Both tools have been approved by PA DEP and the Environmental Protection Agency (EPA) as resources to calculate load reductions from agricultural BMP's. The Conservation District and NRCS have used these tools in the past and feel fairly comfortable continuing to use these tools after BMP implementation. Hopefully combining these models with some on-the-ground water quality data an accurate account of load reductions can be achieved.

Finally, a comprehensive stream reassessment by PA DEP should be conducted in the Mill Creek Watershed in the next 5 years. With the amount of work that has already been done in the watershed since the last assessment and the amount of work proposed in the next 5 years this action is suggested. Tributary streams that have been significantly worked on recently should be the focus of this reassessment. The hope is that if small tributary streams in the watershed can be removed from the impaired list the overall Mill Creek proper will improve with added conservation measures.

Monitoring Milestones

The following are Milestones we hope to achieve during the course of implementing this plan:

- If we implement 45% of the agricultural BMP's in this plan we hope to reduce phosphorous and sediment loads in the entire watershed by 25%. This milestone should take approximately 12 years (+/- 2-3 years) to achieve.
- If we implement 30% of the riparian buffers in this plan we hope to see a 20% increase in intolerant macroinvertebrate species in the streams. This milestone should take approximately 8 years (+/- 1-2 years) to achieve.
- If we implement 25% of the stream bank stabilization measures in this plan we hope to see a 15% increase in fish species densities throughout the watershed. This milestone should take approximately 6 years (+/- 1-2 years) to achieve.
- If we implement 20% of the urban BMP's practices in this plan we hope to see a 1-2 degree temperature decrease in water temperatures in the streams. This milestone should take approximately 6 years (+/- 2-3 years) to achieve. (This milestone assumes new development will reduce or sustain current stormwater flows and that current urban BMP projects can be retrofitted to alleviate stormwater issues.)

Remedial Actions

Obviously the goal of this plan is to meet the TMDL's for the sub-watersheds in the basin and also have a cleaner and healthier Mill Creek Watershed. If progress is not seen with the implementation of the proposed BMP's in this plan and things do not improve actions will need to be taken to fix these issues. This current implementation plan will need to be looked at more closely to assess if the problems within the watershed are fully addressed in the plan. If inadequacies are noticed the plan will need to be altered to alleviate these issues. The one caution the Conservation District would like to mention at this time is that it takes time to see the true benefits of many of the conservation practices that we install. We would hope that regulatory agencies would not jump to conclusions if improvements are not seen in a timely fashion. Buffers need time to mature, farmers

need time for education of conservation measures and following plans, weather conditions are always fluctuating, and there is never a time of constant data. With these issues being noted hope is that the plan will address the sediment and nutrient challenges in the Mill Creek Watershed.

References

1. Pennsylvania Department of Environmental Protection. September 2003. Watershed Restoration Action Strategy, State Water Plan Subbasin 07J, Conestoga River, (Susquehanna River), Lancaster, Lebanon, and Berks County.
2. Schott, Robert J. of PA DEP. February 1994. Nonpoint Agricultural Pollution Aquatic Biological Investigations Muddy Run and Unt. Pequea Creek, June 24 and 25, 1992.
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5. PA DEP and Tetra Tech, Inc. February 2001. Total Maximum Daily Load for the Muddy Run Watershed, Pennsylvania.
6. PA DEP and the Susquehanna River Basin Commission. August 2004. Total Maximum Daily Load (TMDL) Unnamed Tributary to Mill Creek, Lancaster County.