CHAPTER 6

IDENTIFYING WATER QUALITY PROBLEMS AND SETTING GOALS

6.1 Confirm/Refute Initial Community Concerns

6.1.1 Original Community Concerns

The original impetus of the White River Watershed Project was the community's concerns about local water quality issues relating to public health (drinking water and fish consumption advisories), natural habitat loss (wildlife diversity and aesthetics), and impacts to recreation (fishing, boating, swimming).

Looking at both the historic subwatershed conditions as well as the results of the baseline study, the following can be said about these original concerns:

- Public Health:

  There is a fish consumption advisory for the White River and Buck Creek in Delaware County. The contaminants causing the listing are mercury and PCBs. PCBs are a historic contaminant found in the sediment of these waterways, while mercury comes from air deposition from such places as coal burning power plants (of which Delaware County has one, located at Ball State University).

  The majority of the citizens of Delaware County acquire their drinking water from the municipal water system. This water, which comes from the White River (and Prairie Creek Reservoir when needed), is treated by the Indiana-American Water Company. Therefore, local drinking water sources do not have contaminant levels over legal standards. However, several non-point source pollution contaminants (Atrazine, ammonia, nitrate, orthophosphate, *E. coli*) have been identified in the Prairie Creek Reservoir and its tributaries. Being a drinking water reservoir, it would be prudent for the community to work to eliminate such pollutants and protect the integrity of this public drinking water source.

  E. coli levels found throughout all three subwatersheds are indicative of the presence of not only that particular bacteria, but of other pollutants coming from warm blooded animal fecal matter (humans included) that can be a risk to human health.

- Loss of Natural Habitat:

  Since 1973, actions taken by the Muncie Sanitary District and the Bureau of Water Quality have vastly improved fish and macroinvertebrate populations due to their work to clean up and prevent point source water pollution. Personal interviews have recounted that other wildlife species have returned to the river in that time, as well. However, Buck Creek and Killbuck/Mud Creek are listed as having impaired biotic communities with IDEM. The results of the WRWP baseline study shows that fish and macroinvertebrate populations are lacking to a varying degree in all three of the subwatersheds. Killbuck/Mud Creek Subwatershed results were indicative of low water quality. Buck Creek Subwatershed results were indicative of higher water quality, the best overall of the three subwatersheds. The listing of Buck Creek Subwatershed in the 303(d) list for impaired biotic communities may be a reflection of IDEM's use of warm water sampling parameters, when Buck Creek may be a cool or cold water stream (as discussed earlier in this report).

Further improvements are sure to be made when actions are taken by the community to clean up and prevent non-point source water pollution.

Aesthetics is a subjective term that will differ from person to person. However, there are both positive and negative things that can be said with regards to the way our waterways appear in all three of the subwatersheds. Prairie Creek Subwatershed has most of its reservoir surrounded by trees or grass which is appealing on many different fronts, most importantly as a zone of protection against non-point source pollution runoff. Buck Creek Subwatershed also has a relatively high amount of trees and grass buffers along its stream corridor that works as a protection zone, as well as protecting the fragile temperature range that may allow Buck Creek to one day become a cold water stream. Killbuck/Mud Creek Subwatershed has the greatest amount of acres in grass filter strips of all three subwatersheds. Further work can be done in all three subwatersheds to decrease non-point source water pollution levels, which affect the level of aesthetics of any waterbody.

- Impacts to Recreation

  There is no doubt that if a community feels its waterways are not "clean", their level of recreational participation in and around those areas will be diminished. The White River has, indeed, seen an unbelievable improvement over the last 30 years. Some in the community are not aware of this fact. Even with this improvement, historic and current data have found non-point source pollution problems in Delaware County, including all three of the studied subwatersheds, *E. coli* contamination being the most prevalent. *E. coli* also happens to be one contaminant that can potentially have the most direct and immediate negative affect to human health, and therefore, fear of it can keep people out of the water. Efforts to reduce this contaminant, and several others that have been found to be problematic, are suggested later in this document.

  Another area of impact to recreation is the previously stated fish consumption advisory. There is much to be done with understanding how communities can remove persistent PCB levels in stream sediment. Air deposition from mercury can be reduced by encouraging sources that emit this contaminant to take actions to prevent such deposition.

6.1.2 Subwatershed Community Concerns

As described in Chapter 1, upon selection of the three subwatersheds, citizens from each were brought together to identify their local water quality concerns. Below are the concerns listed by subwatershed:

<u>6.1.2.1 Killbuck/Mud Creek Subwatershed</u>

Septic Systems – Water sampling results and interviews with individuals and the Delaware County Health Department indicate septic system contamination in this subwatershed. Most of the homes in the subwatershed will be connected to the local sewer project by the end of 2004, however, some residences will not be included. Actions to encourage those residents to fix their systems are included in the subsequent goal statements listed in Chapter 7.

Drainage – The request to identify all underground drainage tiles was done with limited success. Further analysis of the infra-red photography turned over to the DCSWCD in 2004 shall be conducted during the next phase of the WRWP. There was evidence of water pollution being transferred through drainage tiles from agricultural sources in this subwatershed.

Agricultural Conservation – Land use/land cover analysis and personal interviews have identified filter strips along both Killbuck and Mud Creeks. Total suspended solid levels were high in this subwatershed, which has an agricultural land use base of over 70% and over 50% of the 30 meter riparian corridor in agricultural crops.

Chemical Usage on Genetically Engineered Agriculture Crops – There was no work done to identify which agricultural fields were in genetically engineered crops. There was evidence of Atrazine water contamination in the subwatershed, regardless of crop origin.

Illegal Dumping – In response to the committee's request to educate local citizen on hazardous material disposal, the WRWP worked with the Hamilton Township Fire Department to develop and distribute informational postcards during their April, 2003 boot drive. (See Appendix F to view the postcard template.) Analysis of illicit dumping was not part of the baseline study program.

Outreach/Education – There has been ongoing public outreach and education throughout the planning phase of the White River Watershed Project. This emphasis on outreach and education, on specific topics, will continue into the implementation phase. (Please see Chapter 7 for further details.)

E. coli – Water sampling results indicate a high degree of *E. coli* contamination in this subwatershed. Through the water monitoring and land use analysis, sources are most likely to be coming from septic system contamination. The majority of septic systems in this subwatershed shall be connected to municipal sewers by the end of 2004.

6.1.2.2 Buck Creek Subwatershed

Septic Systems – Water sampling results and personal interviews indicate septic system contamination in this subwatershed. Through the water monitoring and land use analysis, sources are coming from agriculture, septic systems and combined sewer overflows.

Drainage – The request to identify all underground drainage tiles was done with limited success. Further analysis of the infra-red photography turned over to the DCSWCD in 2004 shall be conducted during the next phase of the WRWP. There was evidence of water pollution being transferred through drainage tiles from agricultural sources in this subwatershed.

Agricultural Conservation - Land use analysis and personal interviews have identified riparian buffers and filter strips on over 50% of the 30 meter Buck Creek corridor, and a high amount of reduced tillage practices being used. However, total suspended solid levels were high throughout the subwatershed, especially during the May 2003 high flow events (evidence of surface runoff contamination).

Chemical Contamination – Atrazine and Diazanon were both found in this subwatershed during water sampling, as were above standard/guideline levels of ammonia, nitrates and orthophosphates.

Illegal Dumping – Through land use analysis, salvage yards were identified. No specific education was done with regards to proper disposal in this subwatershed and illicit dumping was not included in the baseline study.

Outreach/Education - There has been ongoing public outreach and education throughout the planning phase of the White River Watershed Project. This emphasis on outreach and education will continue into the implementation phase. (Please see Chapter 7 for more details.)

Urban Sprawl – Through land use analysis, current land use in the subwatershed was identified. Non-point source pollution levels in stream reaches influenced by CSOs were associated with impervious surface runoff from development.

6.1.2.3 Prairie Creek Subwatershed

Drainage - The request to identify all underground drainage tiles was done with limited success. Further analysis of the infra-red photography turned over to the DCSWCD in 2004 shall be conducted during the next phase of the WRWP. There was evidence of water pollution being transferred through drainage tiles from agricultural sources in this subwatershed.

Agricultural Conservation - Land use analysis and personal interviews have identified extensive riparian buffers and filter strips around the Prairie Creek Reservoir, as well as along some of the tributaries. In addition, a good portion of this subwatershed was found to have reduced tillage practices being utilized. However, ammonia was high through the entire subwatershed and nitrates and orthophosphates were high in all three tributaries.

Urban Sprawl – Through land use analysis, current land use in the subwatershed was identified. As part of the implementation phase, there will be efforts to partner with the Muncie-Delaware County Plan Commission to conduct a Master Plan for this subwatershed. The non-point source pollutants found in this subwatershed can be attributed both to agriculture and residential land uses.

Geese – Water sampling results indicate a high degree of *E. coli* contamination in this subwatershed, although it is less severe as in the other two subwatersheds. Levels are even over state standards in the reservoir itself. Through the water monitoring and land use analysis, sources are coming from agriculture and septic systems. *E. coli* source identification analysis will be done as part of the implementation phase of this project. (See Chapter 7)

Recreation on the Reservoir – Focus on recreational usage in and around the reservoir was not part of the baseline study for the WRWP. However, it is anticipated to be included in the Master Plan work that the WRWP plans to partner with the Muncie-Delaware County Plan Commission.

Woodland Loss – As part of the implementation phase, there will be efforts to partner with the Muncie-Delaware Plan Commission to conduct a Master Plan for this subwatershed. A specific recommendation in this plan is to protect and enhance the wooded areas located around the reservoir and the tributaries to protect the quality of the public drinking water reservoir.

6.2 Confirmed Water Quality Impairments (Statement of Problems)

Impairments are listed in the order of priority within each subwatershed.

6.2.1 Killbuck/Mud Creek Subwatershed

Total Suspended Solids: Agricultural runoff, construction and stream bank erosion are all contributing to high levels of total suspended solids in the Killbuck/Mud Creek subwatershed.

Feasibility – It is feasible for the project to provide technical assistance and/or cost-share for agricultural best management practices (no-till, filter strips, riparian restoration, and cover crops), and to encourage proper seeding/erosion control on construction sites. It is feasible for the project to provide technical assistance and cost share for the revegetation of stream banks using trees and/or warm season grasses, and to work with the County Surveyor and local landowners to support such plantings. Accomplishing a complete reengineering of both Killbuck and Mud Creeks is not a feasible option at this time. However, establishing a partnership with Ball State University (or other appropriate group) to conduct a feasibility study may be possible.

Location – Throughout the entire subwatershed.

Urgency – High = TSS levels are very high in this subwatershed; actions taken to reduce TSS should also reduce ammonia and orthophosphates and improve DO levels. Therefore, the multiple benefits associated with actions to address TSS also make such actions potentially the most cost effective.

Ammonia and Orthophosphates: Agricultural runoff, failed/failing septic systems and failing subdivision treatment plants are all contributing to high levels of ammonia, orthophosphates and *E. coli* in the Killbuck/Mud Creek subwatershed.

Feasibility – The issue of septic system and treatment plant failures is currently being addressed by the installation of municipal sewers in the majority of the subwatershed. We expect to see a marked reduction in ammonia, orthophosphates, and *E. coli* upon completion of the sewer project. In addition, it is feasible for the project to provide technical assistance and cost share for agricultural best management practices (no-till, filter strips, riparian restoration, and cover crops).

Location – Ammonia and *E. coli* = agricultural areas throughout the subwatershed; septic systems/treatment plants not included in the sewer project. Orthophosphates = throughout the entire subwatershed, with particular emphasis on the Mud Creek drainage area.

Urgency – High = the same practices to reduce TSS should also reduce ammonia and orthophosphates; the vast majority of septic systems will be connected to the municipal sewer system by the end of 2004.

Nitrates: Leakage through drainage tile systems and failing/failed septic systems have combined to create high nitrate levels in the Killbuck/Mud Creek subwatershed.

Feasibility - The issue of septic system and treatment plant failures is currently being addressed by the installation of municipal sewers in the majority of the subwatershed. We expect to see a marked reduction in nitrates (as well as ammonia, orthophosphates, and *E. coli*) upon completion of the sewer project. In addition, it is feasible for the project to provide technical assistance and cost share for agricultural best management practices (tile flow treatment, filter strips, manure/nutrient management, and cover crops).

Location - Throughout the subwatershed, with particular emphasis on the Killbuck Creek drainage area

Urgency – Medium = the majority of septic systems will be connected to the municipal sewer system by the end of 2004; some of the actions taken to reduce the other nutrients will help reduce nitrates

DO, Stream Habitat, Macroinvertebrates and Fish: All = a lack of stream cover and poor in-stream habitat, improper stream channel design, sedimentation and algal growth have combined to severely lower levels of dissolved oxygen and the scores for biology and habitat are indicative of low water quality in the Killbuck/Mud Creek subwatershed. DO = especially at the three most downstream sampling points.

Feasibility – It is feasible for the project to provide technical assistance and cost share for the revegetation of stream banks using trees and/or warm season grasses, and to work with the County Surveyor and local landowners to support such plantings. Accomplishing a complete re-shaping of both Killbuck and Mud Creeks is not a feasible option at this time. However, establishing a partnership with Ball State University (or other appropriate group) to conduct a feasibility study may be possible.

Location – Primary waterways in the subwatershed.

Urgency – Medium = some of the proposed actions to reduce TSS (specifically stream channel reengineering and riparian corridor restoration) will work to improve DO levels, and stream habitat, macroinvertebrate, and fish scores

***E. coli*:** Failed/failing septic systems and subdivision treatment plants are combining to create high levels of *E. coli* in the Killbuck/Mud Creek subwatershed.

Feasibility – The issue of septic system and treatment plant failures is currently being addressed by the installation of municipal sewers in the vast majority of the subwatershed. We expect to see a marked reduction in *E. coli* (as well as ammonia and orthophosphates) upon completion of the sewer project.

Location – Throughout the entire subwatershed

Urgency – Low = the vast majority of septic systems will be connected to the municipal sewer system by the end of 2004.

6.2.2 Buck Creek Subwatershed

Temperature: Consistently low water temperatures suggest Buck Creek as a cold water stream (potentially able to support salmonid populations), however, if the current level of woody vegetation along the stream corridor is not preserved and enhanced, temperatures are likely to rise.

Feasibility – It is feasible for the project to work with the local plan commission, landowners, and the County drainage board and surveyor to protect and enhance the stream corridor. It is also feasible for the project to provide technical assistance and cost share for agricultural best management practices (riparian corridor restoration and filter strips). The project would also be able to coordinate a study of Buck Creek's ability to support salmonid populations.

Location – Primary stream corridor

Urgency – High = Protection and restoration of the riparian corridor on Buck Creek will work to reduce TSS, ammonia and orthophosphates as well as improve conditions for recreational fishing opportunities and the maintenance of a unique stream ecosystem in this part of the state.

Total Suspended Solids, Ammonia and Orthophosphates: TSS = Spring agricultural runoff, Ammonia and Orthophosphates= combined sewer overflows, agricultural runoff and failed septic systems are creating high total suspended solid levels in the Buck Creek subwatershed.

Feasibility – All = it is feasible for the project to provide technical assistance and cost share for agricultural best management practices (no-till, riparian corridor restoration and protection, filter strips, and grassed waterways, manure/nutrient management, cover crops). Ammonia and Orthophosphates = removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

Location – TSS = agricultural areas in the drainage area upstream from BC-5. Ammonia = agricultural area in the drainage area between BC-8 and BC-7, secondary stream corridor located midway between BC-8 and BC-7 on the East side of Buck Creek, combined sewer overflows. Orthophosphates =levels steadily climb going downstream, therefore actions throughout the subwatershed would be appropriate

Urgency – High = TSS levels are high in this subwatershed; actions taken to reduce TSS should also reduce ammonia and orthophosphate levels. In addition, some actions suggested would also protect and improve the unique temperature conditions found in Buck Creek (specifically protection and restoration of the riparian corridor). Therefore, the multiple benefits associated with actions to address TSS also make such actions potentially the most cost effective.

***E. coli*:** Failed/failing septic systems, combined sewer overflows and agricultural runoff have combined to create high levels of *E. coli* in the Buck Creek Subwatershed, with a particular spike occurring during high flow events in May.

Feasibility – The project is not able to provide funds to repair/replace failed/failing septic systems, but it can provide education and outreach regarding system maintenance. Removal and/or mitigation of all combined sewer overflows are taking place through efforts made by the Muncie Sanitary District. It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (manure management, filter strips, and riparian restoration and protection).

Location – Throughout the entire subwatershed.

Urgency – High = actions being taken by the Muncie Sanitary District to remove and/or mitigate all CSOs will help reduce *E. coli* loads; public education and outreach on maintenance and repair of septic systems will also help reduce *E. coli* loads; installing manure runoff reducing agricultural BMP installation should also help

Nitrate: Leakage through drainage tiles and failed/failing septic systems are combining to create high levels of nitrates throughout the entire Buck Creek subwatershed.

Feasibility – It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (tile flow treatment, manure/nutrient management, filter strips). The project is not able to provide funds to repair/replace failed/failing septic systems, but it can provide education and outreach regarding proper system maintenance. Removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

Location – Throughout the subwatershed.

Urgency – Medium = some of the actions taken to reduce the other nutrients will help reduce nitrates; public education and outreach on maintenance and repair of septic systems will also help

Stream Habitat and Macroinvertebrates: Stream habitat is good throughout the Buck Creek subwatershed, except for BC-6, due to the presence of wooded stream corridors.

Feasibility – It is feasible for the project to work with the local plan commission, county surveyor, landowners, and the county drainage board to protect and enhance the stream corridor. It is also feasible for the project to provide technical assistance and cost share for agricultural best management practices (no-till and riparian corridor restoration). It is also feasible for the project to work with the proper authorities to remove the unauthorized rock dam located in the vicinity of BC-6.

Location – Protection and enhancement of entire stream corridor; removal of illegal dam just upstream from BC-6

Urgency – Medium = it would be relatively easy to remove the illegally placed dam and restore these parameters to their natural states

Fish (IBI): Fish scores are better throughout the Buck Creek subwatershed than the other two subwatersheds.
Feasibility – Removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

Location – Combined sewer overflows.

Urgency – Low = Removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

Dissolved Oxygen: Dissolved oxygen seems to be problematic only at the BC-4 sampling site, due to combined sewer overflow discharge.

Feasibility – Removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

Location – Combined sewer overflows.

Urgency – Low = Removal and/or mitigation of all combined sewer overflows is taking place through efforts made by the Muncie Sanitary District.

6.2.3 Prairie Creek Subwatershed

Ammonia: Agricultural runoff and failed/failing septic systems have combined to create high levels of ammonia in the entire Prairie Creek Subwatershed, especially during high flow events.

Note that ammonia attaches to soil particles, hence actions that reduce TSS would also reduce ammonia. However, TSS levels are not problematic in the Prairie Creek Subwatershed. This indicates that the source(s) of ammonia in this subwatershed are reaching the waterways in a more direct manner.

Feasibility – The project is not able to provide funds to repair/replace failed/failing septic systems, but it can provide education and outreach regarding system maintenance. It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (manure/nutrient management, filter strips, cover crops).

Location – Throughout the entire subwatershed.

Urgency – High = Ammonia was found (along with *E. coli*) to be the most problematic parameter in this subwatershed. Certain actions suggested to reduce ammonia would also reduce *E. coli*, orthophosphates and nitrates, and increase DO levels. Therefore, actions taken to reduce ammonia would be more cost effective by improving levels of multiple parameters.

Stream/Reservoir Habitat, Fish, and Macroinvertebrates: Stream habitat, fish and macroinvertebrate scores are good in the tributary of PC-7. The rest of the sampling locations more closely resemble a lake environment than a stream, therefore population measurements were not tallied using the current sampling methodology.

The good ratings for PC-7 are due to the stream corridor being wooded and/or in filter strips. Habitat around the reservoir itself is also good due to the current wooded and grassed buffer surrounding the entire reservoir.

Feasibility – The project is able to work with the plan commission, land owners, and other entities to protect and enhance the reservoir buffer area.

Location – Reservoir and stream corridors.

Urgency – High = protection of the well established woods and grassed areas around the reservoir and along some of the tributaries is working to help keep contaminant levels lower in Prairie Creek Subwatershed than in the other two subwatersheds.

DO: Failing/failed septic systems and agricultural runoff is combining to create low levels of dissolved oxygen in the reservoir and PC-6 of Prairie Creek Subwatershed.

Feasibility – The project is not able to provide funds to repair/replace failed/failing septic systems, but it can provide education and outreach regarding system maintenance. It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (manure/nutrient management, filter strips).

Location – Throughout the subwatershed for septic system failure; agricultural areas in the drainage area for PC-6

Urgency – Medium = actions taken to reduce ammonia in these areas should also work to improve DO levels.

Nitrate: Flow in drainage tiles and agricultural runoff are leading to high nitrate levels in the three tributaries (PC-6, 7 and 8) that feed into the reservoir in the Prairie Creek Subwatershed.

Feasibility – It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (tile flow treatment, manure/nutrient management, filter strips.

Location – Agricultural areas within the drainage areas of PC-6, 7 and 8.

Urgency – Medium = actions to improve ammonia should work to reduce Nitrates; installation of tile flow treatment would also be beneficial

Orthophosphate: Agricultural runoff is leading to high orthophosphate levels in the three tributaries (PC-6, 7 and 8) that feed into the reservoir in the Prairie Creek Subwatershed.

Feasibility – It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (no-till, manure/nutrient management, filter strips.

Location – Agricultural areas within the drainage areas of PC-6, 7 and 8.

Urgency –Medium = actions to reduce ammonia should also reduce orthophosphate levels

***E. coli*:** Failed/failing septic systems and agricultural runoff are contributing to high levels of *E. coli* in the Prairie Creek Subwatershed (the three tributaries [PC-6, 7, and 8] in particular). Note that *E. coli* levels are lower in this subwatershed than the other two involved in this plan, however, levels are still considered high (even within the reservoir itself).

Feasibility – The project is not able to provide funds to repair/replace failed/failing septic systems, but it can provide education and outreach regarding system maintenance. It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (manure management).

Location – Throughout the subwatershed.

Urgency – Medium = actions to reduce ammonia should also reduce *E. coli*

6.2.4 General Subwatershed Parameters

Atrazine: Atrazine, an herbicide used in the agricultural production of corn, was found at the downstream most point in all three subwatersheds. Levels were high during the May 2003 sampling session, due to the fact that May is the general time when this herbicide is applied. Finding this chemical in the waterways in indicative of three things: 1. Surface runoff from fields, 2. Tile drainage from fields, and/or 3. Drift or overspray into waterways bordering fields. Historical conditions in the White River Basin also note agricultural herbicides, in particular Atrazine, as being problematic for water quality.

Feasibility - It is feasible for the project to provide technical assistance and cost share for agricultural best management practices (tile flow treatment, riparian restoration, filter strips) and public education on alternative agricultural/gardening methods (organic/chemical-free).

Urgency – High = The occurrence of Atrazine is indicative of agricultural runoff, which can also contribute to increased TSS, ammonia, nitrate, orthophosphate, and (if livestock is involved) *E. coli*, and can reduce fish and macroinvertebrate populations. Therefore, actions taken to reduce agricultural runoff will reduce many other contaminants; hence, such actions are more cost effective than those that target only one parameter.

Diazinon: Levels were reported to be below the method detection limit for the October 2003 sampling session, and November 2003 samples had a high concentration, but less than both the aquatic life standard and the drinking water guideline.

Feasibility – With such low levels, there is no need for action.

Urgency – Low

6.3 Estimated Current Pollutant Loads and Targeted Load Reductions

6.3.1 Methodology and Calculations

Pollutant loads for the sampling points listed below were calculated by; a) calculating the median flow using the flow data collected for each subwatershed, b) determining the percentage of flow contributed by the acreage of each sub-subwatershed identified for each sampling point, and c) calculating the average (median for *E. coli*) for each water quality parameter studied, all for which there was a reasonable amount of data to do such calculations with a sound degree of confidence.

Target load reductions for each parameter were calculated by a) determining target concentrations (based on standards and guidelines previously mentioned in this document), b) calculating target loads for each parameter based on those standard/guideline based target concentrations and multiplying by average streamflow and, c) determining target load reductions by subtracting the target loads from the estimated loads for each parameter within a given sub-subwatershed.

Table 6.1: Estimated Current Pollutant Loads and Targeted Load Reduction
(continued on the next two pages)

Parameter	Total Reduction (lbs/year)/ *E. coli* (cfu/year)
K/M ammonia	3851.07
K/M *E. coli*	6.32307E+15
K/M nitrate	5846.29
K/M orthophosphate	776.55
K/M TSS	1013520.84
BC ammonia	10646.23
BC *E. coli*	6.375E+16
BC nitrate	17554.47
BC orthophosphate	-3455.50
BC TSS	-2806091.24
PC ammonia	4620.71
PC *E. coli*	3.63745E+15
PC nitrate	-33810.11
PC orthophosphate	-2242.85
PC TSS	-1844244.09
Total ammonia	19118.02
Total *E. coli*	7.37105E+16
Total nitrate	-10409.35
Total orthophosphate	-4921.80
Total TSS	-3636814.49

Note: BC-8 was not calculated for due to the lack of acreage for the BC-8 sub-subwatershed area (lack of data available for Henry County). Flow was not calculated for any of the tributaries studied in the Prairie Creek Subwatershed due to the lack of flow data for those tributaries. Flow was only calculated for the reservoir outflow (PC-3). Target concentrations for ammonia were determined by averaging the temperature results for each sampling point, taking the neutral pH of 7.0 and using the state standards chart (327 IAC 2-1-6 in Appendix E) identified the standard target for ammonia.

Values in red type indicate parameters where estimated current load levels are lower than targeted levels based on current state standards and scientific guidelines

Sampling Point	Median Flow (ft3 /sec)	Parameter	Average /Median	Load (lbs/day)/ *E. coli* (cfu/day)	Load (lbs/year)/ *E. coli* (cfu/year)	Target Concen-tration	Target Load (lbs/year)/ *E. coli* (cfu/year)	Target Load Reduction (lbs/year)/ *E. coli* (cfu/year)
KB - 1	14.75	ammonia (mg/l)	0.286	22.72	8292.62	0.0539	1565.19	6727.44
	14.75	*E. coli* (cfu/100ml)	1130.000	4.07782E+13	1.48841E+16	235	3.09536E+15	1.17887E+16
	14.75	nitrate (mg/l)	2.020	160.71	58658.16	1.60	46461.91	12196.25
	14.75	orthophosphate (mg/l)	0.151	12.01	4384.84	0.10	2903.87	1480.97
	14.75	TSS (mg/l)	185.143	14729.61	5376306.52	80.00	2323095.41	3053211.11
KB - 2	7.63	ammonia (mg/l)	0.620	25.51	9311.72	0.0539	809.52	8502.20
	7.63	*E. coli* (cfu/100ml)	1370.000	2.55701E+13	9.33307E+15	235	1.60093E+15	7.73214E+15
	7.63	nitrate (mg/l)	1.793	73.77	26926.76	1.60	24030.25	2896.50
	7.63	orthophosphate (mg/l)	0.222	9.15	3338.49	0.10	1501.89	1836.60
	7.63	TSS (mg/l)	169.514	6975.12	2545919.46	80.00	1201512.64	1344406.82
KB - 3	4.27	ammonia (mg/l)	0.271	6.25	2282.64	0.0539	453.28	1829.36
	4.27	*E. coli* (cfu/100ml)	1660.000	1.73486E+13	6.33222E+15	235	8.96429E+14	5.43579E+15
	4.27	nitrate (mg/l)	1.810	41.70	15221.62	1.60	13455.57	1766.04
	4.27	orthophosphate (mg/l)	0.201	4.62	1687.95	0.10	840.97	846.98
	4.27	TSS (mg/l)	99.843	2300.42	839651.83	80.00	672778.69	166873.14
KB - 4	5.75	ammonia (mg/l)	0.295	9.16	3343.90	0.0539	610.38	2733.52
	5.75	*E. coli* (cfu/100ml)	1170.000	1.64653E+13	6.00983E+15	235	1.20710E+15	4.80273E+15
	5.75	nitrate (mg/l)	2.424	75.21	27453.31	1.60	18118.86	9334.45
	5.75	orthophosphate (mg/l)	0.130	4.04	1475.39	0.10	1132.43	342.96
	5.75	TSS (mg/l)	151.657	4705.23	1717409.27	80.00	905943.10	811466.17
KB - 5	3.52	ammonia (mg/l)	0.419	7.95	2900.59	0.0539	373.51	2527.08
	3.52	*E. coli* (cfu/100ml)	2620.000	2.25627E+13	8.23540E+15	235	7.38671E+14	7.49673E+15
	3.52	nitrate (mg/l)	2.157	40.95	14948.46	1.6	11087.60	3860.86
	3.52	orthophosphate (mg/l)	0.116	2.21	806.82	0.1	692.97	113.85
	3.52	TSS (mg/l)	164.714	3127.20	1141428.61	80	554379.90	587048.71
KB - 6	1.69	ammonia (mg/l)	0.291	2.65	965.82	0.0539	178.98	786.84
	1.69	*E. coli* (cfu/100ml)	688.000	2.83910E+12	1.03627E+15	235	3.53958E+14	6.82311E+14
	1.69	nitrate (mg/l)	3.113	28.32	10336.60	1.6	5312.99	5023.62
	1.69	orthophosphate (mg/l)	0.111	1.01	370.01	0.1	332.06	37.95
	1.69	TSS (mg/l)	115.571	1051.42	383768.32	80	265649.27	118119.05

Sampling Point	Median Flow (ft3 /sec)	Parameter	Average /Median	Load (lbs/day)/ *E. coli* (cfu/day)	Load (lbs/year)/ *E. coli* (cfu/year)	Target Concen-tration	Target Load (lbs/year)/ *E. coli* (cfu/year)	Target Load Reduction (lbs/year)/ *E. coli* (cfu/year)
BC - 3	59.76	ammonia (mg/l)	0.191	61.51	22452.66	0.0539	6340.86	16111.80
	59.76	*E. coli* (cfu/100ml)	1635.000	2.39029E+14	8.72455E+16	235	1.25399E+16	7.47056E+16
	59.76	nitrate (mg/l)	1.630	525.36	191755.09	1.6	188225.85	3529.23
	59.76	orthophosphate (mg/l)	0.064	20.72	7562.65	0.1	11764.12	-4201.47
	59.76	TSS (mg/l)	49.857	16069.18	5865252.02	80	9411292.63	-3546040.62
BC - 4	55.54	ammonia (mg/l)	0.208	62.40	22776.11	0.0539	5893.98	16882.13
	55.54	*E. coli* (cfu/100ml)	3825.000	5.19786E+14	1.89722E+17	235	1.16561E+16	1.78066E+17
	55.54	nitrate (mg/l)	1.754	525.57	191831.74	1.6	174960.55	16871.20
	55.54	orthophosphate (mg/l)	0.066	19.82	7232.74	0.1	10935.03	-3702.29
	55.54	TSS (mg/l)	49.714	14893.90	5436274.12	80	8748027.32	-3311753.20
BC - 5	49.32	ammonia (mg/l)	0.163	43.36	15826.43	0.0539	5233.40	10593.03
	49.32	*E. coli* (cfu/100ml)	911.000	1.09923E+14	4.01217E+16	235	1.03497E+16	2.97720E+16
	49.32	nitrate (mg/l)	1.837	488.70	178376.78	1.6	155351.48	23025.31
	49.32	orthophosphate (mg/l)	0.055	14.55	5312.47	0.1	9709.47	-4397.00
	49.32	TSS (mg/l)	46.743	12434.20	4538482.40	80	7767573.79	-3229091.39
BC - 6	40.20	ammonia (mg/l)	0.133	28.90	10548.60	0.0539	4265.79	6282.80
	40.20	*E. coli* (cfu/100ml)	1060.000	1.04253E+14	3.80525E+16	235	8.43616E+15	2.96163E+16
	40.20	nitrate (mg/l)	1.996	432.73	157946.30	1.6	126628.39	31317.91
	40.20	orthophosphate (mg/l)	0.054	11.65	4251.10	0.1	7914.27	-3663.18
	40.20	TSS (mg/l)	42.800	9280.30	3387309.36	80	6331419.36	-2944110.00
BC - 7	12.69	ammonia (mg/l)	0.188	12.90	4708.18	0.0539	1346.77	3361.40
	12.69	*E. coli* (cfu/100ml)	816.500	2.53533E+13	9.25396E+15	235	2.66342E+15	6.59054E+15
	12.69	nitrate (mg/l)	2.121	145.23	53007.13	1.6	39978.44	13028.69
	12.69	orthophosphate (mg/l)	0.047	3.25	1185.08	0.1	2498.65	-1313.58
	12.69	TSS (mg/l)	40.000	2738.25	999460.98	80	1998921.95	-999460.98
PC - 3	13.23	ammonia (mg/l)	0.254	18.09	6602.08	0.0761	1981.37	4620.71
	13.23	*E. coli* (cfu/100ml)	543.000	1.75693E+13	6.41278E+15	235	2.77533E+15	3.63745E+15
	13.23	nitrate (mg/l)	0.301	21.50	7848.11	1.6	41658.22	-33810.11
	13.23	orthophosphate (mg/l)	0.014	0.99	360.79	0.1	2603.64	-2242.85
	13.23	TSS (mg/l)	9.167	653.88	238666.88	80	2082910.97	-1844244.09

6.3.2 Summary of Load Calculation Table (Table 6.1)

As with any calculation based on assumptions, there are limitations to the results found in the table above. The calculation limitations are present due to the finite amount of flow and sampling data available for each subwatershed.

Results of this table can be interpreted in a multitude of ways. First, the table characterizes the loading under ambient conditions (averaging both high and seasonal flow events and their associated sampling data) thereby mediating the affects of extremes in flow conditions. For example, target loads may not be met under high flow conditions when the chances of non-point source pollution running off into surface water bodies are increased. Second, target reductions were calculated for both sub-subwatershed and subwatershed levels, as well as for the total of all three subwatersheds. Looking at load reductions in multiple ways provides the ability to identify critical areas for both protection and improvement of water quality on several scales. It would be misleading to only list the target reductions for the total areas of the three subwatersheds, as they are three separate headwater subwatersheds and do not influence one another. One is provided a clearer picture of conditions when looking at the subwatershed and sub-subwatershed levels.

By looking at the results of the loading calculations, it is apparent that Killbuck/Mud Creek Subwatershed has a greater level of non-point source water pollution in a larger number of parameters than the other two subwatersheds. Buck Creek and Prairie Creek Subwatersheds are experiencing reduced levels of pollutants, with specific parameters being more problematic than others. These figures match what has been observed both in the field and by comparing water quality results with land use and land cover analysis.

Determining cost estimates for each parameter for each sub-subwatershed was attempted, in order to give the reader an idea of what it may cost to bring a given area to the target load reduction. This was done with very limited success due to several factors: there is an innumerable combination of remedial actions that can be taken in a community to reduce various non-point source pollutants. There is no true way to predict the mixture and concentration of future actions to be taken; calculating load reductions for ammonia and *E. coli* was not done for this plan due to a lack of methodology (like the EPA Region5 worksheets used for TSS, P and N load reduction calculations). There have been costs calculated for the 3-5 year implementation actions (listed in Chapter 7 of this document). This provides the reader an idea of costs associated with specific management practices, outreach and education activities, monitoring and management requirements needed to reduce specific non-point source pollution parameters designated as priorities by the local community.

Some of the goals listed in the next section work to reduce the levels of pollutants in each of the subwatersheds, while some work to protect currently high water quality levels. Both types of actions are vital to managing for low levels of non-point source water pollution.

6.4 Goal Statements (for the next 3 to 5 years)

Load reductions were calculated using the EPA Region 5 load reduction model worksheets. Load reductions were not able to be calculated for ammonia and *E. coli*, as there were no methods available to do so (such as the EPA Region 5 worksheets). The goals and their designated priorities were determined through a series of public meetings (with the technical, steering, watershed committees). It was the desire of these community members to create goals for the next three to five years, with the anticipation to revisit the plan and these goal statements periodically to revise, add to or remove them as needed. The specific acreages listed under the goal statements were also decided upon by the previously described group of community citizens, based on the known land use acreages and their perception of an attainable acreage goal within the boundaries of voluntary community participation.

6.4.1 High Priority

Reduce levels of total suspended solids, ammonia, orthophosphates, Atrazine and nitrates coming from agricultural areas through the installation 250 acres (20 miles at 50' wide) of wooded and/or grass buffer strips in the next five years (primary and secondary waterways, widths and cover type to vary accordingly) and 6 acres of grassed waterways (2 miles at an average of 25' wide). This would give an estimated load reduction for the following parameters: sediment = 307 tons/year, phosphorus = 470 lbs/year, and nitrogen = 934 lbs/year. TSS, ammonia, orthophosphate and nitrate levels would continue to be monitored to determine the extent of load reduction.

Reduce levels of total suspended solids, ammonia, orthophosphates, Atrazine and nitrates coming from agricultural areas by increasing the acreage of reduced tillage by 7400 acres in the next five years (roughly 1/3 of the total agricultural acreage for the three subwatersheds). This would give an estimated load reduction for the following parameters: sediment = 3324 tons/year, phosphorus = 4782 lbs/year, and nitrogen = 9554 lbs/year. TSS, ammonia, orthophosphate and nitrate levels would continue to be monitored to determine the extent of load reduction.

Reduce levels of total suspended solids, ammonia, orthophosphates, *E. coli* and nitrates coming from urban/suburban areas through the installation of 100 acres (approximately 4 miles at and average of 100' wide) of wooded and/or grass buffer strips in the next five years (primary and secondary waterways, widths and cover type to vary accordingly). This would give an estimated load reduction for the following parameters: TSS = 11242 lbs/year. TSS, ammonia, orthophosphate and nitrate levels would continue to be monitored to determine the extent of load reduction.

Develop targeted methods of *E. coli* reduction by identifying sources of *E. coli* contamination through the implementation of an *E. coli* source water quality monitoring program during the next three years. Results of this program would indicate local sources and their degree of contribution.

Maintain the low temperature regime in Buck Creek through the protection and enhancement of the primary riparian corridor by partnering on planning efforts with the Muncie-Delaware County Plan Commission and local landowners over the next three years.

Maintain and improve the water quality in Prairie Creek reservoir by protecting and enhancing its vegetated buffer area through partnering on planning efforts with the Muncie-Delaware County Plan Commission and local landowners over the next three years.

Reduce *E. coli* contamination, TSS, ammonia, orthophosphates, nitrates through targeted public education and outreach programs over the next three years. Public participation and feedback will be measured to estimate the effectiveness of such programs.

6.4.2 Medium Priority

Reduce total suspended solids and *E. coli* through the installation of ten acres of constructed wetlands (one for septic effluent treatment and one for stormwater filtration) during the next three years. This would give an estimated load reduction for TSS of 4627 lbs/year.

Reduce nitrate levels coming from agricultural areas by installing 3 tile flow treatment demonstration sites (one per watershed) over the next five years. Nitrates will be measured to determine if the practice works.

Improve stream habitat and biology in Buck Creek, remove the illegal rock dam at BC-6 during the next three years. Habitat and biology would continue to be monitored to determine the affects of the removal.

6.4.3 Low Priority

Reduce total suspended solid, nitrate and orthophosphate levels in Buck Creek by stabilizing 400 feet of the bank upstream of BC-7 within the next five years. TSS levels would continue to be measured to determine load reductions. This would give an estimated load reduction for the following parameters: sediment = 75.6 tons/year, phosphorus = 64.3 lbs/year, and nitrogen = 128.5 lbs/year. TSS, ammonia, orthophosphate and nitrate levels would continue to be monitored to determine the extent of load reduction.

Improve stream habitat and biology, along with reducing total suspended solids by conducting a feasibility study to reengineer Killbuck and Mud Creeks during the next three years. Reengineering a stream channel would take years of planning and, therefore, it is suggested to start by determining if such actions are even feasible prior to developing a plan for such action.

Total load reductions for the above actions total (ammonia and *E. coli* were not calculated):

Total Suspended Solids: 15869 lbs/year
Sediment: 3706.6 tons/year
Nitrogen: 15933.1 lbs/year
Phosphorus: 5316.3 lbs/year

These reductions would alter the total reduction for each parameter in the following manner:
(a “–“ indicates target load is already met)

Total TSS:
Reduction needed to meet target = -3636814.49
Implementation Load Reduction = 15869
New Target Reduction = -3652683.49

Total Nitrogen:
Reduction needed to meet target = -10409.35
Implementation Load Reduction = 15933.1
New Target Reduction = -26342.45

Total Phosphorus:
Reduction needed to meet target = -4921.80
Implementation Load Reduction = 5316.3
New Target Reduction = -10238.10