7.0 WATER QUALITY AND AQUATIC HABITAT

7.1 Water Quality

Water quality and water quantity are interrelated and an assessment of water quality issues that have a direct and substantial effect on water resource availability is critical in the evaluation of a potentially water-stressed area. As such, an assessment of relevant water quality monitoring reports, projects, and studies on the streams in Morrison Cove was completed. These data were compiled and analyzed to provide a summary of water quality issues and concerns in each of the major watersheds within the region.

Historically, the most significant water quality issue in Morrison Cove is the high concentrations of nitrate in the groundwater. In 2004, the USGS completed an extensive study on the sources of water and contaminants to water supply wells in the Martinsburg area. This was done using geochemical indicators, analysis of anthropogenic contaminants, and simulation of groundwater flow.

Groundwater is an essential resource for this rural area as it is the main drinking water source for more than 3,000 people. Martinsburg has four wells in the carbonate-bedrock aquifer that supply the drinking water. The quantity of water from these wells is not a concern but the quality of the water definitely is. Concentrations of nitrate in the well water have exceeded the Maximum Contaminant Level (MCL) of 10 mg/l numerous times. High concentrations in groundwater are not limited to Martinsburg; a Pennsylvania Department of Agriculture study reported that water from 35 percent of wells sampled in the Morrison Cove Valley exceeded the MCL for nitrate. The Martinsburg project provides an excellent case study about the issues related to nitrogen-contaminated groundwater.

Potential sources of groundwater contamination can be directly correlated to land use types. The land within the groundwater boundaries for the Martinsburg wells falls into three major land use categories: forested, agricultural, and low density residential. The forested areas (17 percent) provide no source of nitrogen other than precipitation, the agricultural areas (80 percent) contribute nitrogen from numerous sources including manure and fertilizers, and the low density residential areas (2.5 percent) present the possible sources of leaking sewer lines, on-lot septic systems, and lawn fertilizers.

Lindsey and Koch (2004) collected field data to provide streamflow information as well as data on groundwater levels in order to delineate the areal extent of the zone of contribution to the Martinsburg wells. Water quality data were also gathered to determine the source of contamination to the wells. Eight private wells, two municipal wells, one spring, and four streams were sampled. The water samples were analyzed for major ions, nutrients, nitrogen isotope ratios, wastewater compounds, and bacteria. Numerous methods were used to determine potential sources of contaminants to the wells, including geochemistry, anthropogenic contaminants, bacterial source tracking, and a groundwater model. Nitrogen isotopic ratios are used to determine sources of nitrogen because chemical fertilizers have a distinctly different

isotope ratio for nitrogen than organic waste, such as manure, does. Microbial source tracking was used to further differentiate between human, livestock, and other possible bacterial sources.

The results from this study shed some light on the sources of contamination and provided useful information for moving forward to resolve the issues. The primary form of nitrogen detected in the groundwater, as expected, was nitrate, with concentrations ranging from 5.7 to 36 mg/l. The municipal supply wells had concentrations of 8.9 and 9.1 mg/l, which was consistent with what was routinely measured by Martinsburg Borough in these wells. The nitrogen isotope signatures results were not very clear, in that the ranges indicated sources likely to be from manure, human sewage, or chemical fertilizers, but more likely a mixture of the three. Wastewater analysis pointed to human sewage not being the likely nitrogen source. Fecal coliform bacteria were detected in all wells and streams sampled; four stream samples were traced by microbial methods to dairy cattle sources. Three wells and the one spring were also linked through bacteria to dairy cattle.

Multiple lines of evidence were used in this study. Because of the complexities of modeling in carbonate terrain, geochemical, anthropogenic, and microbial analyses were used in combination to assess the validity of model simulation results. Combining the geochemical data with the output from the model concerning the areal extent of contribution zones for each well field led to the following major conclusion: the primary source of nitrate groundwater is from agricultural activity and not human sewage. Since agricultural sources such as manure and crop fertilizers are a central component of the livelihood of many of the residents in the Martinsburg area, nitrate contamination from agricultural practices is not something that can be eliminated easily.

7.2 Riparian Areas and Aquatic Habitat

Intact riparian areas provide numerous functions and benefits to streams in the following three categories: 1) hydrology and sediment dynamics; 2) biogeochemistry and nutrient cycling; and 3) habitat and food web maintenance. Functions related to hydrology and sediment dynamics include storage of surface water and sediment, which reduces damage from floods downstream from the riparian area. Riparian areas intercept, cycle, and accumulate chemical constituents in shallow subsurface flow, thus filtering out pollutants from overland flow and shallow groundwater that might otherwise contaminate adjacent water bodies. Riparian vegetation provides streams (and dependent aquatic communities) with microclimate modification and shade, organic litter and wood inputs, nutrient retention and cycling, streambank stability, and control of sedimentation. Maintaining biodiversity is a major ecosystem function that riparian areas provide and is the basis for fisheries in addition to providing bird and wildlife habitat. Riparian areas host numerous invertebrates, almost all local amphibian species and reptiles, a majority of bird species, and many mammal species.

Activities that disrupt riparian vegetation result in an increase in the amount of solar radiation that reaches a stream, thereby resulting in higher stream temperatures and affecting aquatic primary production. Removal of riparian vegetation also results in a decreased ability to retain water, sediment, and excess nutrients (e.g., nitrogen and phosphorus) during overland

flows or flood events. In areas where riparian buffers have been disrupted or removed, overland flow or flood events result in increased erosion rates and inundate riparian areas and floodplains with sediment limiting their filtering functions. Silt and sediment loads cover riffle areas, which are critical habitat for benthic macroinvertebrates and fish eggs. Silt and sediments can also become embedded among the coarser substrate materials in a stream, thereby eliminating hyporheic habitat and preventing the exchange of oxygen to any benthic organisms or eggs within the substrate. Removal of riparian areas is particularly damaging in agricultural lands where upslope chemicals and excess fertilizers can flow unimpeded into streams, thereby negatively impacting aquatic communities. Excess nutrients can lead to excessive aquatic macrophyte and algal growth, which can choke a slow-moving stream and deplete streams of oxygen as it decomposes. Without riparian areas present to reduce flow velocities, stream channels accommodate these flow events by increasing their cross-sectional area through channel widening or streambed downcutting. Livestock grazing in agricultural areas can result in the removal and trampling of riparian vegetation, sloughing of banks, compaction of riparian soils, and dispersal of exotic or non-native plant species and pathogens. Because livestock tend to congregate in these areas, their impact on riparian areas can be disproportionately large.

There is a direct link between riparian buffers and water quality. Because of the geology of the Morrison Cove region, there is a high degree of interaction between surface water and groundwater. Thusly, elevated surface water nitrate concentrations likely reflect groundwater concentrations. Forested riparian buffers can have a significant impact on reducing the concentration of nitrate in groundwater. One study (Schoonover and Willard, 2003) showed a 61 percent reduction with just a 10-meter buffer and another showed a 78 percent reduction in nitrate concentration through a 38-meter forested buffer. Wider riparian buffers generally remove more nitrate. From all studies compiled by the United States Environmental Protection Agency (USEPA) (2005), the mean nitrate removal effectiveness was 74 percent, with predicted removal rates of 50 percent with a 3-meter buffer, 75 percent with a 28-meter buffer, and 90 percent effectiveness with a 112-meter buffer. This paper also discusses the effectiveness of grasses as riparian buffers, which is less than forested but still provides some nitrate removal.

Nitrate in groundwater and surface water is a threat to the waters of Morrison Cove. Planting riparian buffers may be the simplest answer to reducing the concentration of nitrate. While there are certain types of riparian buffers that may be more ideal and effective, the USEPA review paper demonstrates that a buffer of nearly any width and made up of any combination of trees, shrubs, and grasses can be a very effective in the removal of nitrate.

7.3 Methods for Water Quality Evaluation

SRBC has been involved in numerous efforts and projects that have included monitoring the water quality of streams in Morrison Cove prior to the start of the current study. One has involved more long-term sampling at sites throughout the Juniata Subbasin in 1995, 2004, and 2010. Another was a year-long quarterly monitoring project at 33 sites within Morrison Cove in 2005. The parameters of interest for this study included those most closely with agriculture (i.e., nutrients and sediment), ones that reflect underlying geology (i.e., calcium, magnesium), and those that are associated with urbanization (i.e., chloride, sodium). Instream flow measurements

were also taken during each seasonal sample, which provides an illustration of the potential fluctuations in stream discharge. In October 2009, concurrent with the seepage run, SRBC staff also documented field chemistry and nitrate concentrations at the same 45 sites, although one-third of the proposed sites were dry when the sampling was conducted. Also in October 2009, Meiser & Earl, Inc. completed a monitoring survey of 40 stream and spring locations throughout Morrison Cove. In addition to in-situ field parameters, a laboratory chemical analysis for parameters of interest was also completed which included nitrate, sulfate, chloride, alkalinity, and sodium.

In addition, other agencies and groups have done water quality surveys on smaller scales throughout portions of Morrison Cove. From 2002 through the present, the Western Pennsylvania Conservancy (WPC) has been involved in water quality monitoring in the Morrison Cove region. Their work primarily revolves around the implementation of streambank fencing on farms to improve water quality by excluding livestock. Samples were collected at farms along Piney, Clover, Beaver, and Hickory Bottom Creeks and Three Springs Run. These samples were analyzed with field test kits but generally were in agreement with all other data for these watersheds. This project extends beyond Morrison Cove and is ongoing. Preliminary findings are showing benefits of streambank fencing and improved water quality.

In 2004-2005, the Blair County Conservation District (BCCD) completed a Piney Creek Watershed Assessment and Conservation Plan. Included in this assessment was water quality sampling at five stream locations. The Piney Creek assessment also pointed to some familiar solutions: streambank fencing, septic upgrades, and improvements to manure management. Then in 2010, BCCD published a Plum Creek Watershed Assessment, Restoration, and Preservation Plan. This study concluded that Plum Creek is one of the few high quality cold water fishery (HQ-CWF) streams in Blair County, and while agriculture has protected the stream from urban impacts, it also has had a negative effect. Data from BCCD were in agreement with all other available data indicating elevated nitrate concentrations throughout Piney Creek and Plum Creek Watersheds.

The Bedford County Conservation District completed a Coldwater Heritage Watershed Assessment for Potter Creek in 2005. Water quality and macroinvertebrate samples were collected at five locations throughout Potter Creek Watershed. Water quality data were in agreement with all other data collected for Potter Creek, showing elevated nitrate concentrations and high alkalinity values associated with limestone streams. Sedimentation and erosion were listed as major issues in Potter Creek.

Each of these projects, whether focused on one stream or broadly across Morrison Cove, points to the same basic issues and concerns. Nitrogen (mostly as nitrate) is the single biggest water quality concern. Additionally, sedimentation has far-reaching impacts on water quality, habitat, and biota. The lack of riparian buffer corridors along the streambanks is also a common theme throughout all the above studies.

An evaluation of the water quality data from each of these individual projects was completed and results were compiled and discussed below for each watershed in Morrison Cove. Water quality results discussed as mean values are given for sites where there were at least five

samples taken by some agency at the same location. Other results and values are noted as anecdotal and supporting data. Table 7-1 displays the water quality criteria used for evaluating the water quality data. Figure 7-1 depicts the stream segments in Morrison Cove that are on the 303(d) List of Impaired Waters.

Table 7-1. Water Quality Criteria and Reference Values with Source

Parameter	Water Quality Criteria or Reference Value	Reference
Temperature	> 20º C	PA Code for CWF
Dissolved Oxygen	< 5 mg/l	PA Code for CWF
pH	< 6	PA Code
pH	> 9	PA Code
Alkalinity	< 20 mg/l	PA Code
Nitrite + Nitrate	> 10 mg/l	PA Code, drinking water
Nitrate	> 1.0 mg/l	USGS, background with no anthropogenic influence
Nitrate	> 2.3 mg/l	SRBC archived data, 75th percentile
Nitrate	> 6.16 mg/l	SRBC archived data, 95th percentile
Phosphorus	> 0.1 mg/l	USGS, background with no anthropogenic influence
Sodium	> 20 mg/l	NY groundwater
Chloride	> 250 mg/l	PA Code, drinking water
Sulfate	> 250 mg/l	PA Code, drinking water
Chlorine	0.019 mg/l	PA, one hour average

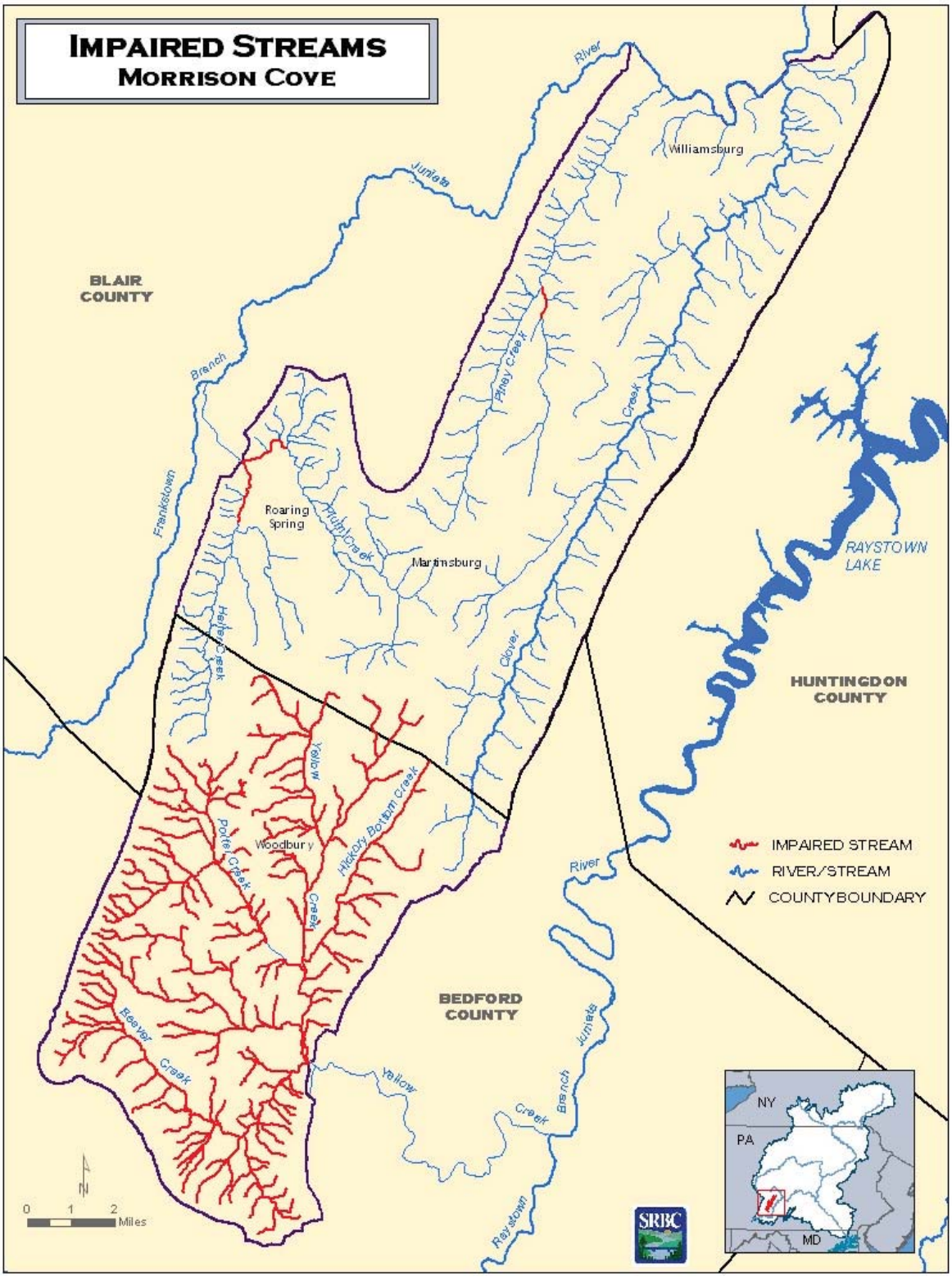

Figure 7-1. Impaired Streams in Morrison Cove

7.4 Watershed Evaluations

7.4.1 Clover Creek

The Clover Creek (WBD 0205030203) Watershed drains 50 square miles and makes up about 27 percent of Morrison Cove. It flows northeast, nearly parallel to Piney Creek (Figure 7-2). The main channel of Clover Creek flows through primarily agricultural land and is influenced by ridge geology from tributaries and by the carbonate valley between the ridges. Clover Creek has a PADEP Chapter 93 Designated Use Classification of High Quality Cold Water Fishery (HQ-CWF). It drains north-northeast to the Frankstown Branch of the Juniata River. The headwaters of the Clover Creek mainstem originate on the slopes of Tussey Mountain. Land use is over 54 percent forested and 42 percent agriculture.

Water Quality

Clover Creek is the only major subwatershed in the Cove that does not have any segments or tributaries listed in the 303(d) list of stream impairments. There were two sites on Clover Creek that had at least five data points, and there were minimal differences in the water quality at the upstream and downstream two locations. Nitrates averaged about 5.0 mg/l at the downstream site and about 6.0 mg/l at the upstream site. Based on molar ratios of Ca/Mg less than 1.6, much of the water in Clover Creek originates from a dolomite-based groundwater system. Hardness, pH, and conductivity are also typical for these types of waters.

Sodium, chloride, and sulfate are all in the low range, meaning there are likely no significant anthropogenic sources of these ions in Clover Creek Watershed. There were numerous other one-time grab samples taken throughout Clover Creek, which provided a few other anecdotal pieces of information.

The most upstream sampling location had lower alkalinity, magnesium, chloride, and nitrate concentrations, which may point to the headwaters being more influenced by the tributaries that come off the ridge and have markedly different water chemistry.

Riparian Area Condition

The headwaters of Clover Creek are located in heavily forested lands, with riparian areas almost entirely intact. Along the lower headwater segments, at the beginning of the mainstem Clover Creek, riparian areas appear to have been cleared along agricultural lands bordering the stream (Figure 7-3). For the majority of the stream channel flowing along the valley floor through agricultural lands, most riparian areas have been cleared, or where existing, consist of marginal grasses.

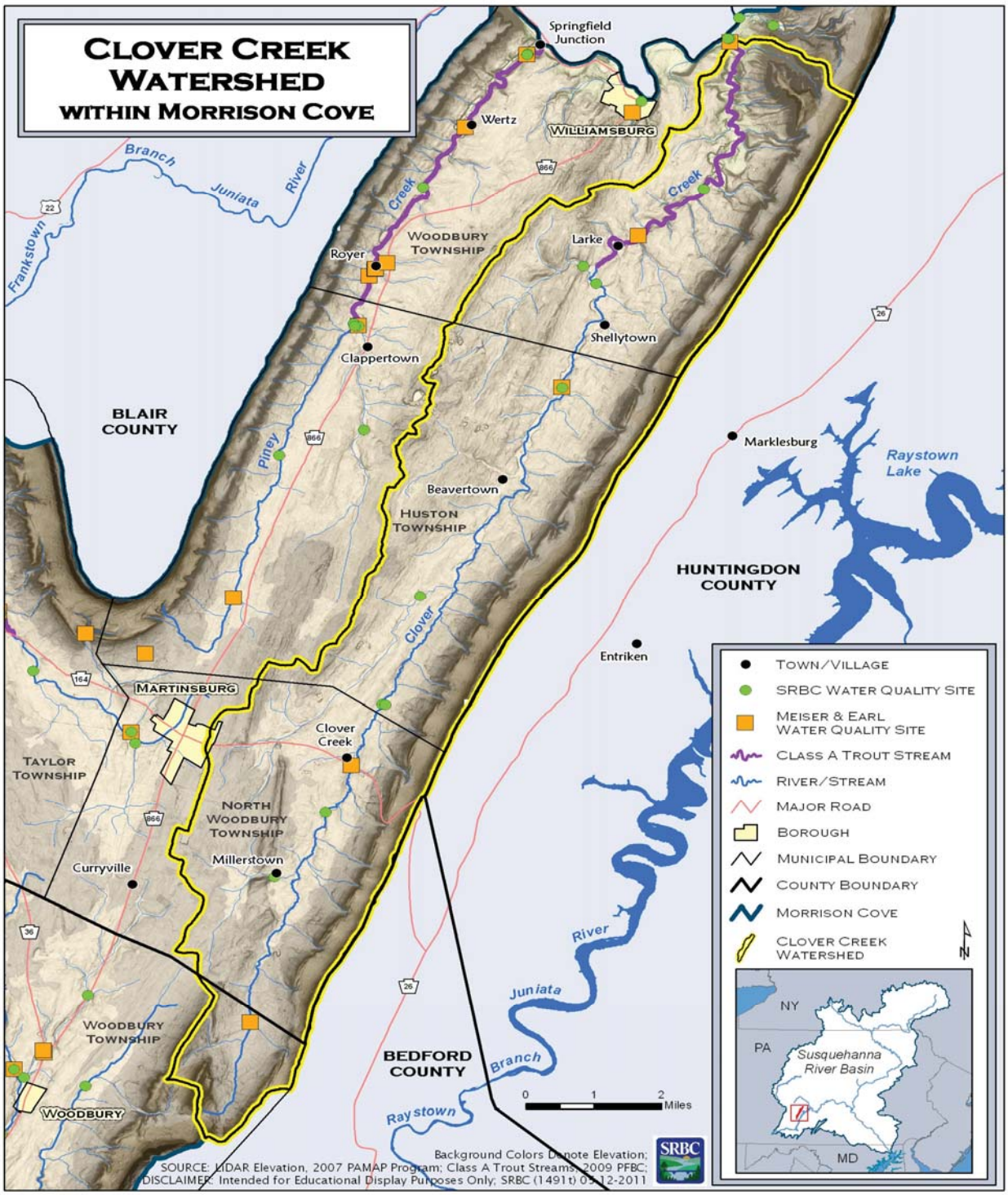

Figure 7-2. Clover Creek Watershed

Figure 7-3. Example of Lack of Riparian Buffer and Agriculture along Clover Creek

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at nine sampling points along Clover Creek in October 2009.

The nine sampling points along the Clover Creek were called Clover 9–Clover 1 (upstream–downstream, respectively), and represented a variety of instream habitats. Clover 9, Clover 7, and Clover 6 were located in lands dominated by cropland and pasture, where riparian areas had been removed. Instream habitat at these sample points was relatively marginal in terms of epifaunal substrate, instream cover, embeddedness, diminishing available fish cover habitat, and interstitial habitat for benthic macroinvertebrates. Sampling points Clover 8, Clover 5, Clover 4, and Clover 2 were also primarily located in agricultural or residential lands and had minimal riparian areas with extremely limited tree cover and narrow grass buffers. Instream habitat at these sample points was suboptimal in terms of epifaunal substrate, instream cover, embeddedness, and channel alteration. Marginal scores resulted for instream habitat parameters as related to sedimentation deposition and frequency of riffles. Sampling points Clover 3 and Clover 1 had higher quality riparian areas along the sampled stream length, consisting of more vegetative cover and more stable streambanks. The instream habitat condition also presented as higher quality overall than all other sample points.

Subwatershed Stream Condition and Recommendations

The entire subwatershed is listed on PADEP's 303(d) list as attaining for supporting aquatic life use (Figure 7-2). It is likely that the intact forested lands surrounding Clover Creek's headwaters are protecting these systems in terms of water quality and quantity, thus contributing natural flows to the downstream reaches of Clover Creek. Water quality supplied from these source headwaters, and all contributing headwater tributaries, must be of such high quality that they are able to support aquatic life use along Clover Creek. This trend stands out in light of the large portion of the stream surrounded by agricultural lands in areas in which riparian areas have been thinned, modified, or removed. Instream habitat results indicate a connection between the quality and extent of riparian areas and the quality of habitat present within a sampled reach. Sites with increased habitat scores for riparian cover and bank stability showed corresponding higher scores for instream habitat parameters such as instream cover and epifaunal substrate.

Recommendations for maintaining the stream classification in this subwatershed include maintaining all existing forested riparian buffers. Further removal of existing forested riparian areas would enhance erosional activities and increased bank instability, thereby resulting in a degradation of the stream's water quality. Maintaining these riparian areas is especially critical in the subwatershed's headwaters, as the majority of the riparian areas are surrounded by mostly intact forested lands functioning to protect the natural form and function of these systems. These lands should be prioritized for preservation to maintain the higher quality instream habitat and riparian areas associated with these stream segments.

7.4.2 Piney Creek

Piney Creek Watershed (WBD 0205030203) has similar land use and water chemistry as Clover Creek but has only about half the drainage area (25 square miles), making up about 14 percent of Morrison Cove. Piney Creek has a PADEP Chapter 93 Designated Use Classification of HQ-CWF). It drains north-northeast to the Frankstown Branch of the Juniata River (Figure 7-4). The headwaters of the Piney Creek mainstem originate on the eastern slopes of Lock Mountain. The Piney Creek mainstem flows through a mixture of agricultural and forested lands. There are numerous headwater tributaries located along the western portion of Piney Creek's drainage basin. These headwaters originate within the forested ridgelines and slopes of Lock Mountain, likely providing the Piney Creek receiving waters with cool waters, stable sediment loads, and a sustainable energy source to downstream aquatic and terrestrial food webs. The lower gradient valley bottom portions of the subwatershed are dominated by agricultural land use. Overall, agricultural lands account for 44 percent of the subwatershed. Forested lands account for approximately 51 percent of the subwatershed. Developed lands constitute a marginal portion of the subwatershed, accounting for 5 percent of land use.

Water Quality

Only one small unnamed tributary is on the 303(d) list of impaired waters (Figure 7-1). Two sites on Piney Creek had at least five data points, one near the mouth and one about halfway up the stream. Nitrate levels in Piney Creek are similar to Clover Creek but a little higher on average at both upstream and downstream locations (6.9 and 6.1 mg/l, respectively). Like Clover Creek, Ca/Mg ratios suggest a dolomite water source although the most upstream sites

had a higher ratio suggesting perhaps some limestone influence. Chloride, sodium, and sulfate were all low and very similar to Clover Creek. Hardness, pH, and conductivity were normal and consistent throughout the watershed. In addition, Blair County Conservation District (BCCD) completed a full watershed assessment on Piney Creek in 2005. Their nitrate results were in line with the findings of SRBC and Meiser & Earl, Inc., with average concentrations of 6.3 mg/l (BCCD, 2005).

Riparian Area Condition

Riparian areas are comparably intact in the lower portions of the subwatershed as compared to the upgradient headwaters areas. The source headwater areas located on the slopes of Lock Mountain include intact forested riparian areas. As the headwaters transition downslope to the valley floor, riparian areas are no longer present along much of these waters. As Piney Creek flows through the agricultural lands that dominate the valley floor, most riparian areas have been removed, thinned, or disturbed. A fairly substantial forested riparian area exists along the mainstem Piney Creek in the middle portion of the subwatershed, and remains intact for most of the stream's length to its confluence with the Frankstown Branch of the Juniata River.

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at five sampling points along Piney Creek in October 2009. The habitat assessment methodology focuses on instream parameters (e.g., epifaunal substrate, instream cover, channel alteration, streambank condition). A site-specific score is generated from the assessment and can be used to make general observations (e.g., optimal, suboptimal, marginal, poor) about habitat at that location.

The five sampling points along Piney Creek, called Piney 6–Piney 1 (upstream-downstream, respectively), represented a variety of instream habitats. Piney 6 was surrounded by agricultural lands. The riparian area scored suboptimal for width and vegetative cover. Instream habitat parameters scored suboptimal for a few instream habitat parameters (epifaunal substrate, channel alteration) and marginal for instream cover, embeddedness (e.g., the amount of fine sediments surrounding substrate materials), and sediment deposition. A riparian area does not exist at this sample point, so stormwater runoff from the surrounding fields likely flows unimpeded into the stream, thus impacting the habitat quality. Piney 5 had no data collected due to lack of flow at the site. Piney 4 had a close-cropped riparian area with minimal vegetative cover. Instream habitat parameters were marginal at this site, except for embeddedness and channel alteration, which presented suboptimal scores. Field notes indicate livestock were not restricted from the riparian area or stream and that severe sedimentation was noted. Piney 3 had a forested riparian area coupled with optimal channel form and instream habitat parameters. Piney 2 was noted as having an impacted, narrow riparian area with minimal vegetative cover, and scored suboptimal for all instream habitat parameters. Piney 1 was located at the farthest downstream point in the subwatershed and presented the highest, site-specific habitat score. Field notes by SRBC staff indicated this site had an intact forested riparian area coupled with optimal channel form and suboptimal instream habitat parameters.

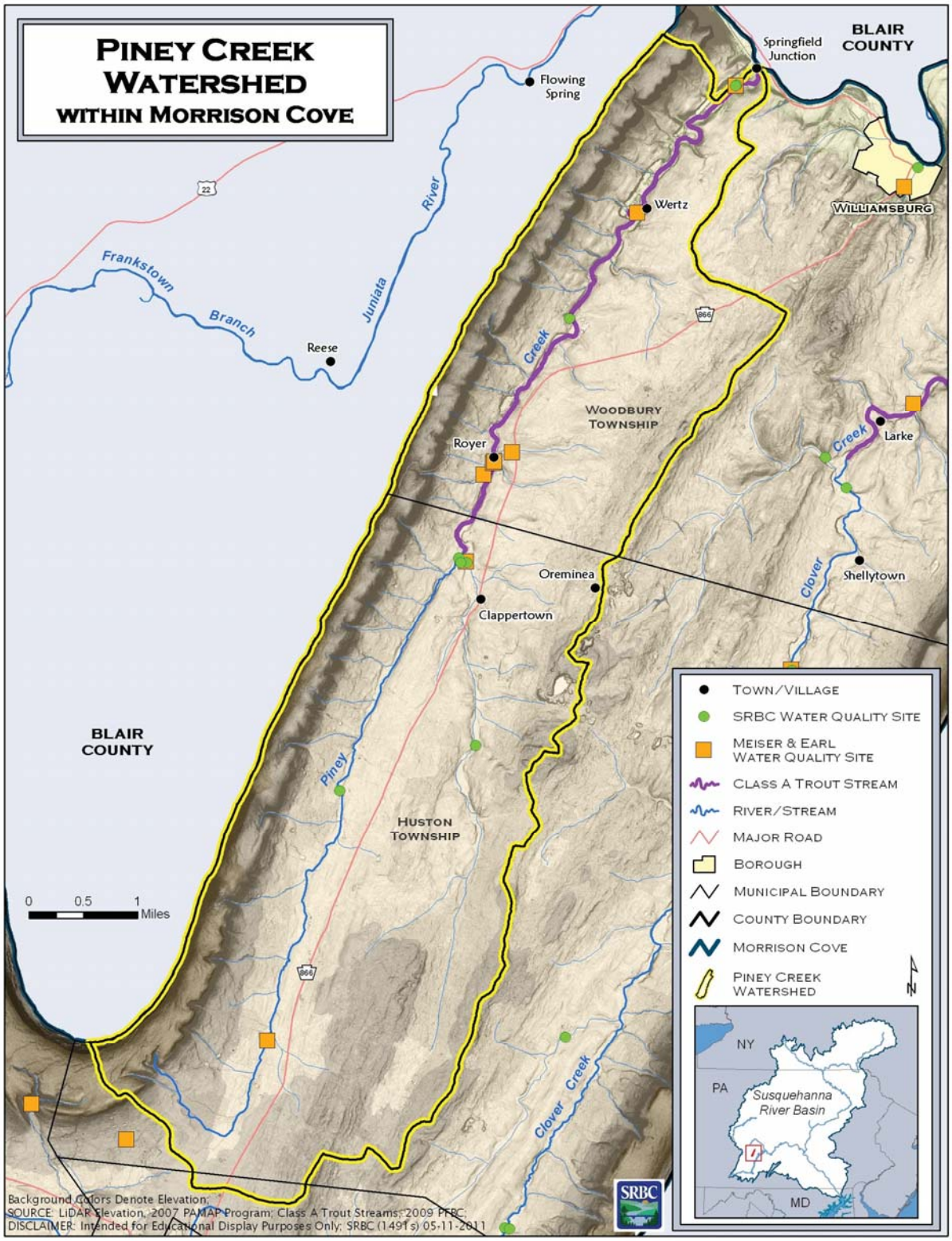

Figure 7-4. Piney Creek Watershed

Subwatershed Stream Condition and Recommendations

It is likely that the relatively intact forested lands along the ridgelines and slopes of Lock Mountain support the many functions provided by the associated headwater tributaries draining along the western portion of Piney Creek. The PADEP Designated Use Classification of HQ-CWF for Piney Creek (and all contributing tributaries) bespeaks a functioning stream ecosystem in which the aquatic community is supported by water quality not significantly impaired by the agricultural land use surrounding the headwaters and upgradient portions of the mainstem Piney Creek. Instream habitat assessments show a clear link between adjacent riparian buffer condition and channel form/instream habitat parameters. Sites with increased habitat scores for riparian cover, bank stability, and width showed corresponding higher scores for instream habitat parameters.

Recommendations for maintaining the stream classification in this subwatershed include maintaining all existing vegetative riparian buffers. Further removal of existing riparian areas would enhance erosional activities and increase bank instability, thereby resulting in degradation of the stream's water quality.

7.4.3 Halter Creek

The Halter Creek (WBD 0205030201) Watershed is the most developed watershed within Morrison Cove and as such, has additional water quality issues on top of the agriculturally-based ones discussed for the surrounding watersheds. Currently, Halter Creek has a PADEP Chapter 93 Designated Use Classification of Warm Water Fishery (WWF), although that is under review; the current existing use for a large portion of the stream is Cold Water Fishery (CWF). Additionally, the final 2.3 miles of Halter Creek, downstream of its confluence with Plum Creek, have recently been designated as Class A Trout Waters by the Pennsylvania Fish and Boat Commission (PFBC). Halter Creek drains northwest to its confluence with the Frankstown Branch Juniata River (Figure 7-5). The lower three miles of Halter Creek are listed on the 303(d) list as impaired waters for total suspended sediment due to urban runoff and storm sewers (Figure 7-1). There are numerous headwater tributaries draining off the forested hillslopes west of the Halter Creek mainstem. The land use surrounding Halter Creek headwaters is agricultural and residential. As Halter Creek flows through the subwatershed, it is primarily surrounded by agricultural lands, with forested hillslopes located along the entire western section of the subwatershed. The borough of Roaring Spring is situated in the lower portion of the subwatershed, near the confluence of Halter Creek and Plum Creek. The Roaring Spring (Figure 7-6), in the town with the same name, is of vital importance to the local economy, as much of the industry is dependent on that water source. Overall, agricultural lands account for approximately 49 percent of the subwatershed. Forested lands account for approximately 34 percent of the subwatershed. Developed lands account for 17 percent of land use.

Cabbage Creek is a small tributary to Halter Creek and accounts for approximately four square miles in drainage area. Cabbage Creek has a PADEP Chapter 93 Designated Use Classification of WWF. The primary land use surrounding Cabbage Creek headwaters is agricultural. Overall, agricultural lands account for approximately 70 percent of the subwatershed. Forested lands account for approximately 11 percent of the subwatershed.

Developed lands constitute a relatively large portion of the watershed, at 19 percent. As Cabbage Creek flows through the southern outskirts of the Borough of Roaring Spring, minimal riparian areas are present (Figure 7-7). At the confluence of Cabbage Creek and Halter Creek, there is a small portion of forested land that does include vegetated riparian areas. It is in this most downstream reach that riparian cover, bank condition, and vegetative zone width were highest.

Plum Creek is the other significant tributary to Halter Creek and it drains 17.4 square miles. Currently, Plum Creek has a PADEP Chapter 93 Designated Use Classification of WWF, although that is under review and the current existing use is HQ-CWF. In addition, from the confluence of Plum Creek and Halter Creek, to a distance of 3.4 miles upstream, the stream has been classified by PFBC as a Class A Wild Trout Stream. The land use surrounding Plum Creek headwaters is a mixture of urban developed and agricultural. The Plum Creek mainstem flows through primarily agricultural lands. There are numerous headwater tributaries located along the northeastern portion of Plum Creek's drainage basin, flowing from forested upgradient hillslopes on the western slopes of Lock Mountain. The lower gradient valley bottom portions of the subwatershed are dominated by agricultural land use and urban developed land use surrounding the town of Martinsburg. Overall, agricultural lands account for approximately 54 percent of the subwatershed. Forested lands account for approximately 32 percent and developed lands account for 14 percent of land use. The final 1.4 miles of Plum Creek are listed on the 303(d) list of Impaired Waters for siltation due to road runoff and bank modification (Figure 7-1).

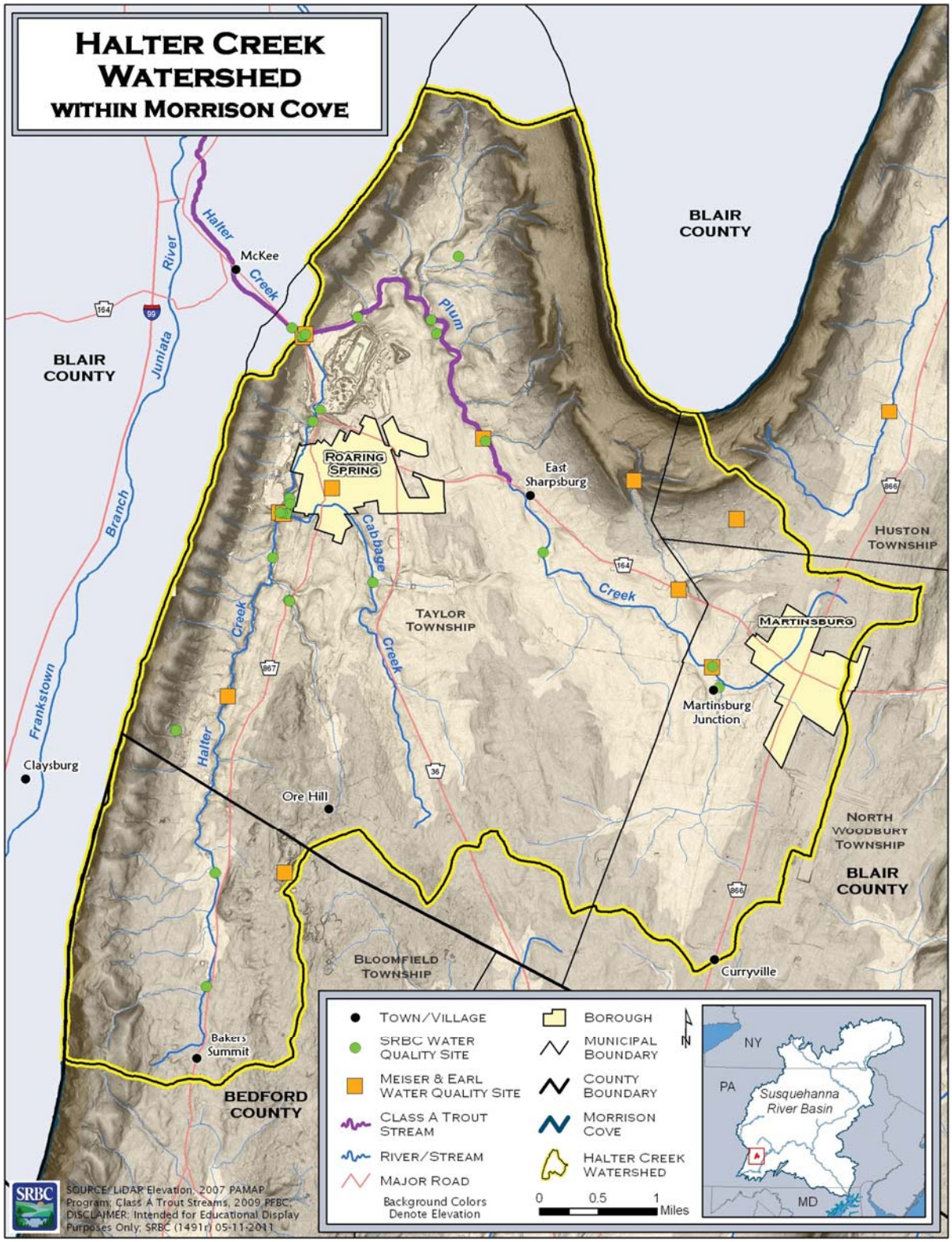

Figure 7-5. Halter Creek Watershed

Water Quality

Within the 32-square-mile drainage of Halter Creek, numerous springs help provide consistent base flow, but also input excess nutrients into the surface water. Due to issues of ongoing development and the critical importance of water, SRBC sampled the Halter Creek Watershed more intensely. As a result, a more spatially robust dataset (six sites on Halter Creek, two sites on Cabbage Creek, and three sites on Plum Creek) is available for this watershed. The headwaters of Halter Creek have a different chemical signature than the remaining sections of the watershed. These headwaters are likely influenced prominently by the ridge geology as the water chemistry signals do not reflect carbonate valley geology. Alkalinity, hardness, and conductivity are much lower and nitrate concentrations are less than 1 mg/l. Upstream of the confluence of Cabbage Creek, Halter Creek has more typical water chemistry for Morrison Cove. Nitrate concentrations above the confluence with Cabbage Creek average 2.8 mg/l. Cabbage Creek is a small drainage but it has a great influence on Halter Creek, raising the nitrate concentrations by nearly 2 mg/l. Cabbage Creek originates in a spring complex (Figure 7-8) and numerous samples from these springs were analyzed. Nitrate concentrations were consistently greater than 10 mg/l. Downstream of Cabbage Creek but upstream of the Town of Roaring Spring, water quality is similar to the site upstream of Cabbage with the exception of nitrate, which averaged 4.6 mg/l.

Figure 7-6. Roaring Spring Outflow (Instrumented weir provided daily flow measurements for use in this study.)

Figure 7-7. Cabbage Creek Flowing under the Driveways of Homes in Roaring Spring (The plant growth in the stream is predominantly watercress.)

Figure 7-8. Spring Complex along Cabbage Creek

On Halter Creek, downstream of the wastewater treatment plant, nitrate levels remain unchanged but a noticeable spike in chloride is evident. Further downstream, below the quarrying operation, nitrates remain constant but the chloride concentrations spike again and there is a dramatic increase in sulfate. Above Roaring Spring, chloride concentrations average 16 mg/l, and below the wastewater treatment plant and quarry, the average is 48 mg/l. These chloride levels are well below the water quality standard of 250 mg/l but the spike is worth noting nonetheless. Similarly, sulfate concentrations below the quarry are nearly three times higher than just a mile upstream. Again, sulfate does not violate water quality standards, but it is worth noting. Halter and Cabbage Creek both have a Ca/Mg ratio of about 1.3, which indicates a dolomite source.

Plum Creek joins Halter Creek just below the quarry in Roaring Spring (Figure 7-9). Plum Creek has its own unique set of water quality issues. Plum Creek has nitrate concentrations above 5 mg/l and as high as 8 mg/l throughout the watershed. Additionally, chloride concentrations are five to ten times higher in Plum Creek than in any other stream in Morrison Cove. In the headwaters of Plum Creek, concentrations were routinely more than 100 mg/l, and the other sites on the stream had an average chloride concentration of more than 45 mg/l. This is likely due to effluent from the Martinsburg Wastewater Treatment Plant. Although Plum Creek is highly spring-fed (Figure 7-10), flow measurements indicate a likely natural decrease of up to 90 percent between spring and fall.

Figure 7-9. Within the High Quality–Cold Water Fishery Section of Plum Creek

Figure 7-10. Outflow from Spring Complex near the Mouth of Plum Creek (Green vegetation in stream is watercress.)

Finally, the northern exit point of Morrison Cove is Halter Creek about two miles before it empties into the Frankstown Branch Juniata River. The water quality at this site is better because the high sulfate concentration of Halter is diluted by the added flow from Plum Creek, and the high chlorides in Plum are diluted by the added flow of Halter Creek. However, the nitrate concentrations remain fairly high with an average value of 5.4 mg/l.

Riparian Area Condition

The headwaters of Halter Creek are located in transitional lands partly forested and partly agricultural, with marginal forested riparian areas located only in the uppermost section of the headwaters. Along the lower headwater segments, at the beginning of the mainstem Halter Creek, riparian areas appear to have been cleared along agricultural lands bordering the stream. For the majority of the stream channel flowing along the valley floor through agricultural lands, most riparian areas have been cleared, or where existing, consist of marginal grasses. Field notes by SRBC staff indicate livestock have unrestricted access to streambanks in various agricultural lands along Halter Creek. In the middle portion of the subwatershed, intact forested riparian buffers are present for approximately two miles until the stream reaches the outskirts of Roaring Spring, where developed lands replace vegetated riparian areas. Halter Creek flows through the lands owned by New Enterprise Stone & Lime Company, adjacent to the New Enterprise Stone Roaring Spring Quarry. The riparian area appears to consist of a narrow grass filter strip in this area.

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at five sampling points along Halter Creek, two points along Cabbage Creek, and five points along Plum Creek in October 2009.

The five sampling points along Halter Creek were named Halter 5–Halter 1 (upstream-downstream, respectively), and presented a relatively stable series of instream habitats. Halter 5 was located in the most upstream portion of the subwatershed, with all subsequent sampling points located downstream. Sampling point Halter 5 was surrounded by mixed land use (residential, forested, agriculture) and was located adjacent to a paved road. Instream habitat parameters (cover and epifaunal substrate) scored poor for this site relative to all other Halter Creek sample points, diminishing available fish cover habitat and interstitial habitat for benthic macroinvertebrates. Additional instream habitat parameters (sediment deposition, embeddedness, channel alteration) scored suboptimal for the sample point. This indicates stormwater runoff is likely eroding streambanks and depositing fine sediments on the channel bottom. Halter 4 was located downstream of a paved road and a farm, along a reach entirely surrounded by a forested riparian area. It scored optimal for riparian cover, vegetation, and bank condition. Instream habitat was suboptimal (epifaunal substrate, instream cover, embeddedness, sediment deposition, channel alteration).

Halter 3 was located immediately upstream of an impounded section of the stream, in a section of the subwatershed with forested riparian areas. It scored optimal for riparian cover, vegetation, bank condition, and channel alteration. Instream parameters for epifaunal substrate, instream cover, and sediment deposition scored suboptimal. Sampling point Halter 2 was located in a small but well-forested riparian area with moderate residential land use and a highway adjacent to it. Roaring Spring Sewage Treatment Plant discharges to Halter Creek, 230 feet upstream of the sample point. Despite its proximity to the discharge point, the sample site presented high quality instream habitat parameters. Alternatively, the site had poor to marginal riparian areas, likely remnant of road construction in the area. Sampling point Halter 2 was located approximately 150 feet downstream of New Enterprise Stone Roaring Spring Quarry, near the confluence of Halter Creek with the Frankstown Branch Juniata River. Typical of developed areas, the riparian area along this stretch of stream had been removed (scoring poor for vegetative cover and riparian width). Epifaunal substrate scored optimal as an instream parameter but all other parameters scored suboptimal.

The two sampling points along Cabbage Creek, called Cabbage 1 and Cabbage 2, respectively, presented varying instream habitats. Cabbage 2 was located at the confluence of the two headwater tributaries, at a point along a roadside ditch section of Cabbage Creek. Sampling point Cabbage 1 was located near the confluence with Halter Creek, at the most downstream portion of the subwatershed, and was entirely surrounded by forested lands. Cabbage 2 included instream rip rap and artificial substrate. One streambank was concrete, gravel, and stone, leading up to a paved road. The opposite streambank had minimal riparian vegetation. The site scored poorly for nearly all instream parameters, including instream cover, embeddedness, sediment deposition, and channel alteration. Thus, available fish cover habitat and interstitial habitat for benthic macroinvertebrates were nearly nonexistent. Cabbage 1 had higher quality riparian areas (optimal scores) along the sampled stream length for vegetative

cover (forested), stable streambanks, and riparian widths. The instream habitat condition also presented optimal for nearly every parameter for this sample point.

The five sampling points along Plum Creek, called Plum 5–Plum 1 (upstream-downstream, respectively), presented a more stable series of instream habitats. Plum 5 was located in the most upstream portion of the subwatershed, with all subsequent sampling points located downstream. Plum 5 was surrounded by agricultural crop lands, although it appeared to have a small forested buffer located at the sample point. This forested buffer is the likely reason that this sample point scored higher for both riparian protective cover and condition of streambanks. However, instream habitat parameters (cover and epifaunal substrate) and sediment deposition scored poor for this site relative to all other Plum Creek sample points, diminishing available fish cover habitat and interstitial habitat for benthic macroinvertebrates. There is a NPDES discharge point (Martinsburg Sewer Treatment Plant) located 570 feet upstream of Plum 5, which is the likely cause of the relatively degraded instream habitat parameters at this sample point. Plum 4 was located in Plum Creek along a reach entirely dominated by cropland. It appeared that this stream reach had a grass riparian area intact, resulting in relatively optimal scores for riparian cover and bank condition. Riparian area width scored poor, as evidenced by a narrow strip buffer in place at the site. Instream habitat scored a mixture of marginal (epifaunal substrate, frequency of riffles) and suboptimal (instream cover, embeddedness, sediment deposition, channel alteration). Plum 2 was located in a section of the subwatershed that included a moderate forested riparian area on its west bank, but was located downslope of a farm on its eastern bank, with no intervening riparian area to filter runoff. Instream parameters for embeddedness, sediment deposition, and riparian areas scored suboptimal for the sample point, whereas nearly all other instream parameters scored optimal. Sampling points Plum 3 and Plum 1 had higher quality riparian areas (optimal scores) along the sampled stream length, consisting of increased vegetative cover (both grass strips and forested), stable streambanks, and increased riparian widths. The instream habitat condition was also optimal for nearly every parameter for these sample points.

Subwatershed Stream Condition and Recommendations

Other than for a small section of Halter Creek near the terminus of the subwatershed, the entire subwatershed is listed on PADEP's 303(d) list as attaining for supporting aquatic life use. The impaired sections of Halter Creek are listed as impaired by suspended solids from urban runoff/storm sewers (Figure 7-1). Relatively simple vegetated retention buffers or swales could be installed at, or immediately downstream of, the discharge points in an effort to promote discharge retention and filtering.

Riparian cover at Halter 5 and Halter 4 was completely different, yet instream habitat parameters indicate similar quality. This indicates that upstream flows and sediment loads likely dictate instream habitat quality through this section of the Halter Creek mainstem despite the presence of an intact forested riparian buffer at Halter 4. This would suggest that restoring riparian buffers adjacent to the stream, along the entire section of Halter Creek as it flows through agricultural lands in the subwatershed, would be beneficial to improve instream habitat quality. The downstream sample points (Halter 3 and Halter 2) were located in areas surrounded by residential land use and included higher quality riparian areas.

The entire Cabbage Creek subwatershed is listed on PADEP's 303(d) list as attaining for supporting aquatic life use. Urban BMPs should be considered for the developed lands in and around Roaring Spring as related to stormwater runoff into Cabbage Creek, especially in sections of the stream adjacent to roadways. Stormwater runoff from impervious cover increases runoff rates, thereby transporting larger volumes of water to streams. This results in flashy flow events that erode and destabilize streambanks. Increased stormwater runoff where riparian areas are absent leads to decreased infiltration and retention rates of stormwater, with all its pollutants, and sediment. These substances are transported directly into Cabbage Creek, resulting in impaired instream habitat and aquatic communities. Forested lands surrounding tributary headwaters and downstream reaches of Cabbage Creek should be prioritized for preservation to maintain the higher quality instream habitat and riparian areas associated with these stream segments.

Other than for a small section of Plum Creek near the mouth of the creek, the entire subwatershed is listed on PADEP's 303(d) list as attaining for supporting aquatic life use. The impaired reaches of Plum Creek adjacent to the quarry are listed as impaired by siltation from bank modification and road runoff. The NPDES discharge point located just upstream of Plum 5 is likely impacting this reach of Plum Creek. Stormwater BMPs outlined by the USEPA could be installed and implemented such that the discharge points at multiple sites along Plum Creek are managed in a way to promote retention and infiltration. Similarly, urban BMPs should be considered for the developed lands in and around Martinsburg as related to stormwater runoff into the Plum Creek headwaters.

For sections of Plum Creek classified as a Class A Wild Trout Stream, riparian restoration efforts should be considered in an effort to protect cool water temperatures in this high quality stream. Forested lands surrounding tributary headwaters and downstream reaches of Plum Creek should be prioritized for preservation in order to maintain the higher quality instream habitat and riparian areas associated with these stream segments.

7.4.4 Yellow Creek

The Yellow Creek (WBD 0205030306) Watershed is a larger (85 square miles, 70 square miles within Morrison Cove) and more complex watershed than either Clover or Piney Creek and makes up 30 percent of Morrison Cove (Figure 7-11). There are four major tributaries to Yellow Creek: Hickory Bottom Creek, Potter Creek, Three Springs Run, and Beaver Creek. Between all these major tributaries and small feeder tributaries, 174 stream miles are impaired by nutrients and/or sediment in the Yellow Creek Watershed. This accounts for more than 98 percent of all the impaired stream miles in Morrison Cove. Possible sources for excessive nitrate concentrations in Yellow Creek Watershed include a range of agricultural activities present within the watershed. These include crop and grazing-related agriculture, as well as animal feeding operations. Nearly the entire portion of the Yellow Creek Watershed located within Morrison Cove is listed as impaired for aquatic life (Figure 7-1). Land use in the portion of Yellow Creek within the Cove is 41 percent forested, 54 percent agriculture, and just 5 percent developed land.

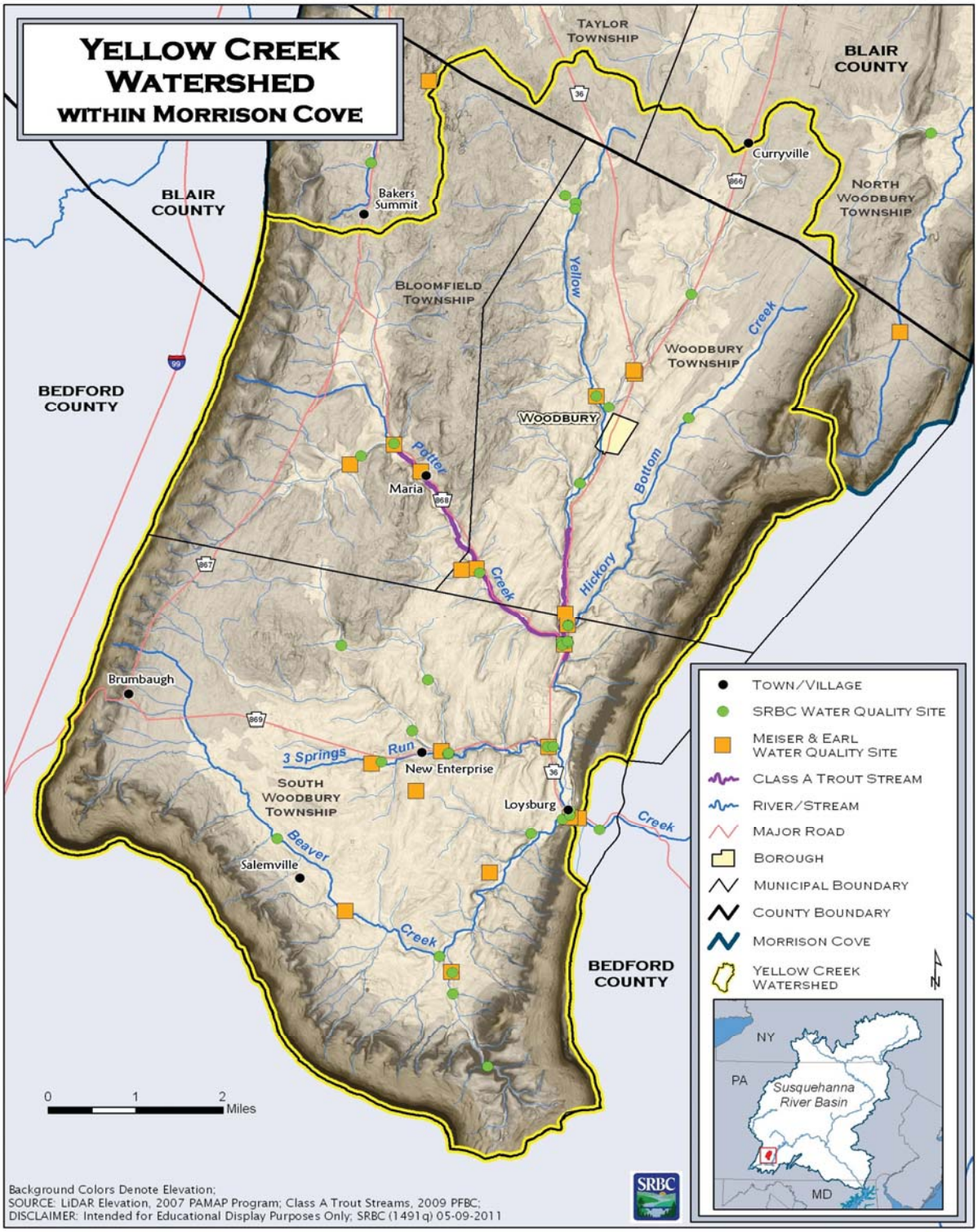

Figure 7-11. Yellow Creek Watershed

Two sites on Yellow Creek (one above Potter Creek and one near where the stream exits Morrison Cove) have at least five sampling data points, as does one site at the mouth of each of the major tributaries. Hickory Bottom has a PADEP Chapter 93 Designated Use Classification of HQ-CWF. Many other sites on Yellow Creek and its tributaries were sampled one time, and these data provide added spatial context to some of the data results. In the Yellow Creek Watershed, the mainstem of Yellow Creek and all major tributaries except Hickory Bottom Creek show a dolomite signature with Ca/Mg ratios less than 1.6. Hickory Bottom seems to originate from a more limestone-based geology with a Ca/Mg ratio of 2.6. A majority of the flow into Hickory Bottom Creek, especially in the summer and fall months, comes from an outflow of Hipple's Cave (Figure 7-12).

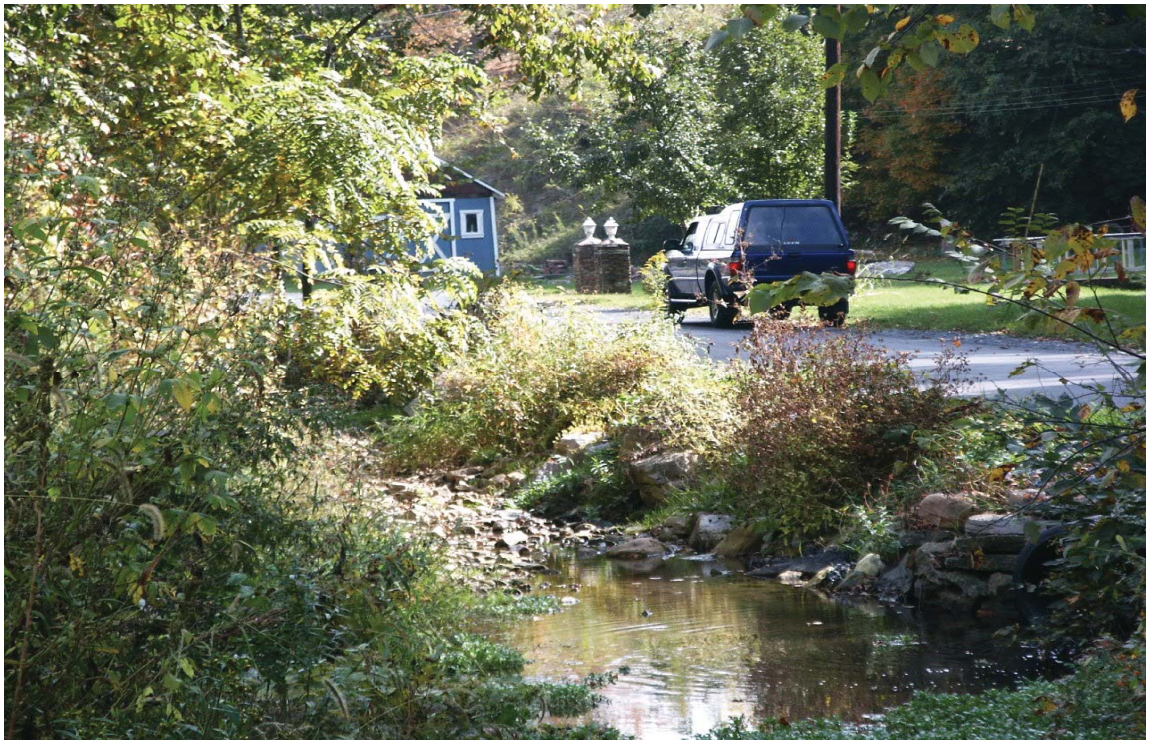

Figure 7-12. Hickory Bottom Creek (Note all flow is coming from Hipple's Cave, a conduit in the toeslope carbonates, under the road and to the right. Hickory Bottom Creek above this point was dry (channel diverging to the left).)

The upstream site on Yellow Creek showed elevated nitrates with an average concentration greater than 8.0 mg/l. Two springs were sampled above this site, one by SRBC and one by Meiser & Earl, Inc., and both had nitrate concentrations of more than 12 mg/l, which is contributing to the elevated nitrate in the upstream reaches of Yellow Creek. The downstream site, near the exit point of the stream out of the Cove, has a nitrate concentration that is 2 mg/l less than the upstream site. Sodium, sulfate, and chloride concentrations were all low and similar to Piney and Clover Creeks. Flows can decrease about 80 percent in Yellow Creek from spring to fall.

Hickory Bottom Creek (a seven-square-mile drainage area) enters Yellow Creek from the east and has the lowest nitrate concentrations of anywhere in Yellow Creek; it is also the smallest of the major tributaries. Nitrate at the mouth of Hickory Bottom Creek averages 4.9 mg/l. Streamflow in the dry summer and fall months is commonly less than one cfs and can decrease as much as 90 percent from spring to fall. Numerous observations have been made that above the confluence with the Hipple's Cave inflow, Hickory Bottom Creek is often dry during September and/or October. Three of the seven farms where WPC was working on streambank fencing projects were in the Hickory Bottom Creek Watershed.

7.4.5 Potter Creek

Potter Creek is the next downstream tributary in the Yellow Creek basin. It enters from the west and drains 13 square miles. Potter Creek has a PADEP Chapter 93 Designated Use Classification of HQ-CWF. It drains southeast to its confluence with Yellow Creek. The entire mainstem of Potter Creek has been classified as a Class A Wild Trout Stream. As Potter Creek flows through the subwatershed, it is primarily surrounded by agricultural lands, with forested hillslopes and ridgelines located along the western and northern portions of the subwatershed. Overall, agricultural lands account for approximately 53 percent of the subwatershed. Forested lands account for approximately 45 percent of the subwatershed. Developed lands constitute a small portion of the subwatershed, accounting for only 2 percent of land use.

Water Quality

At the mouth, nitrate concentrations average almost 5.5 mg/l. Streamflows remained more constant in Potter Creek than other tributaries due to the influence of numerous large springs coming into the stream along its entire length. Four springs that feed Potter Creek were sampled. The more upstream spring locations had nitrate concentrations that were more than two times lower than the most downstream spring sampled by SRBC, which averaged more than 13.5 mg/l. Hardness and conductivity were also much higher in this downstream spring, located along Rt. 868. Potter Creek is one of the most highly-used recreational trout fishing streams within the Yellow Creek Watershed.

Riparian Area Condition

All three main headwater areas draining to the mainstem of Potter Creek are located in heavily forested lands, primarily hillslopes or ridgelines, with riparian areas almost entirely intact. All other headwater tributaries draining off Dunning Mountain appear to include intact forested riparian areas. Along the Potter Creek mainstem, riparian areas appear to have been maintained along limited portions of the stream and cleared along many of the agricultural lands bordering the stream (Figure 7-13).

Figure 7-13. Lack of Riparian Vegetation and Channel Cover along Potter Creek

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at four sampling points along Potter Creek in October 2009.

Potter 4 through Potter 1 were sample points in this subwatershed. Potter 4 was located in the most upstream portion of the subwatershed. Potter 3 was also located in the upper portion of the watershed. Potter 2 and Potter 1 were located downstream from Potter 3. Potter 4 was surrounded by mixed land use (transitional, agricultural, and residential) and included a marginal forested riparian area. Instream habitat parameters (epifaunal substrate, cover sediment deposition) generally scored poorly. Because this site had a marginal riparian buffer, it is likely that stormwater runoff from the surrounding lands impacted the habitat quality at this sample point. Land use surrounding Potter 3 was similar to Potter 4. A minimal forested riparian area was present at the sample point. The sample point scored optimal for instream habitat parameters as related to sedimentation and suboptimal for habitat substrate and cover, suggesting the riparian buffer is functioning to filter out excess sediment loads either from overland flow or storm pulse events. Potter 2 was surrounded by agricultural fields and was just upstream of a farm. There was no intact riparian area present at the site, but a large, 21-acre palustrine/emergent wetland complex was located just upstream of the sample point. Instream habitat parameters (embeddedness, channel alteration, channel flow) scored optimal while epifaunal substrate, cover, channel alteration, and sediment deposition scored suboptimal. Potter 1 was located in a residential area that included no riparian area. Despite the lack of riparian

area, the site scored optimal for nearly all instream habitat parameters other than those related to riparian zone width.

Subwatershed Stream Condition and Recommendations

The sites in this subwatershed presented data generally indicating that the Potter Creek Watershed provides supporting habitat. It seems the numerous forested headwaters draining off Dunning Mountain are contributing stable flows and high quality water to the Potter Creek mainstem. These forested lands, beyond those protected in the State Game Lands, surround the tributary headwaters and should be prioritized for preservation.

Recommendations for maintaining the HQ-CWF stream classification in this subwatershed include maintaining all existing vegetative riparian buffers. Further removal of existing riparian areas would enhance erosional activities and increase bank instability, thereby resulting in a degradation of the stream's water quality.

However, almost the entire subwatershed is listed on PADEP's 303(d) list as impaired by agriculture in terms of siltation. This has resulted in a non-attaining status for supporting aquatic life for the majority of streams in the subwatershed. To remediate excess siltation events that have contributed to the subwatershed's impaired waters, riparian areas need to be restored or reestablished where missing. Streambank fencing and cattle exclusion would also be beneficial in this watershed. For sections of Potter Creek classified as a Class A Wild Trout Stream, riparian restoration efforts should be considered in an effort to protect cool water temperatures in this high quality stream.

7.4.6 Three Springs Run

Three Springs Run also comes into Yellow Creek from the west and is similarly influenced by the influx of numerous springs, although it has a smaller drainage area (9.7 square miles). Three Springs Run has a PADEP Chapter 93 Designated Use Classification of HQ-CWF. It drains east to its confluence with Yellow Creek. Three Springs Run derives its name from the three main headwater springs draining to form the mainstem. The two northern-most headwaters are located in the upper western reaches of the subwatershed and include numerous tributaries originating from the forested hillslopes of Dunning Mountain. As Three Springs Run flows through the subwatershed, it is primarily surrounded by agricultural lands, with intermittent forested riparian areas along the channel. Overall, agricultural lands account for approximately 76 percent of the subwatershed. Forested lands account for approximately 18 percent of the subwatershed. Developed lands constitute a small portion of the subwatershed, accounting for only 6 percent of land use.

Water Quality

Nitrate concentrations at the mouth of Three Springs Run averaged 8.8 mg/l, which is the highest of any of the Yellow Creek tributaries. Conductivity and hardness are also considerably higher than the other tributaries. Upstream grab samples for nitrate showed lower concentrations upstream. Streamflows do not fluctuate as much as in some other Morrison Cove streams, which

is likely due to the high groundwater contribution. Two springs were sampled in the Three Springs Run Watershed, both of which showed nitrate levels of about 8 mg/l.

Riparian Area Condition

All three main headwater areas draining off Dunning Mountain are located in heavily forested lands, primarily hillslopes or ridgelines, with riparian areas almost entirely intact. All other headwater tributaries draining off Dunning Mountain appear to include intact forested riparian areas. As these headwaters reach the valley floor, riparian areas become less prevalent as most land use is agricultural up to the streambanks (Figure 7-14). However, there are many stream segments with intact riparian buffers, and overall, there appears to be more riparian areas in this subwatershed than in many of the other subwatersheds comprising Morrison Cove.

Figure 7-14. Siltation Fencing and Constructed Banks along a Reach of Three Springs Run

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at six sampling points along Three Springs Run in October 2009; however, the three most upstream sites (THRS 6-4) were dry at the time of assessment.

Three of the six sampling points had flow (THRS 3–THRS 1) and were included in the habitat assessment. THRS 3 was located in the most upstream portion of the subwatershed on the southern headwater branch draining to the Three Springs Run mainstem. Land use surrounding THRS 3 consisted of residential and agricultural. Field notes indicate no riparian cover was present at this sample point. With no riparian area to buffer runoff events from surrounding lands, instream habitat parameters were likely impacted, as reflected in marginal

scores for instream cover, epifaunal substrate, sedimentation, and channel alteration. Marginal scores for these parameters indicate that high flow events are likely flashing through the channel unabated. Riparian area vegetation would serve to slow down stormflows and filter pollutants. THRS 2 was located at the confluence of the headwaters to form the mainstem Three Springs Run. Land use surrounding the sample point consisted of agricultural fields, farms, residential areas, and minimal forest cover. Field notes indicate heavy sedimentation immediately upstream of THRS 2. The sample point scored poor for embeddedness and sedimentation, effectively eliminating available interstitial habitat availability for benthic macroinvertebrates. THRS 1 was located the farthest downstream, near the confluence with Yellow Creek. The sample point was just upstream of a paved road, and surrounded by agricultural lands, commercial development, and a farm. A forested riparian area was present on the southern bank of the stream. The site scored suboptimal for most instream habitat parameters except for sedimentation, which scored marginal. The higher instream scores are likely due to the presence of a fairly intact forested riparian area. Instream cover (fish cover) and bank stability both scored well for all three sites.

Subwatershed Stream Condition and Recommendations

The sample points in this subwatershed presented data generally indicating that supporting habitat was available throughout the watershed. Much like in the Potter Creek subwatershed, it seems the numerous forested headwaters draining off Dunning Mountain are contributing stable flows and high quality, spring-fed water to the Three Springs Run mainstem. These forested lands should be prioritized for preservation.

Recommendations for maintaining the HQ-CWF stream classification in this subwatershed include maintaining all existing vegetative riparian buffers. Further removal of existing riparian areas would enhance erosional activities and increase bank instability, thereby resulting in a degradation of the stream's water quality. However, the entire subwatershed is listed on PADEP's 303(d) list as impaired by agriculture in terms of siltation. This has resulted in a non-attaining status for supporting aquatic life for all streams in the subwatershed. To remediate excess siltation events that have contributed to the impaired stream reaches, riparian areas need to be restored or reestablished where missing.

7.4.7 Beaver Creek

Beaver Creek is the last named tributary to enter Yellow Creek within the confines of Morrison Cove and forms the southern boundary of Morrison Cove region. It is also the largest tributary to Yellow Creek, draining 19 square miles. Beaver Creek has a PADEP Chapter 93 Designated Use Classification of HQ-CWF. It drains south and east to its confluence with Yellow Creek. Beaver Creek has numerous headwaters originating on the forested slopes of Dunning Mountain, in the western portion of the subwatershed. As Beaver Creek flows through the subwatershed, it is primarily surrounded by agricultural lands, with intermittent forested riparian areas along the channel. Forested hillslopes form the western and southern boundaries of the subwatershed, from which numerous headwater tributaries drain to the Beaver Creek mainstem. Overall, agricultural lands account for approximately 42 percent of the subwatershed.

Forested lands account for approximately 55 percent of the subwatershed. Developed lands constitute a small portion of the subwatershed, accounting for only 3 percent of land use.

Water Quality

Beaver Creek is unique in that aside from the sampling location at the mouth, which does have a high nitrate concentration (5.6 mg/l), the rest of the upstream locations showed nitrates levels of less than 1.5 mg/l. It is likely that the majority of the nitrate problem is coming from numerous springs in the lower portion of the watershed. One of these springs was sampled by Meiser & Earl, Inc. in October 2009, and had a nitrate concentration of 14.6 mg/l. It is likely that other nearby springs contain similar nitrate concentrations. All samples taken in the upstream portion of the watershed have little to no nitrate above background levels of 1 mg/l. In all the tributaries of Yellow Creek, sulfate, chloride, and sodium were very low and were not water quality issues at all.

Riparian Area Condition

Riparian area condition is similar to that in Three Springs Run subwatershed to the north. All headwater areas draining off Dunning Mountain are located in heavily forested lands, primarily hillslopes or ridgelines, with riparian areas almost entirely intact. As these headwaters reach the valley floor, riparian areas become less prevalent as most land use is agricultural up to the streambanks. The Beaver Creek mainstem flows through agricultural lands across which most riparian areas have been converted, thinned, or removed entirely.

Aquatic Habitat Condition

Visual aquatic habitat assessments were performed by SRBC staff at seven sampling points along Beaver Creek in October 2009; however, two sites (Beaver 7 and Beaver 2) had no flow at the time of assessment.

Five of the seven sampling points had flow (Beaver 6–Beaver 3 and Beaver 1) and were included in the habitat assessment. All five sampling points were located in the lower half of the subwatershed. Land use surrounding Beaver 6 consisted of intact forested lands. The site scored optimal for all habitat parameters except channel flow status. However, given the intact lands surrounding this headwater channel, it seems channel flow was probably just part of the natural hydrologic regime for the October sampling time period. Beaver 5 was surrounded by a farm, a pond, and agricultural fields. A narrow forested riparian area was present at the site. Instream habitat parameters scored suboptimal for sediment deposition and embeddedness, indicating higher sediment loads occurring along this segment of the stream. Streambanks scored optimal in terms of stability, as did epifaunal substrate, instream cover, channel flow, channel alteration, and riparian vegetative cover.

Beaver 4 was located just downstream of Beaver 5 and included similar surrounding land use. Instream habitat parameters and riparian area also mirrored those at Beaver 5. The only noted difference was that instream cover scored marginal for this site. The sample point was located just below an access road, and as such, instream cover may have been marginal due to historic stream alteration from constructing the access road. Beaver 3 was located adjacent to a farm, and surrounded by agricultural fields. Field notes by SRBC staff indicate limited riparian area at Beaver 3 with livestock accessing the stream during the time of sampling. Excessive

sedimentation was also noted at this sample point (Figure 7-15). With no riparian area to buffer runoff events from surrounding lands, instream habitat parameters were likely impacted, as reflected in marginal scores for embeddedness and sedimentation, thereby diminishing available interstitial habitat for benthic macroinvertebrates. All other instream habitat parameters presented suboptimal scores. Beaver 1 was located at the lower end of the subwatershed, near the confluence with Yellow Creek. Land use surrounding this sample point was primarily residential. No riparian area existed at the site. Instream parameters scored suboptimal (instream cover, embeddedness, sediment deposition, channel alteration) and optimal for epifaunal substrate, channel flow status, and frequency of riffles.

Figure 7-15. Erosion and Sedimentation along a Meander on Beaver Creek near the Mouth

Subwatershed Stream Condition and Recommendations

Similar to the data gathered for the adjacent Three Springs Run subwatershed, the sample points in this subwatershed indicate supporting habitat is present. The numerous forested headwaters draining off Dunning Mountain are likely contributing stable flows and high quality water to Beaver Creek. These forested lands should be prioritized for preservation.

Recommendations for maintaining the HQ-CWF stream classification in this subwatershed include maintaining all existing vegetative riparian buffers. Further removal of existing riparian areas would enhance erosional activities and increase bank instability, thereby resulting in a degradation of the stream's water quality.

However, the entire subwatershed is listed on PADEP's 303(d) list as impaired by agriculture in terms of excess nutrients and siltation. This has resulted in a non-attaining status for supporting aquatic life for all streams in the subwatershed. To remediate agricultural runoff events that have contributed to the subwatershed's impaired waters, riparian areas need to be restored or reestablished where missing. Streambank fencing for the purpose of livestock exclusion would also be beneficial in Beaver Creek Watershed.

7.5 Conclusions

Watersheds and subwatersheds include all lands that drain water to the stream network that lies therein. Thus, land use condition within a watershed has direct bearing on the condition of the streams within that setting. Forested lands surrounding streams provide numerous functions to protect high water quality and quantity, in addition to a host of ecosystem services. Agricultural lands, while important to the local economies, can often result in stream impairment from removal of streamside riparian areas. Targeting intact forested lands for preservation or protection will ensure protection of a watershed's streams. Focusing restoration efforts on riparian areas in agricultural and urban areas can often enhance stream channel and bank stability, cool stream temperatures, and provide high quality food sources to instream aquatic communities and habitat to terrestrial wildlife communities.

This chapter has presented factors that contribute to the water quality degradation of the streams in Morrison Cove. Agriculture is the most likely source for the elevated nitrate concentrations throughout the Cove, as it is the dominant land use. Common sources of nitrate are manure, fertilizers, and animal feedlots. Some efforts have been made to address the nitrate problem, including a regional manure digester and working with local farmers to implement BMPs, such as streambank fencing and increased riparian buffers along streams.

Besides the potential impact on human health through drinking water, high concentrations of nutrients can also have negative impacts on stream biota, aesthetics, and recreation opportunities. Eutrophication is defined as a condition in which a body of water has an excess of nutrients, frequently due to runoff from the land, which causes a dense growth of plant life and can lead to oxygen depletion, fish kills, and a loss of biodiversity.

In an effort to reduce nitrate concentrations in the waters of Morrison Cove, the Cove Area Regional Digester (CARD) project was founded. The purpose of this project is to turn the excess manure from surrounding dairy farms into usable products. Many beneficial end results are expected: a reduction in nutrient loading of nitrogen and phosphorus to groundwater and streams, reduction of ammonia gas emissions, an outlet for local manure disposal, and two practical products for re-sale: soil amendment material and power. The Morrison Cove area is home to over 25,000 head of dairy cattle which produce an estimated 200 tons of manure daily. Funding was recently secured for the full implementation of this project. Construction is slated to start in late 2011 with commercial operation beginning in late 2012.

The cause of the increased concentrations of chloride in the lower reach of Halter Creek and all of Plum Creek is likely due to the effluent from sewage treatment plants. The elevated

sulfate concentrations in the lower reaches of the watershed are likely related to the adjacent quarry. The cause is the occurrence of evaporitic minerals (chiefly, the minerals anhydrite and gypsum, which are composed of calcium sulfate and hydrated calcium sulfate, respectively) in the formation being quarried (Bellefonte Formation) in the lower portion of the watershed. Particles of this mineral are released by the crushing and washing of the bedrock to make various grades of aggregate. These particles are then washed or blown into the stream. Chloride shows a seasonal trend; concentrations are much higher in the summer and fall months when streamflow is at its lowest, so the dilution factor is decreased considerably. Then the higher flows of winter and spring dilute the chloride, and concentrations are lower, although still higher than the rest of Morrison Cove streams.

Overall, the streams in Morrison Cove are productive and maintain thriving fish communities and adequate macroinvertebrate communities. However, dramatic seasonal declines in streamflow and the region-wide nitrate problem are important issues to consider. Given the low amount of water availability in Halter Creek, this could potentially be a problem in the designated Class A Trout Stream reach of Halter Creek, downstream of the confluence of Plum Creek. However, the importance of the large influx of colder groundwater from springs cannot be understated when it comes to sustaining excellent trout fisheries. The biggest detriment to macroinvertebrate communities in Morrison Cove is siltation, as fine sediment often compromises the quality of macroinvertebrate habitat.

Streamflow in most of the streams in Morrison Cove drops dramatically in the late summer and fall months and many headwater reaches and tributaries frequently go dry. Besides the nitrate issue, the water quality in these streams is fairly good but the elevated nitrate threatens the water resources of the region and should not be taken lightly. Because of the high degree of interaction between surface water and groundwater, elevated surface water nitrate concentrations reflect groundwater concentrations. This poses a real problem since groundwater is the primary source of drinking water for a majority of the region.

The data from this study linked with other surface water data from various places, including SRBC, seem to show that the nitrate concentrations in the groundwater are higher than those in the surface water, even during low base flow conditions. This leads to the conclusion that nitrate in the groundwater is being removed by some mechanism–possibly riparian corridors. Perhaps focusing efforts on restoring riparian buffer zones along the streams in Morrison Cove would not only reduce nitrogen inputs through overland flow but would also act as a filter for groundwater that is feeding these streams.

At a watershed or subwatershed scale, Morrison Cove presents a setting where land use is a mixture of ridges and valleys that support both intact, forested lands and agricultural areas. Developed or urban areas are sparse throughout the watershed, with the exception of the towns of Roaring Spring and Martinsburg. Subwatershed assessments within Morrison Cove indicate that there are numerous forested headwaters draining off the area's ridgelines. These forested headwaters typically have intact riparian areas, and contribute stable flows and high quality water to several streams located downstream in a subwatershed. Riparian areas, including those in forested headwater settings, function to store surface water and sediment runoff that occur during storm events, which reduces flood damage downstream. Riparian areas intercept, cycle,

and accumulate chemical constituents in shallow subsurface flow, thus filtering out pollutants from overland flow and shallow groundwater that might otherwise contaminate adjacent waterbodies. Riparian vegetation provides streams (and dependent aquatic communities) with microclimate modification and shade, organic litter and wood inputs, nutrient retention and cycling, streambank stability, and control of sedimentation. Maintaining biodiversity is a major ecosystem function that riparian areas provide and is the basis for fisheries in addition to providing bird and wildlife habitat.