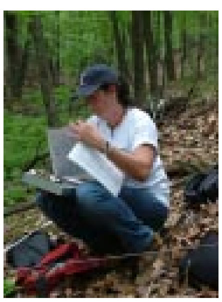
Upper Spring Creek Watershed Coldwater Conservation Plan

Centre County, Pennsylvania

January, 2007



Funded by the Coldwater Heritage Partnership

ClearWater Conservancy

And in partnership with the Penn State Cooperative Wetlands Center

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CLEARWATER CONSERVANCY
SUMMARY OF THE UPPER SPRING CREEK WATERSHED COLDWATER CONSERVATION PLAN
1/31/2007

Approximately sixteen miles of Spring Creek were listed as impaired by the Pennsylvania Department of Environmental Protection in 2002. The majority of impairments were attributed to non-point source pollution coming from urban and agricultural sources, and to poor physical conditions caused by degraded or absent riparian buffers.

Because of the importance of Spring Creek to the environmental health of the area, ClearWater Conservancy created the Riparian Conservation Program in 2004 to assist with riparian conservation in the Spring Creek Watershed. The mission of this program is to distribute information on riparian stewardship, organize projects to remedy degraded riparian buffers, work with landowners to permanently protect riparian properties using conservation easements, and work with local governments to create protective riparian overlay zoning.

In order to address stream impairments in the Upper Spring Creek Watershed, ClearWater Conservancy in partnership with the Penn State Cooperative Wetlands Center conducted a stream assessment of the Upper Spring Creek Watershed with funding from the Coldwater Heritage Partnership and developed this Coldwater Conservation Plan. The goal of this plan is to identify actions that will improve in-stream and riparian zone conditions in Upper Spring Creek to remove impaired reaches from the PA Department of Environmental Protection's 303(d) List of Impaired Waters, prevent any portion from being re-listed in the future, and support wild trout populations.

Twenty-two sites were assessed along Upper Spring Creek and its tributaries from the headwaters to the confluence of Spring Creek with Cedar Run. Data was collected from existing sources where existing data was available and from new surveys where data had not previously been collected. The compiled data included Stream Habitat Assessment (SHA) scores, percent forest cover, buffer scores, bankfull measures, wetland disturbance scores, hydrogeomorphic assessment scores, benthic macroinvertebrate metric scores, and riparian stressor indicators. Data were standardized so that all metrics were on the same scale and comparisons could be made among scores. Scores for data available at each site were integrated into an overall condition score to aid in comparisons among sites.

Recommendations:

Evaluation of the data led to three sections of recommendations. The first section pertains to the protection of stream reaches with low disturbance that currently make the largest contribution to overall water quality of Spring Creek and provide habitat for wild trout. These stream reaches are located on the slopes of Tussey Mountain and within the valley and are generally in good condition, well-vegetated and currently provide outstanding habitat for wild trout.

Suggestions for protecting these low disturbance sites include:

1.A. To the extent possible, properties with streams draining from Tussey Mountain and high-quality wetlands should be protected with conservation easements. Buffers along these streams and wetlands should be a minimum of 10 m and wider if possible, depending upon slope and surrounding land use.

1.B. Ridge and riparian overlay districts should be developed and applied by municipalities to protect streams from encroaching residential development and to minimize hydrologic modifications and vegetation alterations caused by construction in the vicinity of these streams.

1.C. Existing and future roads in the vicinity of Upper Spring Creek and its tributaries should be enrolled in the dirt and gravel road program for pollution prevention measures.

1.D. Landowners of mountain slope forests should be encouraged to enroll in the Forest Stewardship Program through the Department of Conservation of Natural Resources (http://paforeststewards.cas.psu.edu/). This program provides technical assistance and cost share incentives to develop a Forest Stewardship Plan and to install forest stewardship practices. Land owners of high-quality forested properties could also protect their properties with a conservation easement through ClearWater Conservancy.

1.E. ClearWater Conservancy will provide educational materials to property owners advising them of the conservation value of their property and opportunities for participation in conservation programs including conservation easements, riparian plantings, and any tax incentive programs for conservation management of properties. ClearWater Conservancy can provide support for naming unnamed tributaries, mapping natural resources, invasive species education and management, finding resources for protection, and nominations for conservation awards, as appropriate.

The second section pertains to the restoration of riparian buffers with native plants in valley reaches where buffers are either missing or narrow and seriously compromised. The chief threat to the Upper Spring Creek Watershed stream corridors and their ability to sustain brown trout populations is the absence of mature riparian vegetation within the Spring Creek valley, particularly in agricultural areas and some recreational areas.

Suggestions for protecting these valley sites include:

2.A. Landowners in agricultural and residential areas should be encouraged to seek agency support (Centre County Conservation District, PA DEP, USDA Natural Resources Conservation Service, and non-governmental organizations such as ClearWater Conservancy) for obtaining streambank fencing where appropriate and planting riparian trees, shrubs, and herbaceous plants.

2.B. Landowners in agricultural areas should be encouraged to increase the distance between their streambank fencing and the streams to include a wider buffer (>10 m minimum) to further protect stream from agricultural activities. A buffer of > 15 m on each side of the stream, dependent upon the slope and surrounding land use, is preferred.

2.C. Landowners should minimize disturbance in riparian areas (streams, wetlands and floodplains) to prevent colonization by invasive plant species. Steps to control invasive plants that are on the state list of noxious plants should be taken to prevent the spread of these plants along the stream channel.

Finally, Spring Creek has become channelized and incised through the valley where it parallels Route 322 in a number of locations due to the removal of riparian vegetation over time, changes to stream hydrology from stormwater drainage, and increased impervious surfaces from rapidly developing areas. Wetlands have also been eliminated or substantially degraded within the sub-basin. Opportunities for improving stream channel diversity and wetland restoration should be developed where appropriate and when landowners are willing. Specifically:

3.A. Stream channel sinuosity could be improved in select locations including Eugene A. Fasick Memorial Park and the State College Elks Country Club.

3.B. Floodplain wetlands could be restored in public areas along the stream in Eugene A. Fasick Memorial Park and the tributary in Blue Spring Park.

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INTRODUCTION

A. Watershed Description

The Spring Creek Watershed, located in Centre County, Pennsylvania, is approximately 145 square miles of surface topography. Its six sub-basins include the main stem of Spring Creek, Cedar Run, Slab Cabin Run, Big Hollow, Logan Branch, and Buffalo Run (Figure 1). Due to hydrologic conditions, the groundwater boundary of the watershed is larger (175 square miles). The watershed is home to approximately 94,000 people, 14 municipalities, and the University Park campus of the Pennsylvania State University. According to 34 years of historical stream monitoring at Milesburg, PA, an average of 148 million gallons of water leaves the Spring Creek Watershed daily. After this water leaves the Spring Creek Watershed, it flows into Bald Eagle Creek and eventually reaches the West Branch of the Susquehanna River and the Chesapeake Bay.

The Upper Spring Creek Watershed is located in Potter and Harris Townships and is approximately 8,385 acres in size, nearly 7.5% of the Spring Creek Watershed's total area. This sub-watershed includes several headwater tributaries of Spring Creek that originate as springs on the slopes of Tussey Mountain and a portion of the main stem of Spring Creek. The Upper Spring Creek Watershed terminates at the confluence with Cedar Run in Oak Hall. This reach of Spring Creek is designated as a High Quality Cold Water Fishery and Class A Wild Trout Stream that currently contains wild trout. Dominant land use within the Upper Spring Creek Watershed is forest (56.7%), followed by agriculture (21.09%), and residential (9.61%) land uses (Figure 2). Large forested tracks located along Tussey Mountain are largely in private ownership but also include portions of Rothrock State Forest. Agriculture and residential developments dominate the valley area through which Upper Spring Creek flows.

Galbraith Gap Run, Harris Township, PA.

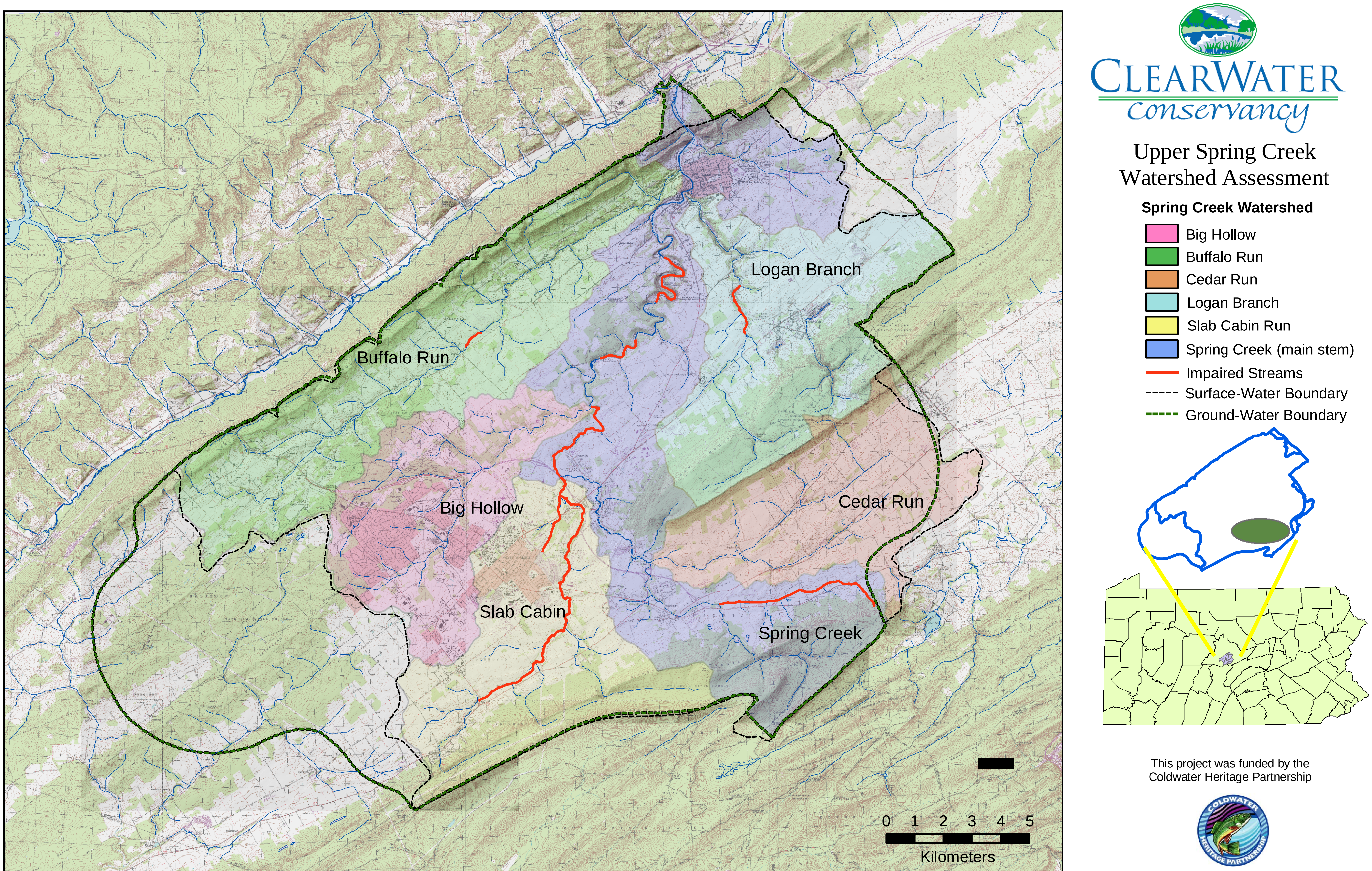

Figure 1. Spring Creek Watershed, Centre County, Pennsylvania.

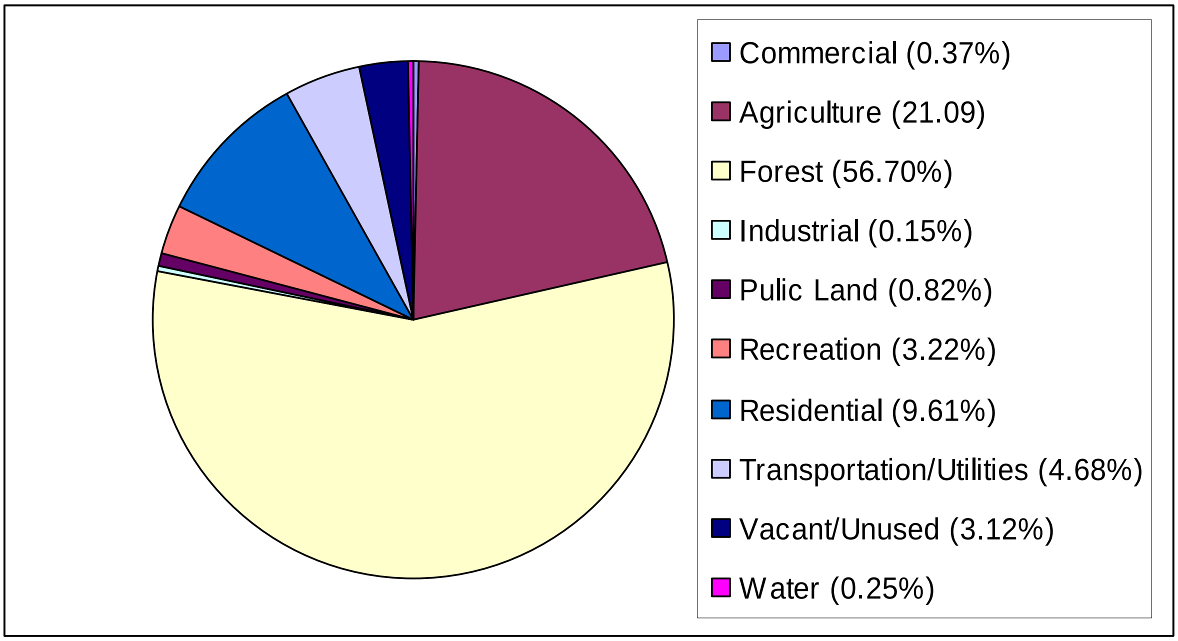

Figure 2. Land use in the Upper Spring Creek Watershed (Confessor and Hamlett 2003).

Streams of the Upper Spring Creek Watershed are primarily first and second order streams draining from the forested slopes of Tussey Mountain to the valley floor where the main stem of Spring Creek flows as a third order stream prior to its confluence with Cedar Run, also a third order stream. The project area is confined to the sub-basin drainage area upstream of the confluence of Spring Creek with Cedar Run (Figure 3).

B. Project Background

In 2001 the Pennsylvania Department of Environmental Protection (PA DEP) assessed the Spring Creek Watershed as part of their Surface Waters Assessment Program and determined that 20%, or 16 stream miles, of the Spring Creek Watershed are impaired (Figure 1) (Hughey 2002). Causes of impairment varied throughout the watershed but the majority (13 miles) are caused by non-point source pollution from urban and agricultural sources and by degraded or absent riparian buffers. The remaining three miles of impairments are caused by point source pollution, specifically fish hatchery discharges (PA DEP 2002).

With the assistance of PA DEP's Growing Greener program and the National Fish and Wildlife Foundation, ClearWater Conservancy created their Riparian Conservation Program to improve impaired stream segments in the Spring Creek Watershed and prevent additional segments from becoming listed. ClearWater's role in achieving these goals includes educating residents about the Spring Creek Watershed and the importance of riparian stewardship, restoring degraded riparian buffers through buffer plantings and invasive species removals, and working with landowners to permanently protect riparian properties using conservation easements. ClearWater Conservancy is also work with local governments and encouraging them to create protective riparian overlay zoning.

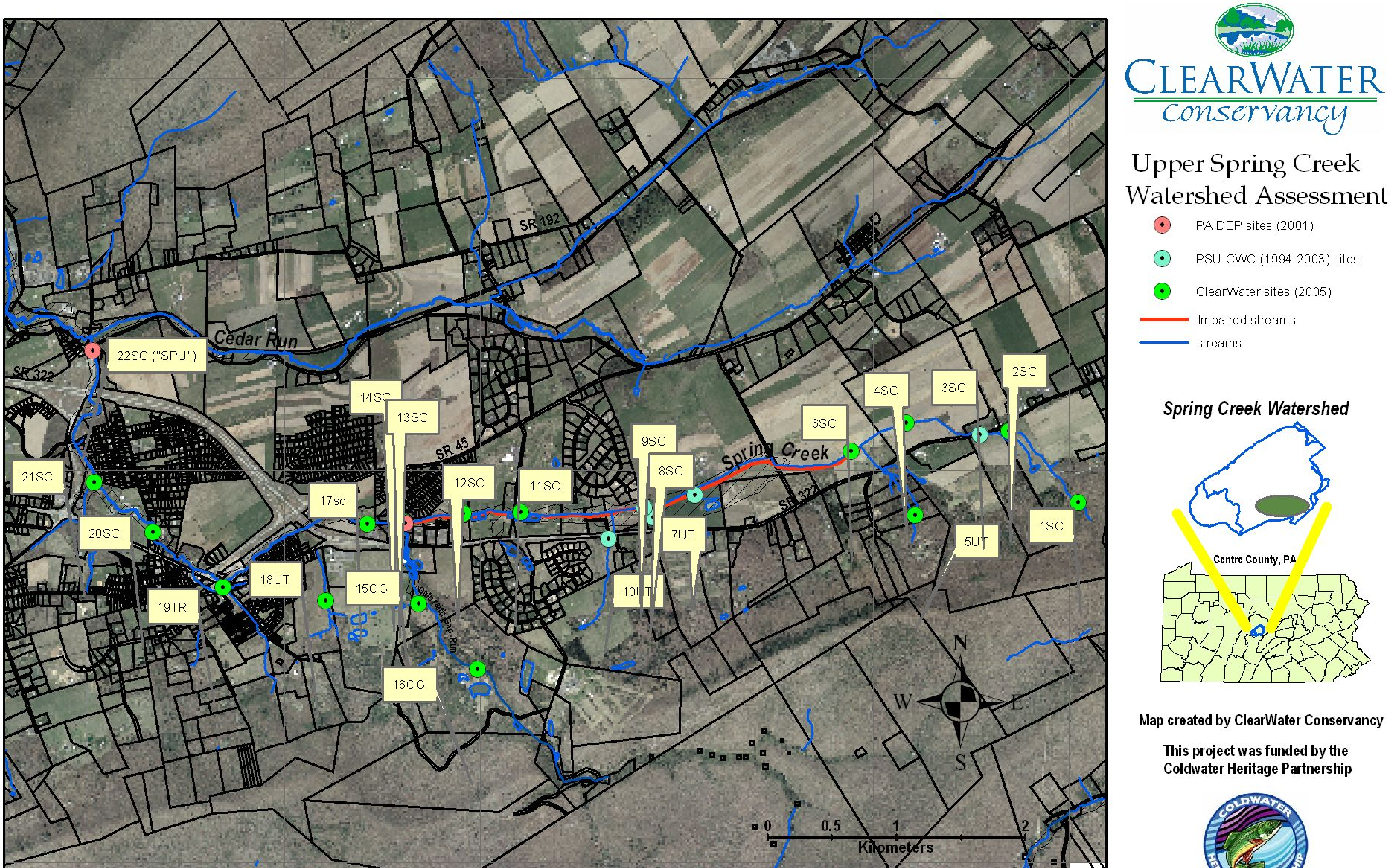

Figure 3. Upper Spring Creek Watershed assessment sites.

ClearWater Conservancy focused its efforts on Upper Spring Creek to begin addressing stream impairments within the Spring Creek Watershed. The first priority was to conduct a stream assessment of Upper Spring Creek and develop this Coldwater Conservation Plan. The goal of this plan is to identify actions that will improve in-stream and riparian zone conditions in the Upper Spring Creek Watershed with the intent of removing the impaired reach from the 303(d) List of Impaired Waters, preventing any portion from being re-listed in the future, and maintaining wild trout populations.

C. Watershed Partnerships

ClearWater Conservancy recognizes that conservation efforts with strong and broad partnerships are critical to both the assessment and implementation of any successful conservation initiative. Development of the Upper Spring Creek Watershed Coldwater Conservation Plan was accomplished through time, input, and data provided by multiple organizations and individuals. ClearWater served as project facilitator and coordinated the involvement of all parties that contributed either time or data. Partners of the Upper Spring Creek Watershed Conservation Plan include:

- U.S. Fish & Wildlife Service (assessment and survey of the State College Elks Club, FGM design, permitting, and instream construction)
- Pennsylvania Fish and Boat Commission (permitting and instream construction)
- Spring Creek Watershed Community's Water Resources Monitoring Project (water quality and quantity data)
- Penn State Cooperative Wetlands Center (field assessment fieldwork and stream, wetland, and floodplain data)
- State College Elks Country Club (future implementation of riparian restoration)
- Harris Township (meeting room for public informational meeting)
- ClearWater Conservancy (project management, stream assessment fieldwork, permitting, and conservation plan implementation)

METHODS

A. Existing data

Existing data were included in this assessment of the Upper Spring Creek Watershed from a combination of three sources: the Penn State University Cooperative Wetlands Center (Brooks 2004, Brooks *et al*. 2006), the PA DEP (Hughey 2002) and the Spring Creek Watershed Community's Water Resources Monitoring Project (unpublished data) (Table 1).

1. Penn State Cooperative Wetlands Center data

Three set of data were available from the Penn State Cooperative Wetlands Center.

In the first data set, the Penn State Cooperative Wetlands Center used the Stream-Wetland-Riparian (SWR) protocol to assess five sites in the Upper Spring Creek Watershed (Brooks *et al*. 2006). The SWR protocol was developed by the Penn State Cooperative Wetlands Center as part of its work with the Atlantic Slope Consortium to develop better indicators of watershed condition. This protocol combines condition assessment procedures from a variety of sources including the Stream Habitat Assessment (SHA) from the Environmental

Protection Agency's (EPA) Rapid Bioassessment Protocol (Barbour et al. 1999), bankfull measurements from the Rosgen stream classification techniques (Rosgen 1997), and rapid field assessment of wetlands (Brooks *et al.* 2002).

Data collection and methods varied among streams, wetlands, and floodplains and are summarized in Table 2. The following is a description of the SWR measures and observations collected at assessment sites:

> SHA: Ten sub-scores on physical features of the stream including substrate, flow, channel stability, and adjacent buffer were summed to provide a total SHA score (Barbour et al. 1999). The condition categories (optimal, suboptimal, marginal, and poor) used for this assessment provide the framework by which all other assessment variables were evaluated.
>
> Buffer score: The buffer score provided an indicator of the width and vegetative quality for 300 m to each side of the stream's center line. The buffer score ranged from 60 (optimal condition) to 0 (poor condition). The thresholds identified for determining an optimal-suboptimal-marginal-poor condition are based on natural breaks in the data distribution and threshold recommendations for buffer condition and width given in the literature (Palone and Todd 1997, Saacke Blunk 2005).
>
> Bankfull parameters: If a defined channel existed on a site, bankfull parameters were measured, including bankfull height, bankfull width, and bank height (Appendix A). From these measures, the flood-prone height was calculated and checked against the bank height in the field to evaluate connectivity of the stream with the floodplain. The incision ratio was calculated as bankfull height/bank height, a variation of Rosgen's entrenchment ratio in which floodplain width/bankfull height is calculated to describe the relationship between a stream channel and its floodplain; an indicator of energy dissipation and channel erosion. The width/depth ratio, also calculated from field measurements, is a non-dimensional parameter, which describes the range of a stream as wide and shallow versus narrow and deep. The implications of the width/depth ratio relate to sediment transport, macroinvertebrate and fish habitats, and the water's thermal qualities.
>
> Wetland disturbance score: The wetlands disturbance score combined information regarding the buffer, land cover, and human induced stressors (e.g., mowing, land movement, etc.) and resulted in a numeric score that indicated the degree to which the wetland was degraded or disturbed. Penn State Cooperative Wetland Center research has shown that wetland condition within riparian areas is often a good indicator of stream and floodplain (non-wetland) condition (Brooks 2004).
>
> Stressors: A checklist of stressors for the stream and floodplain riparian area were adapted from the wetlands stressor checklist developed by the Penn State Cooperative Wetlands Center for the assessment of Pennsylvania's wetlands and determination of a human disturbance score. Of the five major areas in which a stress could be present (stressor category), the presence of one or more stressor indicator resulted in designating that category as a potential stressor in the riparian system. A list of

stressor categories and indicators were used to check the presence or absence of common or known stressors affecting the riparian system at each field site (Table 3).

Classification:

Riparian - On a site sketch map, polygons of land cover were delineated showing the dominant land cover within each patch. Features noted within the riparian area included levees, floodplain wetlands, non-wetland floodplains, upland non-floodplains, and non-floodplain wetlands.

Wetland - Wetlands observed at each station were classified using NWI (National Wetland Inventory) and HGM (hydrogeomorphic) classification schemes.

Hydrology, and wetland soils assessment: The hydrologic condition of the soils within the floodplain and observed wetlands was ranked using a checklist of indicators derived from the *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (U.S. Army Corps of Engineers, 1989) wetlands delineation protocol. Observable evidence of the hydrology such as the presence of obligate hydrophytes, inundation, waterborne sediment deposits, surface drainage, water marks, drift lines, along with soil indicators including chroma, gleyed conditions, and presence of histosol or redox concentrations, were documented to identify the floodplain or wetland as being either extremely (3), moderately (2) or somewhat (1) wet. Sites where no indicators of wet conditions were observed received a '0' for 'not wet'.

Invasive species: Species listed in the Pennsylvania Department of Conservation and Department of Natural Resources brochure entitled "Invasive Species of Pennsylvania" as troublesome invasive plants were surveyed at each site (DCNR 2000). For each site, the percent composition of vegetation contributed by these invasive species was visually estimated. The estimates were recorded as "percent invasives" observed in the field.

The second data set included the SWR measure of land cover that was collected for the five Penn State Cooperative Wetland Center sites. Land cover within in a 1 km-radius of the sites was calculated using GIS and used to determine the degree of human disturbance associated with each assessment site. Land cover percent in forest vegetation, agricultural use, and urban use was calculated. The percent of forest cover is a good indicator of the degree of human disturbances and is well correlated with stream condition. A site with a high percent forest cover generally has less human disturbance and results in a healthier stream. In addition to the five Penn State Cooperative Wetland Center sites, land cover analysis was also available for the two PA DEP sites.

The third data set included further wetland data for one of the five Penn State Cooperative Wetlands Center sites. This site, site 8SC in this report, was a reference wetland site studied and monitored by the Cooperative Wetlands Center since 1994. The information included in this assessment for this site is referred to as the HGM F9 function, a hydrogeomorphic assessment (HGM) indicator which measures the ability of a wetland to maintain characteristic (healthy) plant communities.

A measuring transect used to assess the plant community at Fasick Park

2. PA DEP data

PA DEP had two assessment sites in the Upper Spring Creek Watershed for their Surface Waters Assessment Program in 2001. The first PA DEP site coincided with the Spring Creek Watershed Community's Water Resources Monitoring Project "Spring Creek Upper" (SPU) monitoring station located above the confluence of Spring Creek and Cedar Run. The second PA DEP site was in close proximity to a new ClearWater assessment site created for this study above the confluence of Spring Creek and Galbraith Gap Run (Figure 3). Benthic macroinvertebrate metric scores, SHA scores, and land cover analysis collected by PA DEP at these two sites were included in this assessment. The PA DEP assessment utilized a similar approach for collecting SHA scores as the Penn State Cooperative Wetlands Center assessment that used EPA protocol, however, the overall score had 12 sub-scores compared with the EPA SHA approach that had 10 sub-scores. Water chemistry for these sites was collected by ClearWater Conservancy.

3. Spring Creek Watershed Community's Water Resources Monitoring Project data

A long-term water quality and quantity monitoring station was established in 1999 on Spring Creek above its confluence with Cedar Run. Data collected at this station reflect the water quality and quantity of the Upper Spring Creek Watershed. While these data were not used for this study, they provide a valuable baseline of the pollutants (e.g., nitrates, phosphates, chlorides, and total suspended solids) typical of nonpoint source pollution. A summary of these data are provided in Appendix B for informational purposes.

Table 1. Sources and descriptions of existing and new datasets used for the Upper Spring Creek Watershed Conservation Plan.

DATA SOURCE	DESCRIPTION OF DATA SET	DATA USED	NO. OF SITES*	DATA STATUS
Penn State Cooperative Wetlands Center (1994-2003) (Brooks 2004, Brooks *et al*. 2006)	Streams-Wetlands-Riparian (SWR) assessment protocol (Brooks *et al.* 2006)	• Stream Habitat Assessment (SHA) scores • Buffer score • Bankfull parameters (incision ratio, width/depth ratio) • Wetland disturbance score • Stressor checklist • Classification	5	Existing data
	Mapped land cover using GIS (Myers 2000)	Landscape metrics within 1 km radius of data collection sites • % forest • % agriculture • % urban	(5)	Existing data
	Hydrogeomorphic (HGM) function for riparian wetlands reference sites (Brinson 1995)	• HGM F9 function (ability to maintain wetland vegetation)	(1)	Existing data
Pennsylvania Department of Environmental Protection (2001)	Cause and effect survey including benthic macroinvertebrates, stream habitat assessment, and water chemistry. Regionally calibrated metric score for benthic macroinvertebrates.	• SHA scores • Benthic macroinvertebrate metric score using: – EPT taxa richness – Hilsenhoff Biotic Index (HBI) – % Tolerant individuals – % Intolerant individuals – Shannon Diversity Index • Water chemistry for alkalinity, ammonia (NH_3), Nitrate (NO_3), nitrite (NO_2), total nitrogen (N), total phosphorous (P), BOD_5, TSS	2	Existing data (One site coincides with Spring Creek Watershed Community's Water Resources Monitoring Project site)
Spring Creek Watershed Community, Water Resources Monitoring Project (1999-2002)	Baseline water quality and quantity monitoring	• Flow • Temperature • pH • Dissolved oxygen • Total suspended solids and turbidity • Chloride • Copper, lead and zinc • Nitrogen as nitrate (NO_3) • Orthophosphates (PO_4) • Petroleum hydrocarbons and total organic carbon	(1)	Existing data
ClearWater Conservancy (2005)	SWR assessment protocol (Brooks *et al.* 2006)	• SHA scores • Buffer score • Incision ratio • Stressor checklist • Classification	15	New data collected specifically for Coldwater Conservation Plan

*Parentheses indicate that sites are the same as other assessment sites listed without parentheses. Total number of assessment sites for the Upper Spring Creek Watershed Assessment = 22 sites.

Table 2. Stream-Wetland-Riparian (SWR) protocol methods used to assess each measurement or observation in the three types of riparian areas scored in the Upper Spring Creek Watershed assessment.

Measure/ Observation	Riparian Areas Assessed: Stream	Non-wetland Floodplain	Wetland
SHA	EPA Rapid Bioassessment Procedure[1]		
Buffer Score	0-100 m from stream center point		0-100 m from wetland boundary
Bankfull parameters	Rosgen methods[2]		
Stressors	Category and indicators	Category and indicators	Category and indicators
Classification	Strahler order (GIS)	Cover type to identify microhabitats	HGM[3] and NWI[4]
Hydrology (degree of wetness)		Wetness checklist	Wetness checklist
Soil assessment		Soil type	Soil type
Percent invasive species		Herbaceous, shrub, tree	Herbaceous, shrub, trees

[1]Barbour et al. (1999)
[2]Rosgen (1998); adapted as shown in Appendix A.
[3] Hydrogeomorphic Functional Assessment Model (HGM; Brinson 1995)
[4]National Wetlands Inventory (NWI; Cowardin et al. 1979)

Table 3. Stream-Wetland-Riparian (SWR) protocol stressor categories assessed in the field for streams, wetlands, and floodplains.

Stressor Category	Stressor Indicator	Stream	Floodplain	Wetland
Hydrologic modification	• Channelized	x		
	• Tile drain outfalls	x	x	x
	• Ditch outfalls	x	x	x
	• Artificial levee	x	x	x
	• Impounded	x	x	x
	• Filling, grading, dredging		x	x
	• Water withdrawal	x		
	• Stormwater inputs/culverts	x	x	x
	• Point source non-stormwater	x	x	x
	• Excavation	x	x	
	• Road bed/crossings	x	x	x
	• Ditching in riparian corridors		x	
	• Dead or dying trees		x	x
Sedimentation and erosion	• Sediment deposits/plumes	x	x	x
	• Channel incision	x		
	• Excessively eroding bank slopes	x		
	• Urban/road stormwater inputs	x	x	x
	• Channel flow status	x		
	• Active adjacent construction, plowing, grazing or forest harvesting		x	x
	• Siltlines on ground or vegetation		x	x
	• Dominant presence of sediment tolerant plants		x	x
Dissolved oxygen	• Excessive density of aquatic plants or algal mats	x		x
	• Excessive deposition or dumping of organic waste	x		x
	• Direct discharges of organic wastewater or material	x		x
Contaminant toxicity	• Obvious spills, discharges, plumes, odors	x	x	x
	• Fish and wildlife impacts	x	x	x
	• Adjacent industrial sites	x	x	x
	• Severe vegetation stress			
Vegetation alteration	• Need for aquatic weed control	x	x	x
	• Dominant presence of exotic or aggressive plant species	x	x	x
	• Recent removal of downed woody debris			
	• Recent mowing	x		x
	• Recent grazing		x	x
	• Recent tree harvesting/cutting		x	x
	• Recent brush cutting, mechanized removal		x	x
	• Excessive herbivory		x	x
	• Chemical defoliation of vegetation		x	x
	• Presence of crops		x	x
	• Presence of forest plantations		x x	x

B. Collection of new data

ClearWater Conservancy and Penn State Cooperative Wetlands Center staff conducted SWR assessment at 15 new ClearWater stream assessment sites in Upper Spring Creek during the summer 2005 field season to supplement SWR data collected at the five Penn State Cooperative Wetland Center sites. The ClearWater sites were chosen to fully represent the diversity of existing stream conditions and effects to stream habitat caused by different land cover types (e.g., residential, agriculture, forest, etc.). In total, SWR data from these new sites were combined with those from seven others for at total of 22 assessment sites throughout the Upper Spring Creek Watershed.

C. Data integration

Data compiled from various sources contained different measurements for different sites that needed to be standardized before overall conditions could be compared across sites.

Eight assessment categories were chosen to maximize use of available data (Table 4). Site conditions of Penn State Cooperative Wetlands Center sites were determined from SHA scores, land cover information, buffer scores, bankfull data, wetland disturbance scores, stressor checklists, and, at some sites, HGM scores. Site condition at the Spring Creek Watershed Community site was determined from SHA scores, land cover information, buffer scores, and benthic macroinvertebrate metric scores. Site conditions at ClearWater Conservancy sites were determined from SHA scores, buffer scores, bankfull data, and stressor checklists.

All assessment variables were standardized on a scale from 0 to 1.0 so that variables could be compared among sites. The 1.0 scale was selected because it simplified data to the lowest common denominator (Brooks *et al*. 2006). For this scale, 0.0 is considered of lowest integrity and 1.0 is considered the highest.

Integration of data among sites was accomplished by assigning assessment variables to a condition category (optimal, sub-optimal, marginal, and poor) borrowed from the EPA's SHA. Thresholds for optimal, suboptimal, marginal, and poor categories of each variable were determined from a combination of information obtained from the literature, investigator familiarity with the site and assessment variables, and observed breaks in the data. Thresholds were assigned so that sites would fall into one of four categories.

RESULTS

Table 4 summarizes assessment variables used to determine stream condition at each site. The raw field data for all sites considered in this assessment is summarized in Appendix C. Data are presented in this report in their standardized format for the purpose of simplifying the comparison of sites and stream reaches for protection or restoration.

A description of the results on a variable-by-variable basis follows. Each description includes a graphed summary of the sites, showing their condition ranked from optimal, to suboptimal, marginal, and poor.

Table 4. Sites in the Upper Spring Creek Watershed and the assessment variables that were used to indicate stream condition at these sites. Assessment sites are coded by a number indicating their order along Spring Creek and a code indicating the stream on which the site is located (SC = Spring Creek; UT = Unnamed Tributary, GG = Galbraith Gap Run, TR = Tannery Run) (Figure 3). Sites 13SC and 22SC were existing PA DEP sites. Sites 3SC, 7UT, 8SC, 9SC, and 10UT were existing Penn State Cooperative Wetlands Center sites.

Site code	Site name	Stream Habitat Assessment (SHA) scores	% Forest	Buffer scores (for DEP sites, SHA 12: riparian vegetation)	Incision ratio	Wetland disturbance scores	HGM F9 function (ability to maintain wetland vegetation)	Macroinvertebrate Metric scores	Stressor checklist
1 SC	1-FS-1	■		■	■				■
2 SC	1-FS-2	■		■	■				■
3 SC	SWR 44 Rt 322 Tussey	■	■	■	■	■			■
4 SC	4CF	■		■	■				■
5 UT	6c-GP-1	■		■	■				■
6 SC	7-O-1	■		■	■				■
7 UT	SWR 23 Dreibilbis	■	■	■		■			■
8 SC	SWR 9 NBB HW FP	■	■	■		■	■		■
9 SC	SWR 21 NBB up	■	■	■	■	■			■
10 UT	SWR 43 Tussey trib	■	■	■	■	■			■
11 SC	14-SCE-1	■		■	■				■
12 SC	20.5-HT-1	■		■	■				■
13 SC	DEP 21.1	■	■	■				■	
14 SC	20.5-HT-2	■		■	■				■
15 GG	23a-AC-1	■		■	■				■
16 GG	24-AR-1	■		■	■				■
17 SC	19-COP-1	■		■	■				■
18 UT	23-AC-1	■		■	■				■
19 TR	32-WK-1	■		■	■				■
20 SC	40-ND-1	■		■	■				■
21 SC	44-PHM-1	■		■	■				■
22 SC	DEP 18.6	■	■	■				■	

A. Stream Habitat Assessment (SHA)

The SHA provides an overview of the current state of habitat for the sites evaluated as well as some categorical guidance on the areas of concern for potential restoration. There is a SHA score for every site assessed within the Upper Spring Creek Watershed. The SHA utilized a 0 to 20 scale for each variable, describing physical attributes of the stream, channel, and adjoining riparian buffer. Specific sub-scores for each of the SHA categories and for each of the sites are included in Appendix C. To summarize, Figure 4 illustrates the standardized total SHA score for each site and provides an indication of how the sites compare with one another in regards to habitat opportunity, availability, and overall condition.

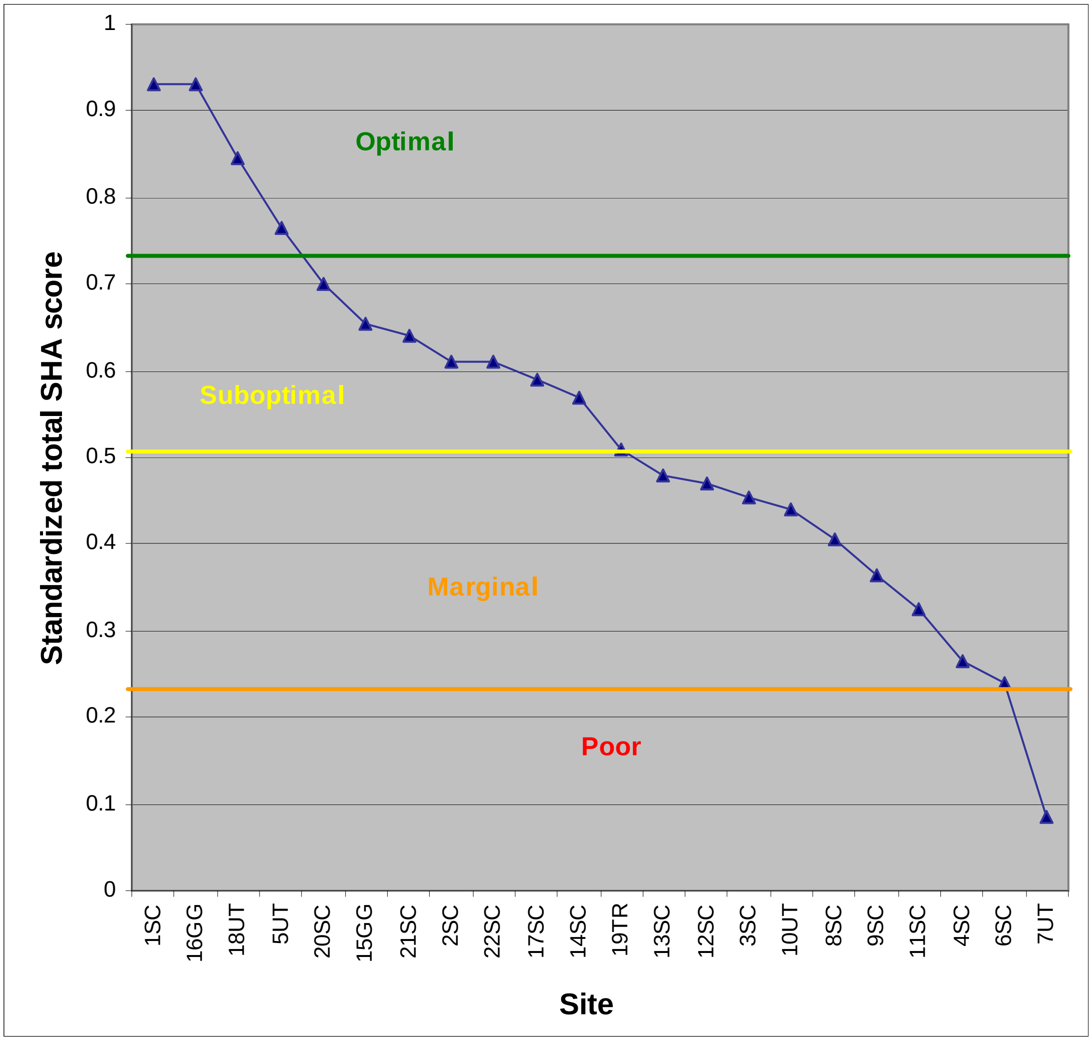

Figure 4. Stream condition of each assessment site in the Upper Spring Creek watershed based on standardized total Stream Habitat Assessment (SHA) scores. The break down of scores by general condition (optimal, suboptimal, marginal and poor) is displayed to show the number of sites in each category. Site codes are given in Table 4.

The total SHA scores observed resulted in a consistent distribution of sites along the condition continuum. Sites considered reference (undisturbed) all had higher scores and were distributed in the optimal condition category. The most seriously disturbed sites are clustered in the poor/marginal condition categories.

While the total SHA score provides a snapshot of the existing condition of the stream, the individual SHA sub-scores may show both an indication of the most serious habitat degradation and opportunities for restoration and protection. Individual SHA sub-scores by site are summarized in Table 5.

Table 5. Standardized Stream Habitat Assessment (SHA) scores by category for each site assessed in the Upper Spring Creek Watershed. Colors indicate general condition assessed for each category at each site (green=optimal, yellow=suboptimal, orange= marginal, red=poor). Site codes are given in Table 4.

Site code	Total score (SHA T)	Epifaunal substrate-available cover (SHA 1)	Embeddedness (SHA 2)	Velocity depth regime (SHA 3)	Sediment deposition (SHA 4)	Channel flow status (SHA 5)	Channel alteration (SHA 6)	Frequency of riffles (SHA 7)	Bank stability (SHA 8)	Bank vegetative cover (SHA 9)	Riparian vegetative zone width (SHA 10)
1 SC	0.93	1	1	0.55	1	1	0.75	1	1	1	1
2 SC	0.61	0.5	0.5	0.7	0.35	0.65	0.9	0.8	0.6	0.6	0.5
3 SC	0.46	0.75	0.75	0	0.65	0	0.8	0	0.4	0.7	0.5
4 SC	0.27	0.5	0.3	0	0.4	0	0.65	0	0.2	0.5	0.1
5 UT	0.77	0.9	0.8	0.55	0.55	0.55	1	0.9	0.8	0.6	1
6 SC	0.24	0.25	0.25	0	0.25	0	0.65	0	0.6	0.3	0.1
7 UT	0.09	0.05	0	0	0	0.05	0.05	0	0.3	0.2	0.2
8 SC	0.41	0.4	0.25	0.15	0.25	0.3	0.55	0.25	0.5	0.6	0.8
9 SC	0.37	0.05	0.05	0	0.8	0	0.65	0	0.06	0.6	0.9
10 UT	0.44	0.25	0	0.1	0.85	0.15	0.65	0	0.8	0.8	0.8
11 SC	0.33	0.25	0.25	0.1	0.25	0.5	0.4	0.01	0.7	0.5	0.2
12 SC	0.47	0.4	0.3	0.45	0.4	0.35	0.55	0.25	0.6	0.6	0.8
13 SC	0.53	0.6	0.5	0.5	0.5	0.9	0.3	0.6	0.9	0.3	0.2
14 SC	0.57	0.85	0.65	0.3	0.45	0.05	0.9	0.3	0.8	0.5	0.9
15 GG	0.66	0.8	0.75	0.45	0.55	0.3	1	0.9	0.5	0.6	0.7
16 GG	0.93	1	0.65	1	0.65	1	1	1	1	1	1
17 SC	0.59	0.9	0.9	0.9	0.75	0	0.8	0	0.7	0.6	0.35
18 UT	0.85	0.95	0.7	0.95	0.65	0.75	0.95	0.95	0.65	0.9	1
19 TR	0.51	0.55	0.5	0.65	0.4	0.4	0.6	0.6	0.6	0.55	0.25
20 SC	0.7	0.8	0.8	0.8	0.8	0.55	0.75	1	0.6	0.6	0.3
21 SC	0.64	0.8	0.8	0.4	0.5	0.75	0.8	0.55	0.5	0.5	0.8
22 SC	0.67	0.7	0.7	0.8	0.7	0.9	0.6	0.8	0.8	0.5	0.2

B. Percent forest in 1-km landscape circles

The Cooperative Wetlands Center uses GIS land cover analyses to consider how the surrounding land cover may impact aquatic resources. Land cover analysis collected from a 1-km circle radius helps quantify the extent to which human activities in the surrounding area of a site have influenced the landscape, potentially impacting the aquatic resource. The landscape circles analyzed provide a point-in-time record of human activity at an exact location intended to be an indicator of a larger area's land cover. Completing the land cover analysis for all SWR sites will be helpful in determining how well percent forest and stream habitat are correlated in this watershed (Figure 5).

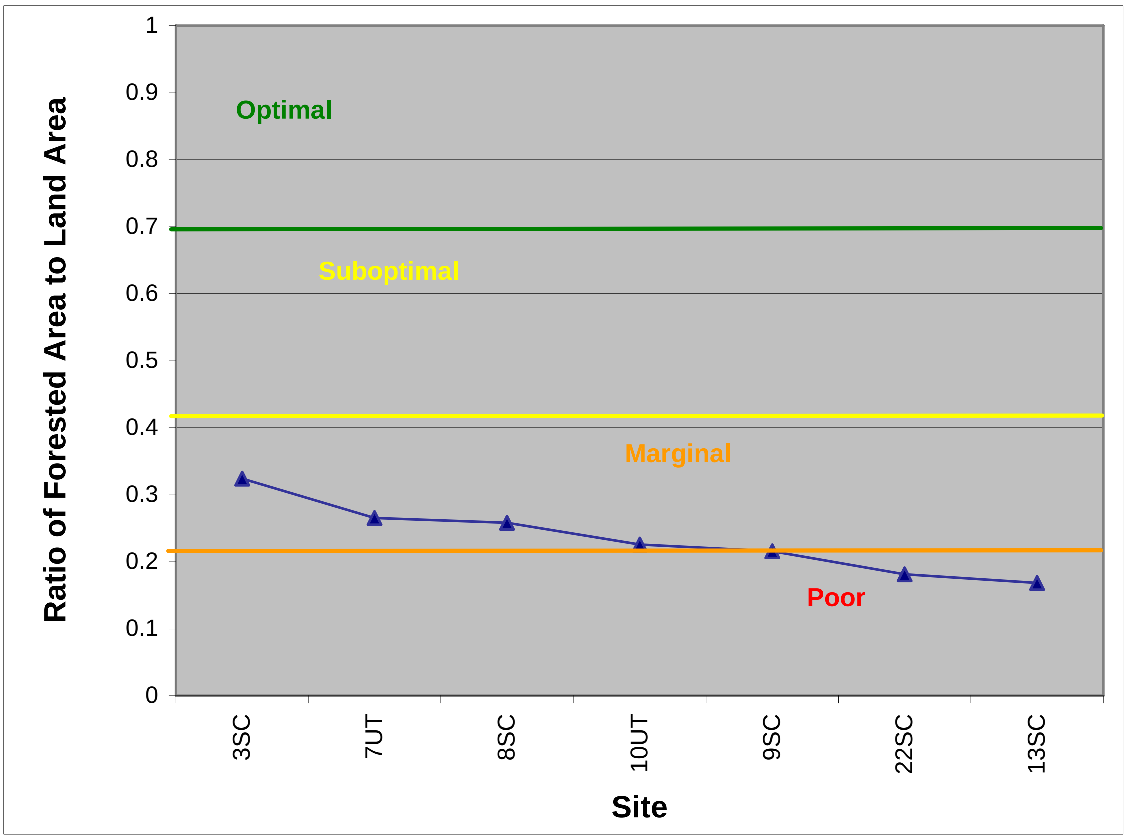

Figure 5. Forest cover within a 1-km radius around seven assessment sites in the Upper Spring Creek Watershed. Site codes are given in Table 4.

C. Buffer score

For each of the Upper Spring Creek Watershed Assessment stations, a buffer score was assigned that assesses the buffer width and vegetative quality. For the PA DEP stations, the buffer score is extracted from the SHA and is scored on a 0 to 20 scale. For the stations where the SWR protocol was conducted, a buffer score that provides a more in-depth description of buffer width and vegetative quality for up to 300 m to each side of the stream was assigned. The SWR buffer score was under development during 2002 and 2003 and consequently evolved from a 0 to 14 scale to a 0 to 60 scale by the time of the 2005 field season. All buffer scores were standardized to a 0 to 1.0 scale so that the different methods for measuring buffer width and quality could be compared (Figure 6).

The thresholds identified for buffer score and condition are based upon natural breaks in the data distribution and on literature that provides a strong basis for threshold recommendations for buffer condition and width.

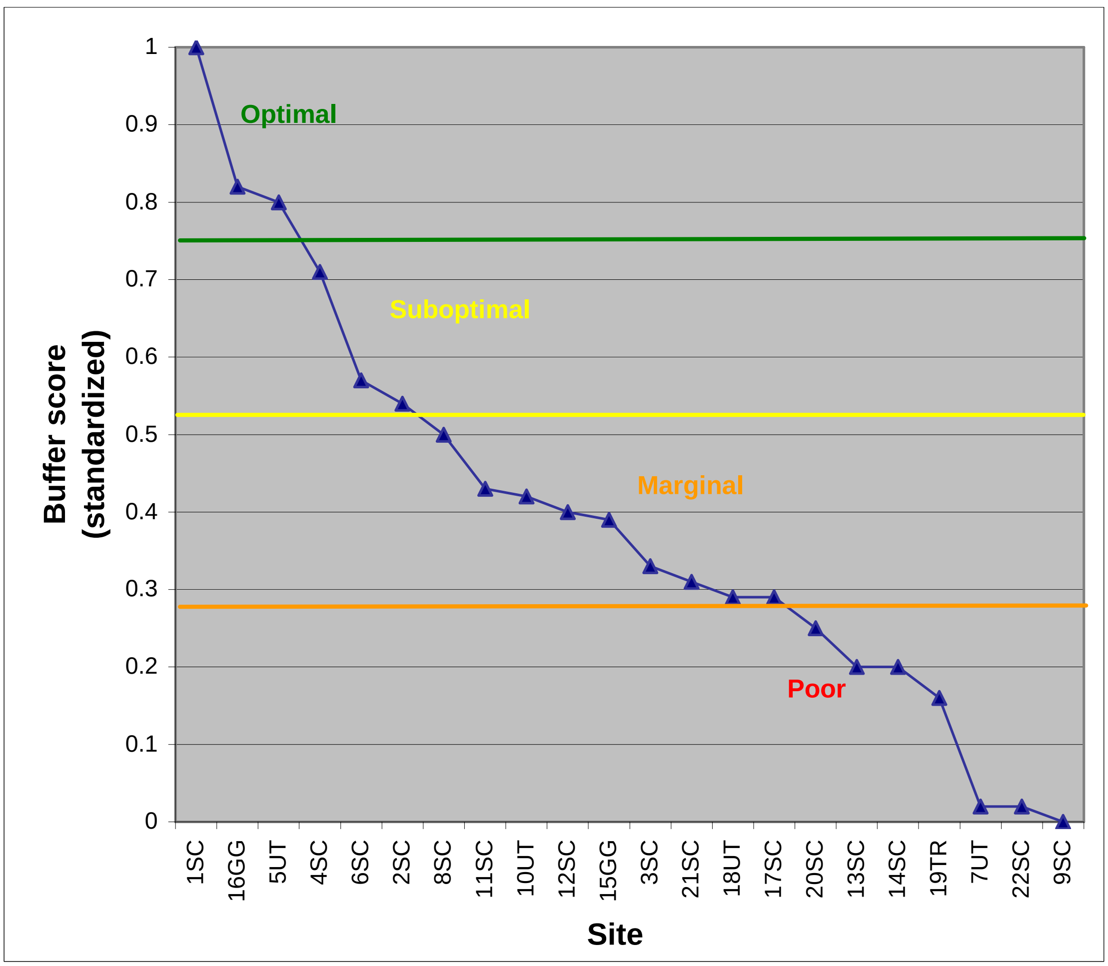

Figure 6. Standardized buffer scores of assessed sites in the Upper Spring Creek Watershed. The break down of buffer scores by general condition (optimal, suboptimal, marginal and poor) is displayed to show the number of sites in each category. Site codes are given in Table 4.

D. Bankfull measures

Bankfull measurements throughout the larger Spring Creek Watershed are difficult to compare due to the natural characteristics of a limestone stream and the fact that Spring Creek can be a "losing" stream in many sections of the Upper Spring Creek Watershed. Stream channel incision is a known detriment to stream flow and channel stability in high-, to moderately-high gradient streams that are typical of the Upper Spring Creek Watershed. The incision ratio reflects the relationship between the bankfull height and the bank height. The higher the incision ratio, the more likely that the stream will overflow its banks and flood the adjacent floodplain under high water conditions, representing optimal conditions for a connected riparian system (Figure 7). The lower the incision ratio, the less likely that high water flow will be able to overflow the stream banks, disrupting the riparian system and minimizing the floodplain's natural ability to accommodate high flows and dissipate storm energy, likely exacerbating further incision and erosion in the stream channel.

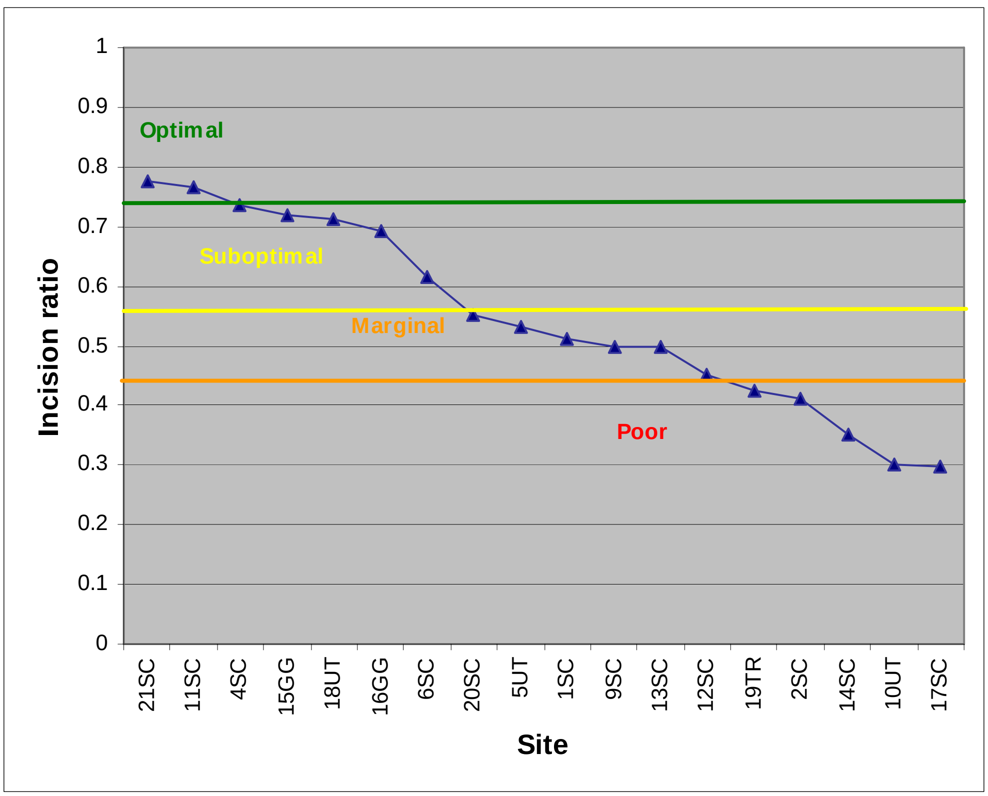

Figure 7. Incision ratios (bankfull height/bank height) of assessed sites in the Upper Spring Creek Watershed. The break down of scores by general condition (optimal, suboptimal, marginal and poor) is displayed to show the number of sites in each category. Site codes are given in Table 4.

E. Wetland Disturbance Score

Wetland disturbance scores allow for comparison of wetland health among sites within a watershed. The scores and their thresholds used here were derived with methods given in Brooks *et al.* (2002), which document the correlation between watershed health and the condition of a watershed's wetlands (Figure 8).

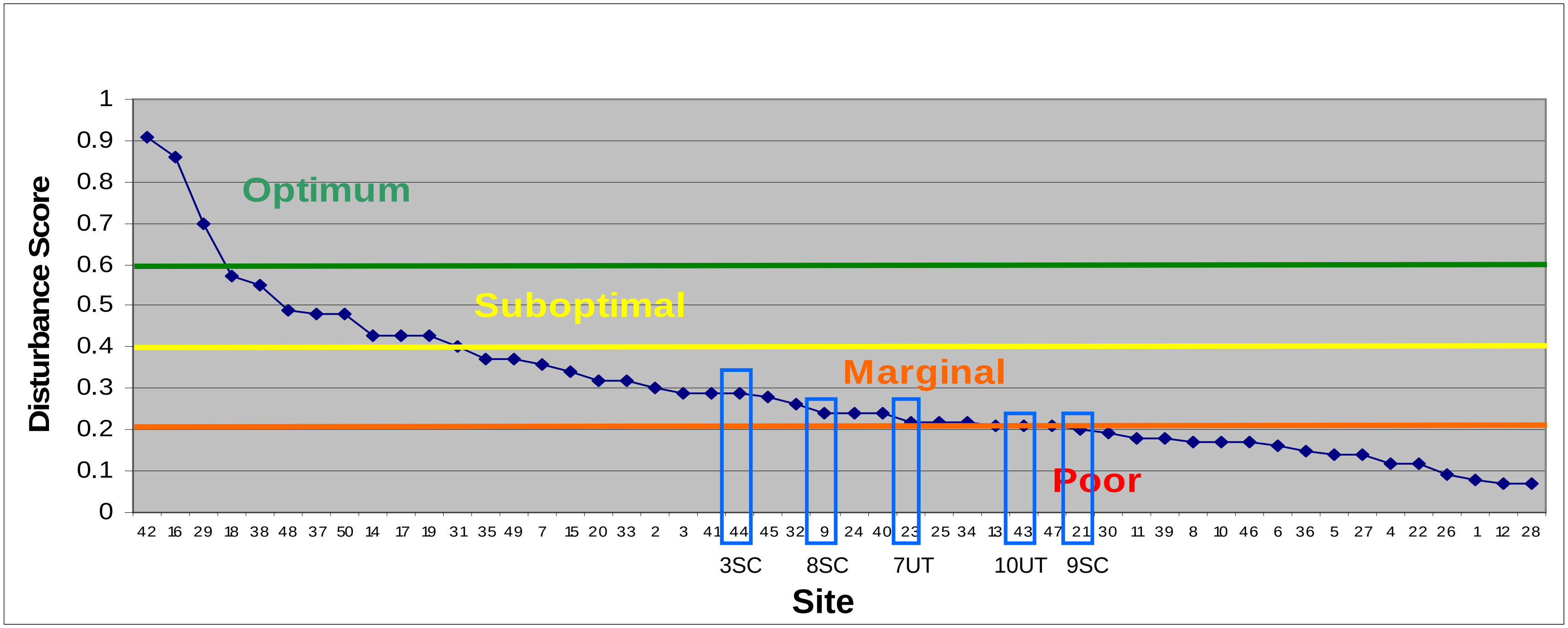

Figure 8. Wetland disturbance scores of assessed sites in the entire Spring Creek Watershed (data from Saacke Blunk 2005). The five sites assessed in the Upper Spring Creek Watershed are highlighted by blue boxes and relabeled according to the site codes used in this report (sites 3SC, 8SC, 7UT, 10UT, 9SC; Table 4) for comparison with the condition of wetlands found throughout the Spring Creek Watershed.

F. Maintenance of characteristic plant community composition
Hydrogeomorphic Functional Assessment Model (HGM) scores were available from the Penn State Cooperative Wetlands Center for one reference wetland in the Upper Spring Creek Watershed, site 8SC (Figure 9). In particular, the HGM F9 assessment variable was of interest because it describes the ability of a site to maintain vegetation characteristic of wetlands. This variable indicates a site's capacity for sustaining wetland vegetation based on hydrogeomorphic features required to support wetland vegetation.

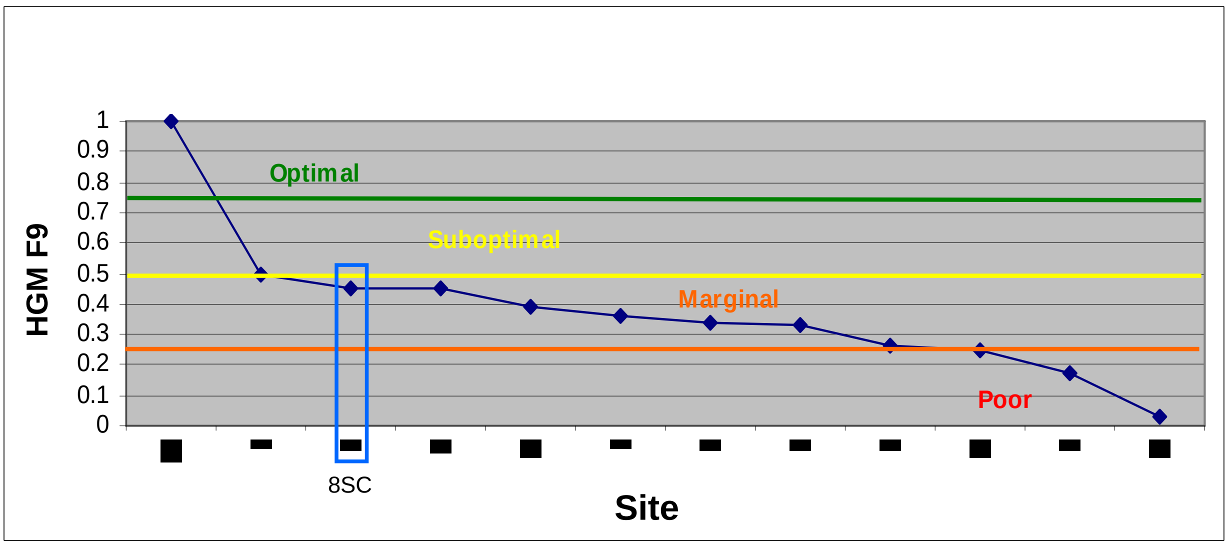

Figure 9. Hydrogeomorphic Functional Assessment Model Function 9 (HGM F9) scores of assessed sites in the entire Spring Creek Watershed. The site assessed in the Upper Spring Creek Watershed is highlighted by a blue box (site 8SC; Table 4) for comparison with the rest of the Spring Creek Watershed.

G. Benthic macroinvertebrate metric score

PA DEP analyzed benthic macroinvertebrate data for all of their 19 Spring Creek Watershed assessment sites using a limestone reference stream dataset that was developed by W. Botts in support of his Big Springs assessments in Southcentral Pennsylvania (Botts 1999*a* and 1999*b*). Incorporated into the resultant cumulative benthic macroinvertebrate metric score were the following metrics: taxa richness, EPT taxa richness, Hilsenhoff Biotic Index (HBI), percent tolerant individuals, percent intolerant individuals, and Shannon Diversity Index. According to PA DEP, the cumulative metric score was essentially a regionally-calibrated multi-metric Rapid Bioassessement Protocol for limestone streams in Pennsylvania intended to provide thresholds for determining the presence or absence of stream impairments.

Only two of the 19 Spring Creek locations were located within the Upper Spring Creek Watershed. These two sites are displayed in context of those assessed for the entire watershed for comparative purposes (Figure 10).

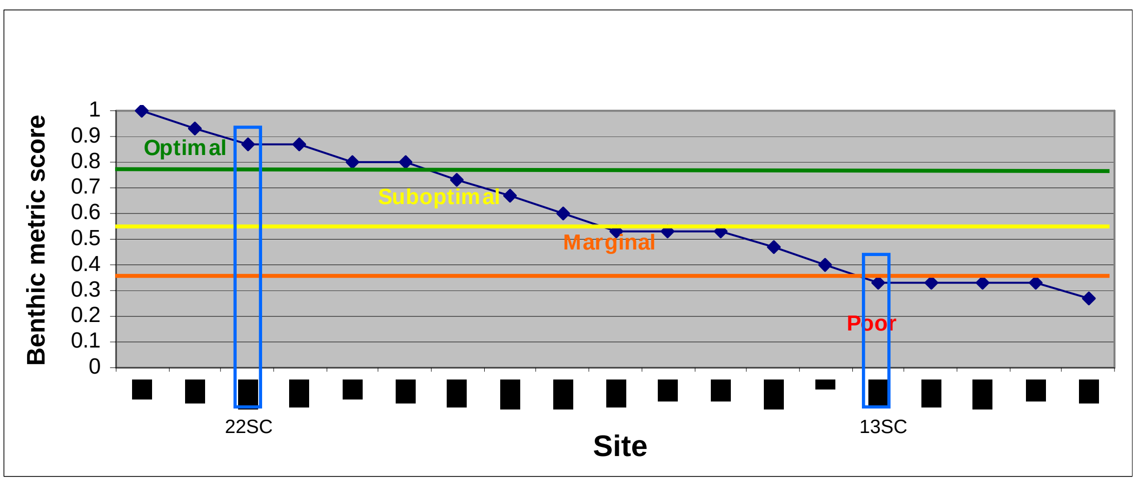

Figure 10. Standardized benthic macroinvertebrate metric score of assessed sites in the entire Spring Creek Watershed. The two assessed sites in the Upper Spring Creek Watershed are highlighted by blue boxes (sites 13SC and 22SC; Table 4) for comparison with the rest of the Spring Creek Watershed.

H. Spatial integration of assessment variables between datasets

This section presents standardized assessment variables collectively so that relationships among variables can be more clearly evaluated and changes along the stream can be better observed. Figure 11 shows the sites from left (most upstream) to right (most downstream) along the x-axis. Noticeable spikes in stream condition can be attributed to tributaries at these stream points. For instance, the first four sites beginning upstream are along the headwater Spring Creek flowing from Tussey Mountain into the agricultural valley and the corresponding overall condition of Spring Creek goes from very high (optimal at 1SC) to very low (site 4SC). The spike in condition noted following site 4SC corresponds with the confluence of a headwater tributary between site 4SC and site 6SC on Spring Creek.

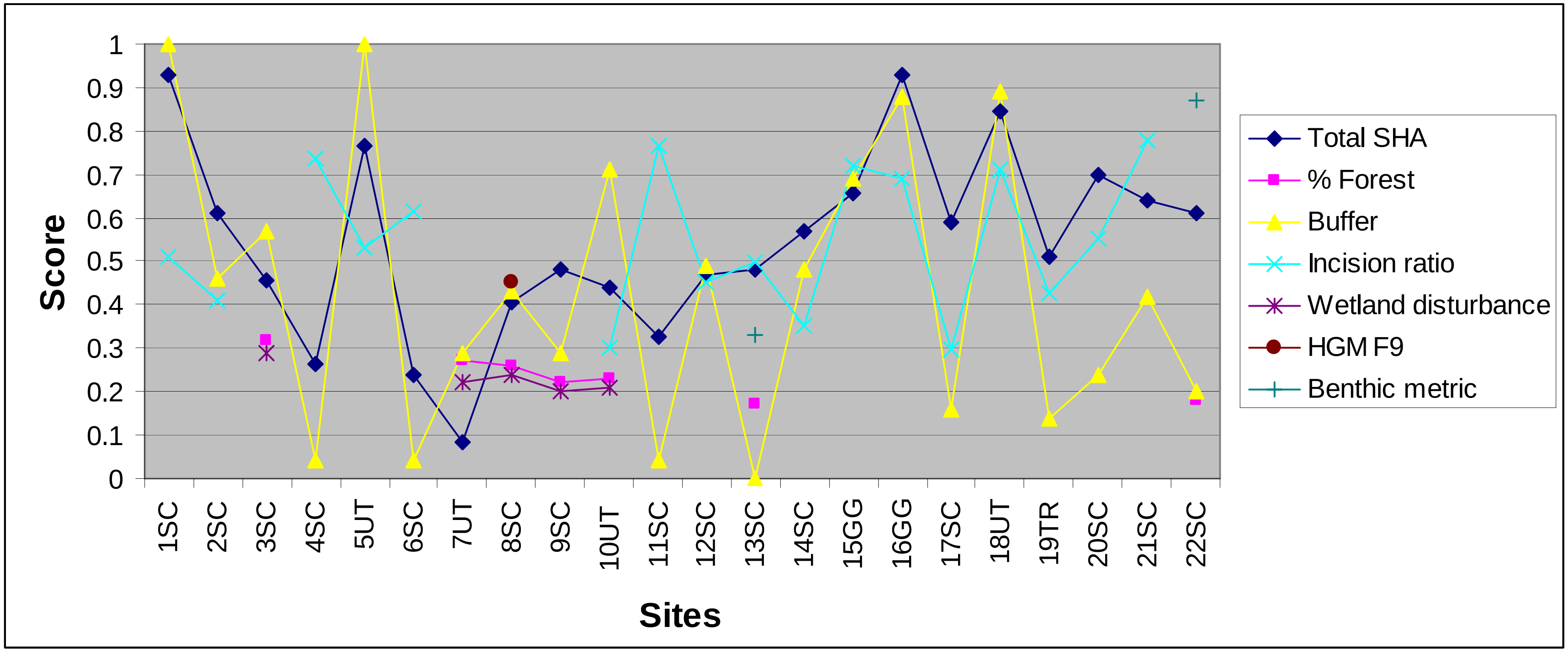

Figure 11. Standardized scores of assessment variables compiled for each site. Sites are ordered from upstream (left) to downstream (right). Site codes are given in Table 4.

I. Riparian stressor indicators

Indicators of human disturbances to riparian areas, stream channel, adjacent floodplain, and wetlands associated with each site were observed and logged. Six different stressor categories were observed in the Upper Spring Creek Watershed. These categories included hydrologic modifications, vegetation alteration, sedimentation/erosion, eutrophication, dissolved oxygen, and contaminant toxicity. Stressor categories not observed in the watershed include turbidity, acidification, thermal alteration, or salinity.

Half of all stressor indicators observed within stream channels were sedimentation and erosion stressors (Figure 12). Next, hydrologic modifications represented more than 25% of the stressors observed. The remaining stressors observed were from vegetation alteration, eutrophication, dissolved oxygen, or the contaminant toxicity stressors.

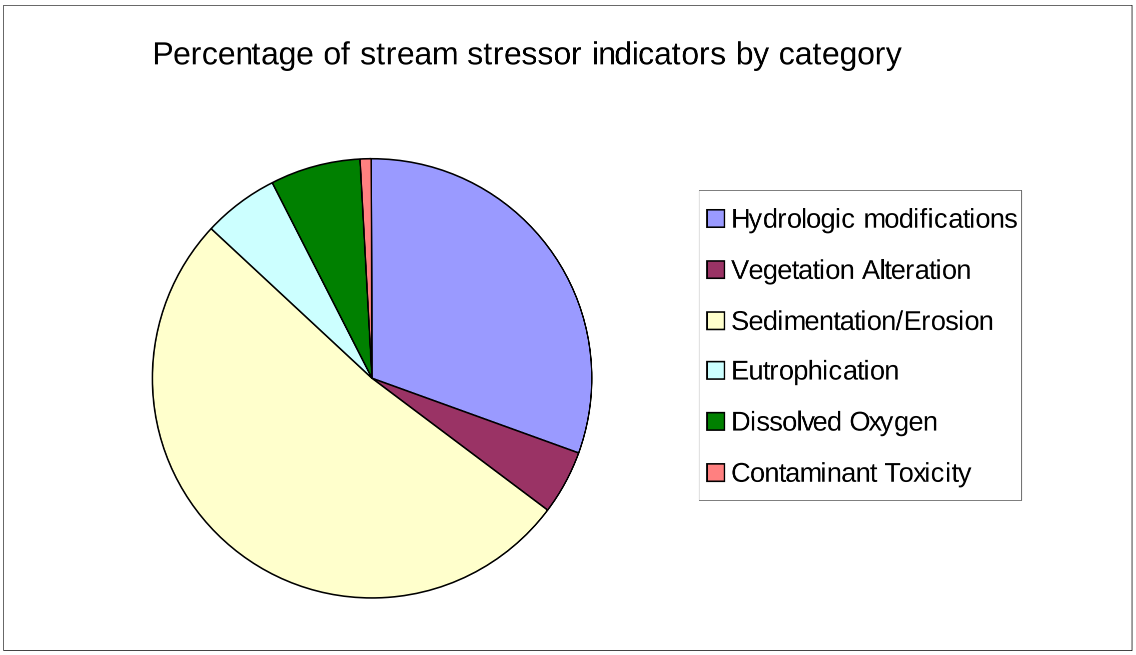

Figure 12. Percentage of stressor indicators within each stressor category that were found within stream channels of assessment sites in the Upper Spring Creek Watershed.

Within floodplains, the largest number of stressor indicators were attributed to hydrologic modifications (Figure 13). Second to hydrologic modifications were stressor indicators attributed to sedimentation and erosion. Third were stressor indicators attributed to vegetation alteration. Eutrophication and contaminant toxicity indicators were a minor percentage of total stressors found in floodplains.

In wetland areas, the breakdown of stressor indicators were similar to those found in floodplains (Figure 14).

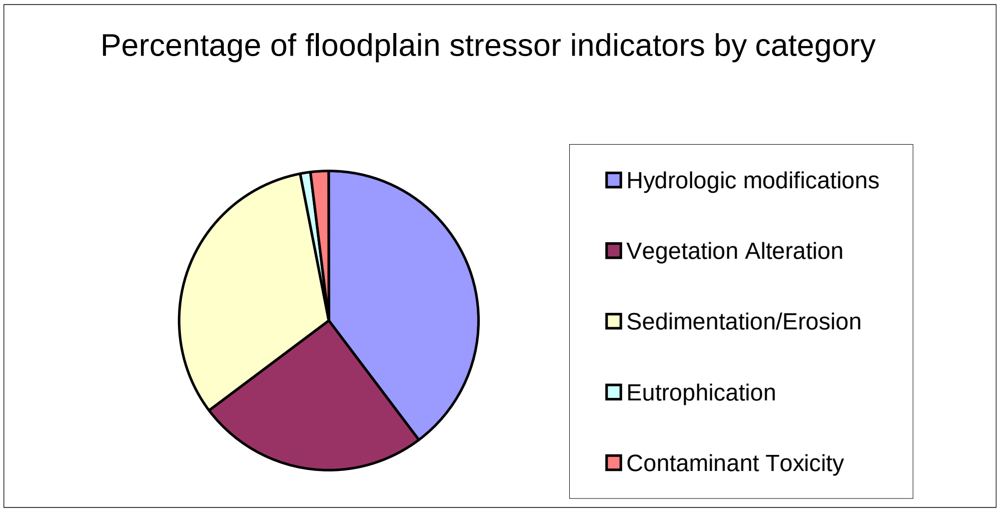

Figure 13. Percentage of stressor indicators within each stressor category found within floodplain areas of assessment sites in the Upper Spring Creek Watershed.

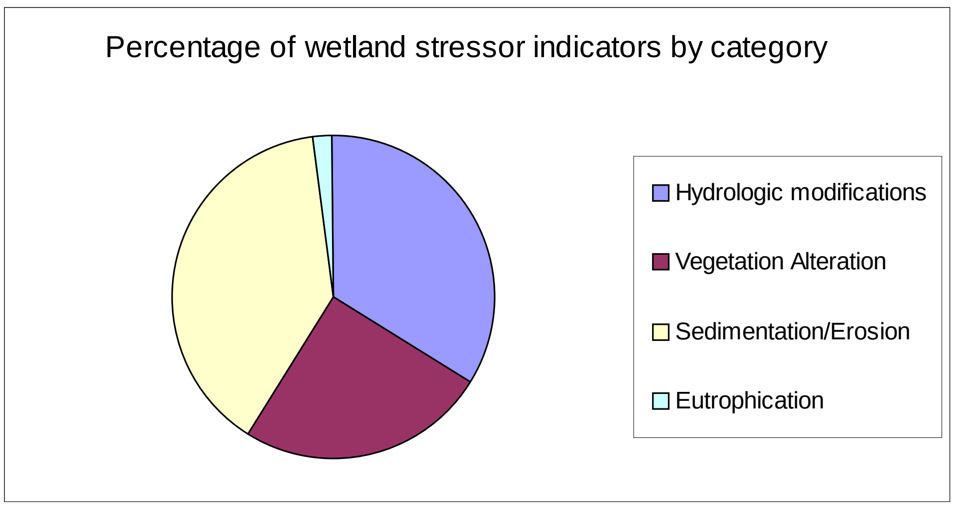

Figure 14. Percentage of stressor indicators within each stressor category found within wetland areas of assessment sites in the Upper Spring Creek Watershed.

Considered together, stressor indicator data from stream channels, floodplains and wetland areas of assessed sites suggest that hydrologic modifications noted within floodplains may be contributing to increased sedimentation and erosion within stream channels. This illustrates the importance of reducing or eliminating new hydrologic modifications within floodplains and ensuring that any new construction occurs outside of delineated floodplains. Similarly, vegetation alteration stressors observed in both floodplain and wetland areas may contribute to the increased percentage of sedimentation and erosion stressors observed within stream channels.

Sites that have been most disturbed by human activities can be identified by examining stressor indicators on a site-by-site basis. Figure 15 summarizes stressors by site, ranking sites from least number of stressor indicators on the left, to the most number of stressor indicators on the right.

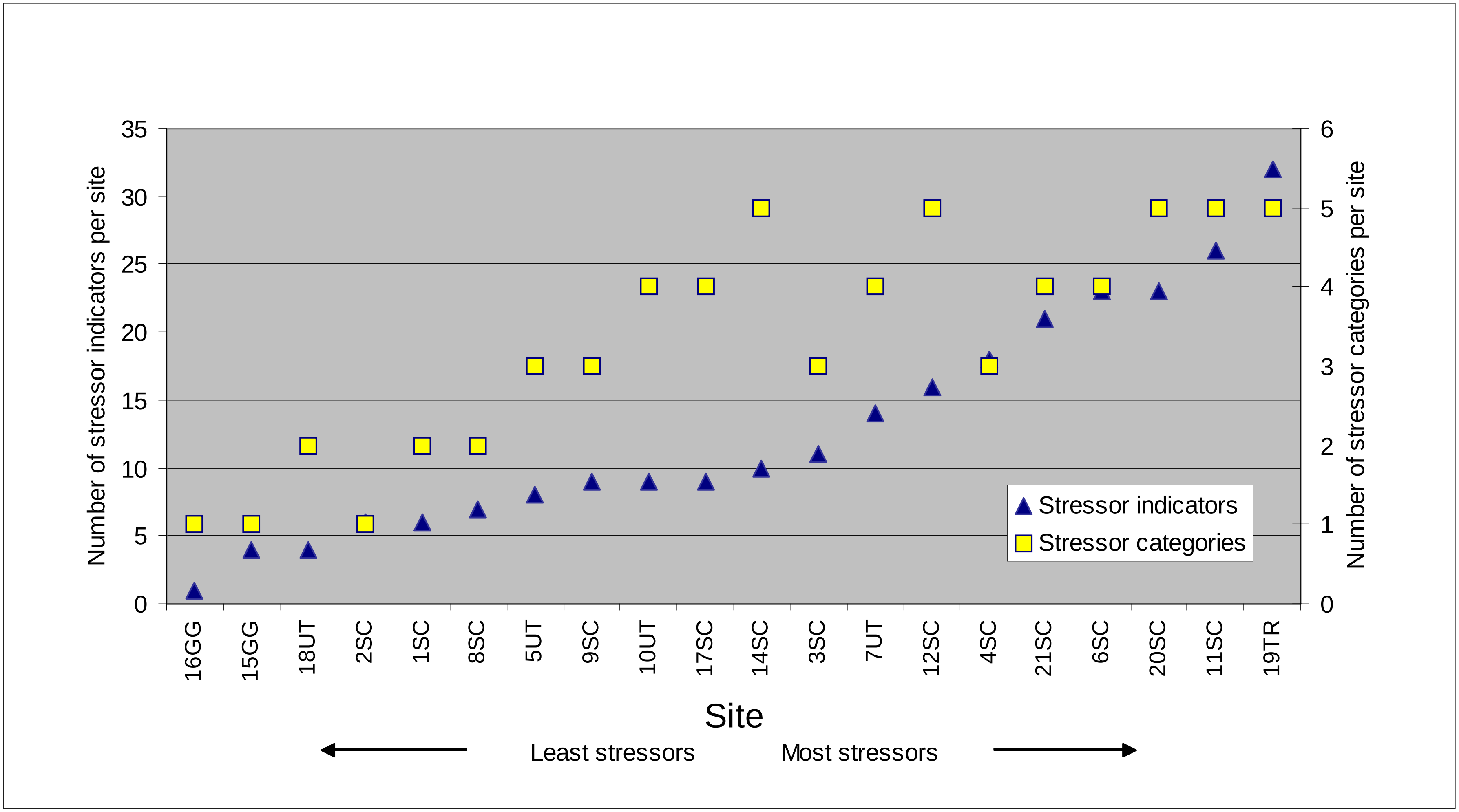

Figure 15. Total number of stressor indicators and categories found in each assessment site for the Upper Spring Creek Watershed.

From Figure 15, natural breaks in of the number of stressor indicators found among sites can be observed, allowing for generalizations to be made of site conditions based on these stressors. General site conditions were as follows:

- Optimal sites: 16GG, 18UT, 15GG
- Suboptimal sites: 1SC, 2SC, 5UT, 8SC
- Marginal sites: 9SC, 10UT, 17SC, 14SC
- Poor sites: 3SC, 4SC, 6SC, 7UT, 11SC, 12SC, 19TR, 20SC, 21SC

Stressor checklist information was not available for sites 13SC and 22SC.

Hydrologic modifications

Using the stream as the benchmark, Figure 16 lists the sites from left to right along the x-axis, showing those with the least number of indicators of hydrologic modification to the highest number of stressor indicators. The number of stressors shown within the floodplain and wetland within the hydrologic modifications category are shown for comparative purposes and as an indication for restoration potential.

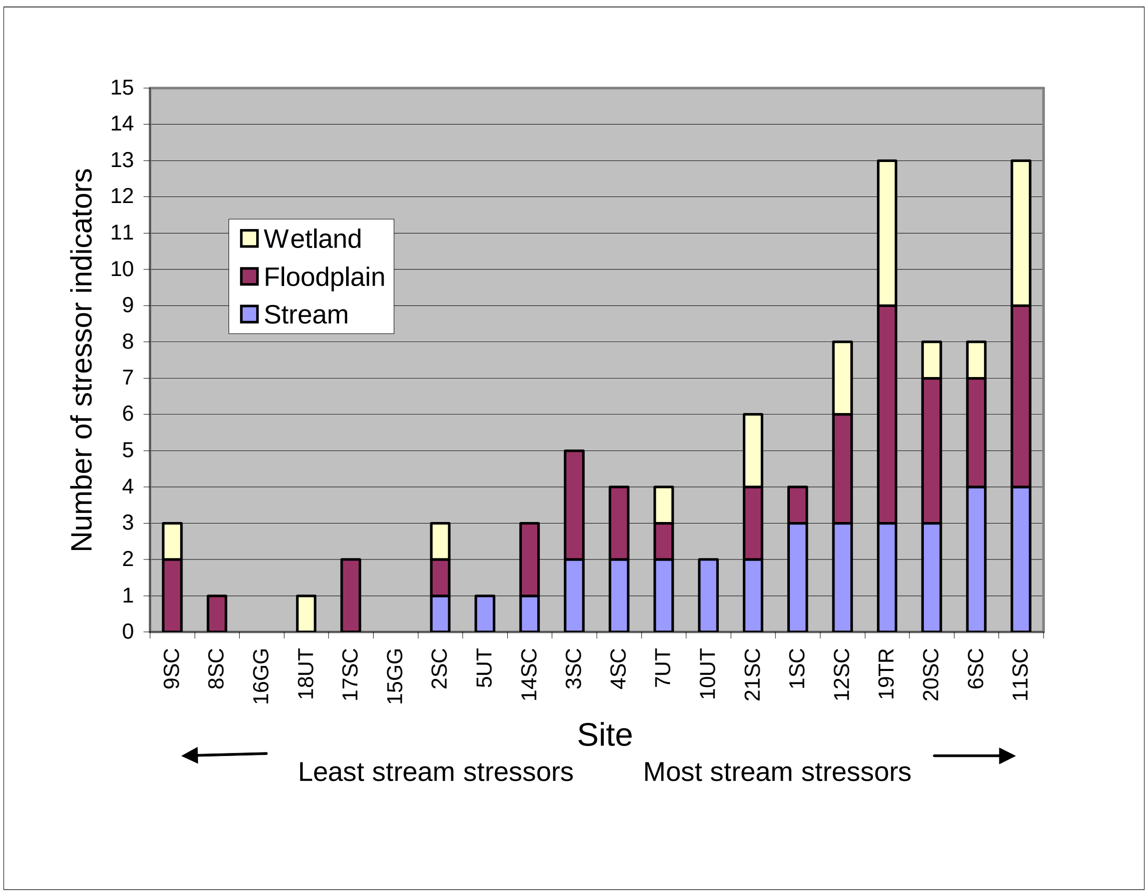

Figure 16. Number of hydrologic modification stressors in riparian areas (wetland, floodplain, stream) of each assessment site in the Upper Spring Creek Watershed.

Sites could be characterized by hydrologic modification stressors as follows:

- Optimal sites: 5UT, 8SC, 15GG, 16GG, 18UT
- Suboptimal sites: 2SC, 9SC, 10UT, 14SC, 17SC
- Marginal sites: 1SC, 3SC, 4SC, 7UT, 21SC
- Poor sites: 6SC, 11SC, 12SC, 19TR, 20SC

Vegetation alteration

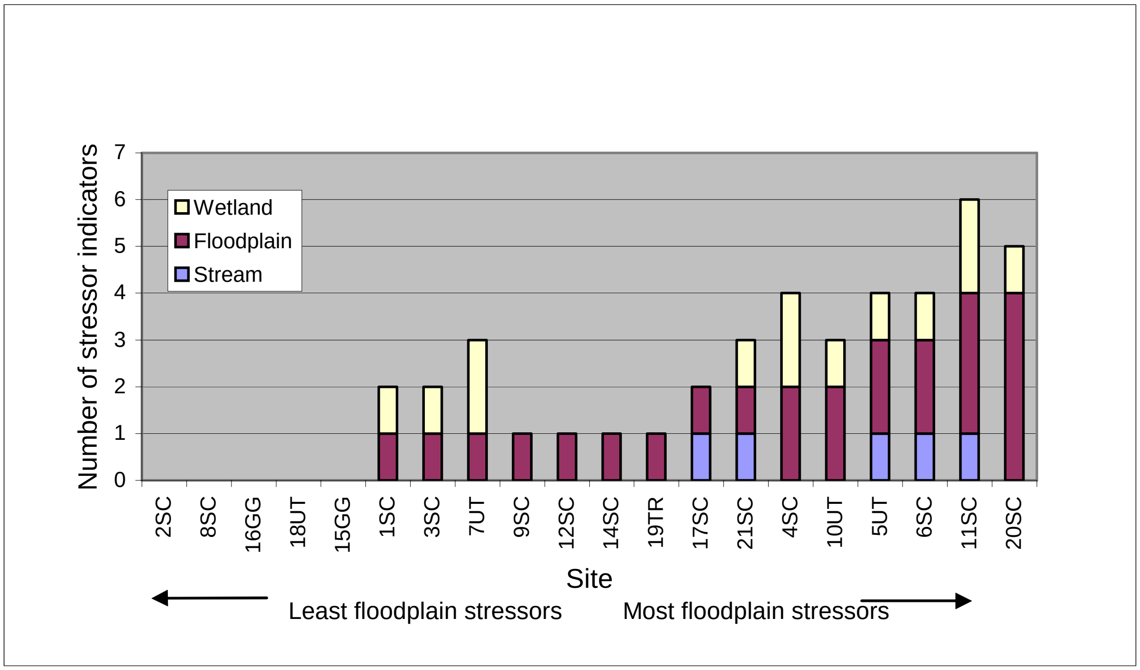

Figure 17. Number of vegetation alteration stressors in riparian areas (wetland, floodplain, stream) of each assessment site in the Upper Spring Creek Watershed.

Sites could be characterized by vegetation alteration stressors as follows:

- Optimal sites: 2SC, 8SC, 15GG, 16GG, 18UT
- Suboptimal sites: 1SC, 3SC, 9SC, 12SC, 14SC, 17SC, 19TR
- Marginal sites: 7UT, 10UT, 21SC
- Poor sites: 4SC, 5UT, 6SC, 11SC, 20SC

Sedimentation and erosion

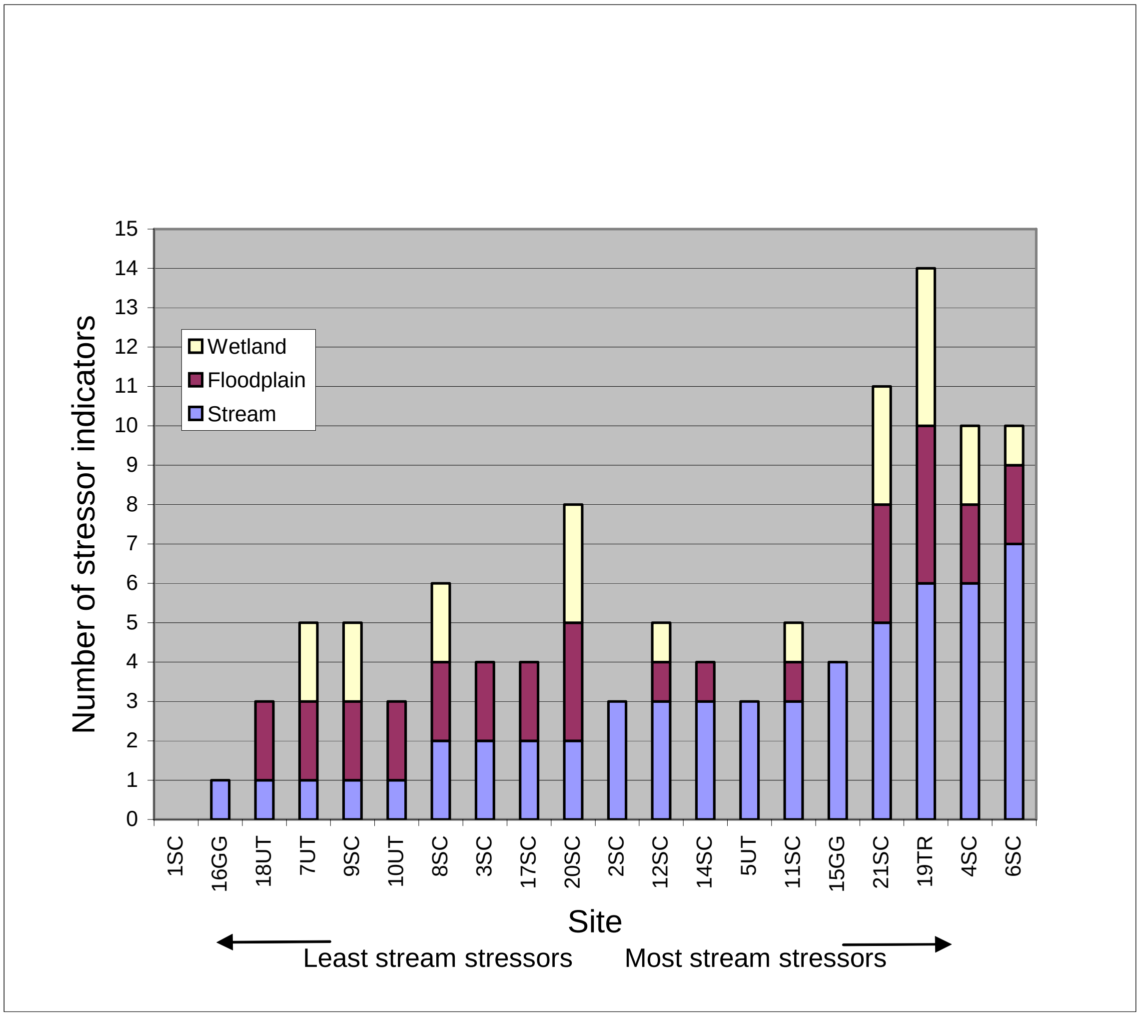

Figure 18. Number of sedimentation and erosion stressors in riparian areas (wetland, floodplain, stream) of each assessment site in the Upper Spring Creek Watershed.

Sites could be characterized by sedimentation and erosion stressors as follows:

- Optimal: Sites 1SC, 16GG
- Suboptimal: Sites 2SC, 3SC, 5UT, 7UT, 9SC, 10UT, 14SC, 17SC, 18UT
- Marginal: Sites 8SC, 11SC, 12SC, 15GG, 20SC
- Poor: Sites 4SC, 6SC, 19TR, 21SC

Eutrophication, Dissolved Oxygen and Contaminant Toxicity

Because these stressor categories had the least number of indicators, they are combined here simply to provide a summary of distribution by site. The sites are sorted from least to most eutrophication stressors in the stream.

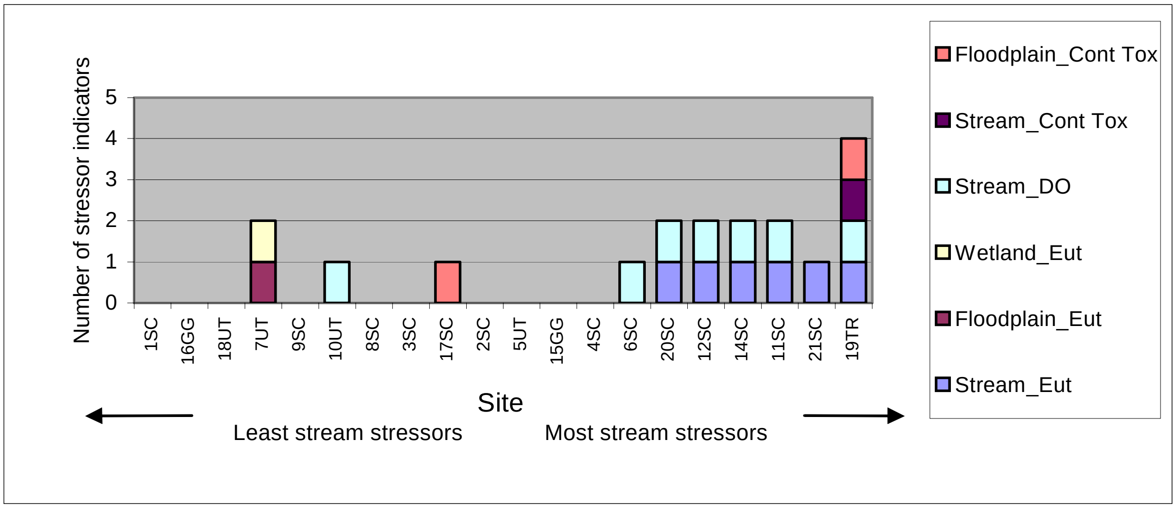

Figure 19. Number of eutrophication (Eut), dissolved oxygen (DO), and contaminant toxicity (Cont Tox) stressors in riparian areas (wetland, floodplain, stream) of each assessment site in the Upper Spring Creek Watershed.

Because of the low frequency of occurrence and the potential for duplicate stressor information, eutrophication, dissolved oxygen, and contaminant toxicity categories were combined to rank assessment sites (Figure 19). Sites could be characterized as follows:

- Optimal sites: 1SC, 2SC, 3SC, 4SC, 5UT, 8SC, 9SC, 15GG, 16GG, 18UT
- Suboptimal sites: 6SC, 10UT, 17SC, 21SC
- Marginal sites: 7UT, 11SC, 12SC, 14SC, 20SC
- Poor sites: 19TR

J. Overall condition of sites: combining assessment variables and stressor information

The overall condition of each site was determined on the basis of which condition category occurred most frequently among the assessment variables for the site. Table 6 summarizes the overall condition of each site, as well as displaying the condition categories for individual assessment variables of each site. Recommendations for protection or restoration were evaluated on a case by case basis for each site based on the site's overall condition.

Sites with the best conditions for brown trout habitat and those with the worst conditions are easily discerned. Several sites do not clearly fall on one end of this spectrum or the other. In general, the worst conditions for brown trout habitat are found in agricultural valleys where riparian buffers are most compromised and streambank fencing does not provide enough width for adequate protective vegetated buffers along the stream. The best sites for brown trout habitat were mountain streams along the steepest slopes of Tussey Mountain and sections of Spring Creek prior to its confluence with Cedar Run where riparian restorative activities and ample perennial stream flow provided outstanding habitat opportunities.

Table 6. Overall conditions of assessment sites in the Upper Spring Creek Watershed considering all assessment variables. Abbreviations of Stream Habitat Assessment (SHA) scores are given in Table 5. Color given to each assessment site indicates the overall condition of the site (green = optimal, yellow = suboptimal, orange = marginal, red = poor). Letters shown for each individual assessment variable for each site indicate the condition of the site for the specific assessment variable (O = optimal, S = suboptimal, M = marginal, P = poor).

Site code	SHA T	SHA 1	SHA 2	SHA 3	SHA 4	SHA 5	SHA 6	SHA 7	SHA 8	SHA 9	SHA 10	% Forest	Buffer score	Incision ratio	Wetland disturbance score	HGM F9	Macroinvertebrate metric score	Total riparian area stressors	Hydrologic modification	Vegetative alteration	Sedimentation and erosion	Eutrophication
1 SC	O	O	O	S	O	O	O	O	O	O	O	--	O	M	--	--	--	S	M	S	O	O
2 SC	S	S	S	S	M	S	O	O	S	S	S	--	S	P	--	--	--	S	S	O	S	O
3 SC	M	O	O	P	M	P	O	P	M	S	S	M	M	M	M	--	--		M	S	S	O
4 SC	M	S	M	P	M	P	S	P	P	S	P	--	S	O	--	--	--	P	M	P	P	O
5 UT	O	O	O	S	S	S	O	O	O	S	O	--	O	M	--	--	--	S	O	P	S	O
6 SC	P	M	M	P	M	P	S	P	S	M	P	--	S	S	--	--	--	P	P	P	P	S
7 UT	P	P	P	P	P	P	P	P	M	P	P	M	P	--	M	--	--	M	M	M	S	M
8 SC	M	M	M	P	M	M	S	M	S	S	O	M	S	--	M	M	--	S	O	O	M	O
9 SC	M	M	P	P	O	P	S	P	S	S	O	M	P	M	P	P	--	S	S	S	S	O
10 UT	M	M	P	P	O	P	S	P	O	O	O	M	M	P	P	--	--	S	S	M	S	S
11 SC	M	M	M	P	M	S	M	P	M	M	P	--	M	0	--	--	--	P	P	P	M	M
12 SC	M	M	M	M	M	M	M	M	S	S	O	--	M	M	--	--	--	M	P	S	M	M
13 SC	S	S	S	S	S	O	M	S	O	M	P	M	M	--	--	--	P	--	--	--	--	--
14 SC	S	O	S	M	M	P	O	M	O	S	O	--	M	P	--	--	--	P	S	S	S	M
15 GG	S	O	O	M	O	M	O	O	S	S	S	--	M	S	--	--	--	O	O	O	M	O
16 GG	O	O	S	O	S	O	O	O	O	O	O	--	O	S	--	--	--	O	O	0	O	O
17 SC	S	O	O	O	O	P	O	P	S	S	M	--	M	M	--	--	--	S	S	S	S	S
18 UT	O	O	S	O	S	O	O	O	S	O	O	--	M	S	--	--	--	O	O	0	S	O
19 TR	S	S	S	S	M	M	S	S	S	S	M	--	P	P	--	--	--	P	P	S	P	P
20 SC	S	O	O	O	O	S	O	O	S	S	M	--	M	M	--	--	--	P	P	P	M	M
21 SC	S	O	O	M	S	O	O	M	S	S	O	--	M	O	--	--	--	P	M	M	P	S
22 SC	S	S	S	O	S	O	S	O	O	S	P	M	P	--	--	--	O	--	--	--	--	--

IV. Recommendations

Objective 1: Protect stream reaches that contribute positively to the water quality of Spring Creek and have the highest potential for providing habitat for wild trout populations.

Several stream reaches in the Upper Spring Creek Watershed located on the slopes of Tussey Mountain are currently in good condition and capable of providing quality habitat for wild trout based on their existing in-stream conditions, current riparian buffers, adjacent land uses, and general absence or low occurrence of human disturbances (1SC, 2SC, 5UT, 15GG, 16GG, and 18UT) (Figure 3). Nearly 60% of the Spring Creek watershed's groundwater recharge occurs within mountain slopes and adjacent mountaintop areas (Parizek 2006). Although mountainous areas within the watershed are less than 20% of the total land base, the function of mountain streams in maintaining base flow in valley streams is disproportionably greater than their area. Consequently, protection of these stream reaches is a high priority for maintaining their current condition and protecting the overall water quality of Spring Creek (Table 7).

In addition to mountain stream reaches, three reaches located within the valley (20SC, 21SC and 22SC) were identified as high-priority for protection (Figure 3). These reaches were identified because quality in-stream habitat in these areas warrants their protection (Table 7).

Thus, a total of nine stream reaches were identified in this study as high-priority for protection.

Table 7. Stream reaches recommended for conservation and protection.

Site code	Justification for inclusion as high priority site for protection.
1SC	Outstanding mountain headwaters to Spring Creek. Hydrologic modification stressors stemming from past impoundments present little or no threat to existing conditions. This stream and tributaries similar to it along Tussey Mountain should be given maximum protection because of their contribution to the water quality of Spring Creek, volume of water they contribute, and riparian habitat they provide.
2SC	This site was identified as having an overall suboptimal condition but has potential for improvement. Because of its intact headwater floodplain, this site is still an asset to the overall quality of this headwater reach of Spring Creek.
5UT	Several tributaries lace this property. Springs are located across the slope. Stream conditions are similar to site 1SC.
15GG	Mature forested riparian buffers exist around Galbraith Gap Run at this site. Groundwater recharge potential is very high here due to headwater floodplain-wetlands found throughout the property.
16GG	Extensive wetlands exist throughout this property surrounding Galbraith Gap Run. Open water-, slope-, and headwater floodplain-wetlands are all part of this riparian complex. Groundwater recharge potential is very high here.
18UT	Multiple types of wetlands are present making this site an important groundwater recharge area. Brook trout were observed on site.
20SC	Property is under private ownership with commitment to conservation of wild trout population. Also, despite numerous adjacent human disturbances (particularly roads), SHA scores suggest existing instream conditions offer high quality wild trout habitat. Private landowners immediately up- and downstream of the assessment site should be encouraged to enhance riparian buffers where they are compromised and to minimize disturbances within the existing vegetated area, particularly mowing or any soil disturbance.
21SC	Riparian zone improvements within the vicinity of the PA Military Museum appear to be improving the overall stream condition. Owners should be informed of successful improvement of stream channel conditions resulting from these actions and encouraged to continue to decrease human disturbances, particularly mowing or any soil disturbance, within the riparian zone. Active erosion and sedimentation problems were observed within the restored area during this assessment. These issues should be addressed to avoid management problems and degradation of the restored area.
22SC	PA DEP's data shows that benthic macroinvertebrate populations at this location are improved relative to < 3.2 km upstream segments with depressed and missing macroinvertebrate populations.

Suggestions for protecting these sites include:

1.A. To the extent possible, properties with streams draining from Tussey Mountain and high-quality wetlands should be protected with conservation easements. Buffers along these streams and wetlands should be a minimum of 10 m and wider if possible, depending upon slope and surrounding land use.

1.B. Ridge and riparian overlay districts should be developed and applied by municipalities to protect streams from encroaching residential development and to minimize hydrologic modifications and vegetation alterations caused by construction in the vicinity of these streams.

1.C. Existing and future roads in the vicinity of Upper Spring Creek and its tributaries should be enrolled in the dirt and gravel road program for pollution prevention measures.

1.D. Landowners of mountain slope forests should be encouraged to enroll in the Forest Stewardship Program through the Department of Conservation of Natural Resources (http://paforeststewards.cas.psu.edu/). This program provides technical assistance and cost share incentives to develop a Forest Stewardship Plan and to install forest stewardship practices. Land owners of high-quality forested properties could also protect their properties with a conservation easement through ClearWater Conservancy.

1.E. ClearWater Conservancy will provide educational materials to property owners advising them of the conservation value of their property and opportunities for participation in conservation programs including conservation easements, riparian plantings, and any tax incentive programs for conservation management of properties. ClearWater Conservancy can provide support for naming unnamed tributaries, mapping natural resources, invasive species education and management, finding resources for protection, and nominations for conservation awards, as appropriate.

Objective 2: Restore riparian buffers with native plants that can be easily maintained by landowners.

The chief threat to the water quality of the Upper Spring Creek Watershed stream corridors and their ability to sustain wild trout populations is the absence of riparian forests within the Spring Creek valley. While improvement was generally noted throughout the study area, there remains an overall absence of forest cover and native herbaceous plant communities in many areas. Furthermore, when riparian buffers were present in many agricultural and recreation areas, these buffers were narrow and seriously compromised. The establishment and protection of buffers can, in part, be addressed through simultaneous efforts of 1) landowners that voluntarily restrict mowing and farming practices in riparian areas and re-vegetate with native tree, shrub, and/or herbaceous species within a designated width of the stream on their properties, 2) organizations such as ClearWater Conservancy, Centre County Conservation District, PA DEP, and USDA Natural Resources Conservation Service that enroll willing riparian landowners into cost-share programs to make improvements to properties and management practices for stream protection, and 3) municipal governments to establish a riparian protection overlay zone for new developments occurring near riparian areas. Priority sites for riparian buffer improvements are listed and described in Table 8.

Suggestions for protecting these valley sites include:

> 2.A. Landowners in agricultural and residential areas should be encouraged to seek agency support (Centre County Conservation District, PA DEP, USDA Natural Resources Conservation Service, and non-governmental organizations such as ClearWater Conservancy) for obtaining streambank fencing where appropriate and planting riparian trees, shrubs, and herbaceous plants.
>
> 2.B. Landowners in agricultural areas should be encouraged to increase the distance between their streambank fencing and the streams to include a wider buffer (>10 m minimum) to further protect stream from agricultural activities. A buffer of > 15 m on each side of the stream, dependent upon the slope and surrounding land use, is preferred.
>
> 2.C. Landowners should minimize disturbance in riparian areas (streams, wetlands and floodplains) to prevent colonization by invasive plant species. Steps to control invasive plants that are on the state list of noxious plants should be taken to prevent the spread of these plants along the stream channel.

Table 8. Agricultural and recreational sites with outstanding opportunities for riparian buffer improvements.

Site code	Justification for riparian buffer restoration
4SC, 6SC, 7UT, 8SC, & 9SC	Wide floodplain with ample opportunity for native plantings and invasive species removal. Streambank fencing improvements may be necessary if livestock are introduced to the adjacent agricultural field.
10UT	The tributary traversing this site has some riparian buffer but could be substantially enhanced through removal of invasive species and addition of mature vegetation.
11SC	Landowner has shown commitment to improvements through existing engagement with ClearWater Conservancy. Great restoration potential exists for in-stream enhancements, additional buffer plantings, and invasive species management.
12SC, 13SC & 14SC	Public property with outstanding demonstration opportunity. Wetlands on this property have been impacted by current and past land uses. Wetlands should be restored and buffered to improve water quality of Spring Creek.

Objective 3: Enhance stream channel sinuosity and restore floodplain wetlands to protect the stream channel from incision.

Spring Creek has become channelized and incised through the agricultural valley where it parallels Route 322 in a number of locations because of riparian vegetation removal and changes to stream hydrology from increased stormwater runoff over time. Changes in the hydrology of floodplain wetlands near the stream have led to the loss of these wetlands and, thus, loss of their important functions in the riparian system. Improvements to stream sinuosity and restoration of floodplain wetlands would protect stream quality from further erosion during times of high flow. This restoration could include both simple and complex improvements. Complex improvements will require further feasibility study and engineering considerations.

Specific suggestions for these improvements include:

> 3.A. Stream channel sinuosity could be improved in select locations including Eugene A. Fasick Memorial Park and the State College Elks Country Club.
>
> 3.B. Floodplain wetlands could be restored in public areas along the stream in Eugene A. Fasick Memorial Park and the tributary in Blue Spring Park.

Table 9. Assessment sites that have channelized stream sections and are located in areas with opportunities for stream channel improvements.

Site code	**Justification for stream channel and floodplain wetland improvements**
11SC	Motivated private land owner and outstanding site visibility. Site is located within stream section that is designated as impaired.
12SC, 13SC & 14SC	Public property and outstanding site visibility. Site is located within stream section that is designated as impaired.

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Appendices

Appendix A. SWR Protocol Used for Field Assessment

General Site Info	
Date	
Investigators	
Plot Identification (#)	
State	
County	
Municipality	
River Basin	
Watershed Name	
Stream Name	
GPS Coordinates (N)	
(E)	
Strahler Order of stream	
Photographs (number taken;mark on map)	
Is the site considered a reference standard site?	
Dominant Stream Class (rapid, run, pool, backwater)	
Is the site a beaver impoundment? [1]	

Describe condition of land-use adjacent to stream within each width class

Land use (RIGHT side of stream)

Cover Type:	**Land-use Width (meters)**				
	100-300m	30-100	10-30	3-10	0-3
Natural Forest	6	6	6	6	6
Shrubs/ Sapling	4	4	4	4	4
Perennial Herb	2	2	2	2	2
Other	0	0	0	0	0

Land use (LEFT side of stream)

Cover Type:	**Land-use Width (meters)**				
	100-300m	30-100	10-30	3-10	0-3
Natural Forest	6	6	6	6	6
Shrubs/ Sapling	4	4	4	4	4
Perennial Herb	2	2	2	2	2
Other	0	0	0	0	0

[1] Use Beaver impoundment habitat assessment sheet

Sketch Map (10 m squares)

State___ Watershed___________ Plot # ___ Initials ____

ADD STREAM FLOW ARROW, MARK PHOTO POINTS, CODE HABITAT POLYGONS, DRAW NORTH ARROW

downstream

plot profile perpendicular to stream (looking downstream)

Riparian Classification
Record the dominant land cover type of each patch in Table 1, using codes defined in table 2. Identify polygons on sketch map using map codes provided in Tables 1 and 2. Additional patch types may be added in blank boxes if necessary.

Riparian Area classification - Levee (if present), Floodplain, Upland Buffer, Wetland (if present)

Is there a levee present?	**YES / NO**
Is there a wetland present?	**YES / NO**

Table 1.

Patch Type	Map Code	Left	Right
Levee	A		
Floodplain Wetland	B		
Non-wetland Floodplain	C		
Upland non-floodplain	D		
Wetland #1	E		
Wetland #2	F		
	G		
	H		

Table 2. Map Codes.

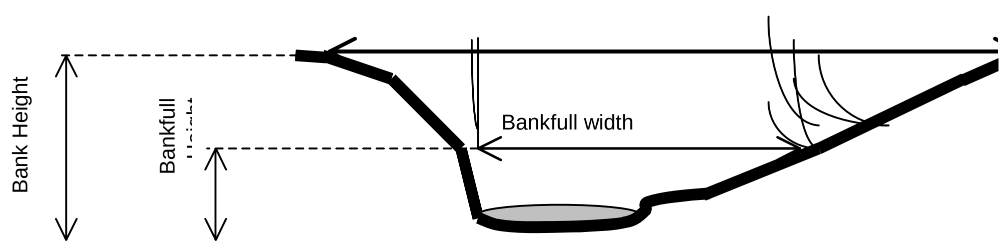
Deciduous (d, >70%), Mixed (m, 30-70%), Coniferous (c, >70%), Non-forest (x, <30%)

Cover type	Cover Type	Forest Type
Mature forest (>50yr, >30cm dbh trees dominate)	1	d, m, or c
Pole stage forest (25-50 yr, 10-30 cm dbh trees dominate	2	d, m, or c
Successional forest (5-25 yr, <10 cm dbh trees dominate)	3	d, m, or c
Conifer plantation	4	c
Recently harvested forest (e.g., clear cut, regeneration harvest)	5	d, m, or c
Dead and dying trees dominate	6	d, m, or c
Brush/ shrub (< 30% tree canopy cover)	7	x
Perennial herbaceous: (1) lawn, (2) pasture, (3) recreational fields, (4) meadows, (5) emergents (6) other	8	x(#)
Annual crop (e.g., corn, soybeans,…)	9	x
Low-density residential (i.e. abundant gardens, lawns, bushes, woods)	10	x
High-density residential (I.e. sidewalks, small 1/4 acre lots, dominated by impervious surface)	11	x
Urban (i.e., combinations of dense residential, commercial, industrial)	12	x

Bankfull Parameters (see diagram)
Take measurements (in cm) at center point, upper 50m and lower 50m of stream reach. Not applicable for beaver impoundments.

Is there a defined channel?	**YES / NO**
Is the channel backed-up by a downstream dam?	**YES / NO**
Is the channel incised?	**YES / NO**

	1(cm)	**2(cm)**	**3(cm)**	**Avg.**
Bankfull Height (thalweg to top of point bar or other indicator of near-annual flow)				
Bankfull Width (width of channel from bank to bank using bankfull indicators used above for bankfull depth)				
Floodprone Height (2 x bankfull height)				
Bank Height (distance from thalweg to top of bank)				



Wetland Classification (HGM/NWI)
For the floodplain (if it is a wetland) and each additional wetland patch in the sketch map record the wetland classification. If wetland is riverine designate Headwater Floodplain (HF) or Mainstem Floodplain (MF).
Enter in the appropriate box the map codes (from Table 2) identifying each wetland present.

Left side (facing downstream)							
	Depression	Slope	Fringe	Mineral Flat	Organic Flat	Riverine (HF, MF)	Other (write in)
Forested							
Scrub/shrub							
Emergent							
Aquatic Bed							
Open Water							

Right side (facing downstream)							
	Depression	Slope	Fringe	Mineral Flat	Organic Flat	Riverine (HF, MF)	Other (write in)
Forested							
Scrub/shrub							
Emergent							
Aquatic Bed							
Open Water							

Hydrology, Wetland, and Soils Assessment
Indicators of hydrologic conditions are arranged in hierarchical ranking from wettest to dryest. Assess floodplain wetlands and any other wetlands present in the plot. Not applicable for beaver impoundments.

Indicators of EXTREMELY wet conditions (one primary indicator (in bold) or two secondary indicators):

Wetland ID:						
Hydrology	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Dominated by obligate hydrophytes						
Visual observation of soil saturation near surface						
Visual observation of inundation not due to recent precip. or flooding						
Sulfidic material (detection of rotten egg smell)						
Soil						
Gleyed conditions in top 10 cm						
Histosol (organic soil, peat, muck) - organic matter dominant to a depth of ___cm below litter layer						
Presence of redox concentrations						

Indicators of MODERATELY wet conditions (one primary indicator (in bold) or two secondary indicators):

Hydrology	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Water-borne sediment deposits						
Surface drainage patterns						
Dominated by obligate and FACW						
Inundated surface due to recent precipitation or flooding						
Oxidized root channels						
Water-stained leaves						
Morphological plant adaptations						
Soil						
Chroma of 2 or less (mottles present - YES / NO)						
Listed hydric mineral soil. peat, or muck (NRCS soil survey)						
Presence of redox concentrations						

Indicators of SOMEWHAT wet conditions (one primary indicator (in bold) or two secondary indicators):

Hydrology	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Water marks						
Drift lines						

ASC - Stressor Checklist Date______________ **Watershed name _____________ Site ID__________**	Total # of stressor categories/items: ____/____	Total # of stressor categories/items: ____/____	**<30m**	**>30-100 m**	Total # of stressor categories/items: ____/____	**<30m**	**>30-100 m**	**Comments:**
enter 1 if present 0 if not present. If present check distance category.								
Category: Hydrologic Modification	**STREAM**	**FLOODPLAIN**			**OTHER WETLANDS**			
channelized								
tile drain (outfalls)								
ditch (outfalls)								
ditching in riparian corridors								Land use at ditch origin:
artificial levee - flood control, spoil berms								
impounded (by weir/dam)								Type (0=beaver, 1=human):
filling,grading, dredging								Distance upstream/downstream (m):
dominance of dead/dying trees (if beaver=0)								Pool area (ha):
water withdrawal (off-take)								Length of channel impounded (m):
stormwater inputs/culverts								
point source (non-stormwater)								
excavation (sand, gravel, topsoil removal)								
road bed/crossings (bridges, fill with culverts, road, railroad)								Type (write in): Footprint area (ha):
other:								
TOTAL ITEMS:								

Category: Sedimentation/Erosion	STREAM	FLOODPLAIN	<30m	>30-100 m	OTHER WETLANDS	<30m	>30-100 m	
sediment deposits/plumes (bottom accretion; EPA SHA #4. ?15 high gradient, ?10 low gradient. Coastal Plain (CP) SHA #2 ? 15								
channel incision								refer to bankfull width measurements:
excessively eroding bank slopes (EPA SHA #8 ?5 either bank. CP SHA #4 ? 8)	L:							
	R:							
urban/road stormwater inputs/culverts								
channel flow status (EPA SHA#5 ?15 high gradient, ?10 low gradient, N/A intermittent. CP SHA #3 ? 10)								
active/recently active adjacent construction, plowing, heavy grazing, or forest harvesting.								
siltlines on ground, vegetation, or stream bottom								
Other:								
TOTAL ITEMS:								

Category: Dissolved Oxygen	STREAM	FLOODPLAIN			OTHER WETLANDS			
excessive density of aquatic plants or algal mats								
excessive deposition or dumping of organic waste (e.g. leaves, grass clippings)								
direct discharges of organic wastewater or material (e.g. milkhouse waste, food-processing waste, other wastewater								
other:								
TOTAL ITEMS:								

Category: Contaminant Toxicity	STREAM	FLOODPLAIN			OTHER WETLANDS			
obvious spills, discharges,plumes,odors								
fish and wildlife impacts (e.g. tumors, fungi, abnormalities)								
adjacent industrial sites, proximity of railroad								
severe vegetation stress								
other:								
TOTAL ITEMS:								

Category: Vegetation Alteration	STREAM	FLOODPLAIN	<30m	>30-100 m	OTHER WETLANDS	<30m	>30-100 m	
mowing								
grazing (livestock)								
tree harvesting/cutting (>50% canopy, woody vegetation within past 5 yrs)								
brush cutting, mechanized removal of shrubs/saplings								
excessive herbivory (wildlife)								
chemical defoliation (utility lines, road side, right of way)								
crops (annual row crops)								
forest plantations								
aquatic weed control (mechanical or herbicide)								
dominant presence of exotic or aggressive plant species (e.g. uniform stands of exotic or aggressive species).								% Cover (circle one): 5-20%, >20-50%, >50%
removal of dead and down woody vegetation/debris								
other:								
TOTAL ITEMS:								

Category: Eutrophication	STREAM	FLOODPLAIN			OTHER WETLANDS			
direct discharges from agricultural feedlots, manure pits, aquaculture etc.								
direct discharges from septic or sewage treatment systems								
Heavy or moderately heavy formation of algal mats								
other:								
TOTAL ITEMS:								

Category: Acidification	**STREAM**	**FLOODPLAIN**	**<30m**	**>30-100 m**	**OTHER WETLANDS**	**<30m**	**>30-100 m**	
acid mine drainage discharges								
adjacent mined land/spoil piles								
ancillary information (yes or no)								known acid deposition region
								excessively clear water
								absence of expected biota
other:								
TOTAL ITEMS:								

Category: Turbidity (if high concentration, check both boxes)	**STREAM**	**FLOODPLAIN**			**OTHER WETLANDS**			
moderate concentration of suspended soilds in water column, obvious sediment plumes								
other:								
TOTAL ITEMS:								

Category: Thermal Alteration (e.g., power plant or industrial heated discharges, if high temperature, check both boxes)	**STREAM**	**FLOODPLAIN**			**OTHER WETLANDS**			
significant increase in water temperature								
recent human-induced canopy removal								
other:								
TOTAL ITEMS:								

Category: Salinity	**STREAM**	**FLOODPLAIN**			**OTHER WETLANDS**			
obvious increase in concentration of dissolved salts								
other:								
TOTAL ITEMS:								

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #________ RIVERMILE________	STREAM CLASS	
LAT ____________ LONG ____________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE ______ TIME ______ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—HIGH GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ___________

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (FRONT)

STREAM NAME	LOCATION	
STATION #________ RIVERMILE________	STREAM CLASS	
LAT ____________ LONG ____________	RIVER BASIN	
STORET #	AGENCY	
INVESTIGATORS		
FORM COMPLETED BY	DATE ________ TIME ________ AM PM	REASON FOR SURVEY

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/ Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than <20% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 20-50% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 50-80% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

HABITAT ASSESSMENT FIELD DATA SHEET—LOW GRADIENT STREAMS (BACK)

Parameters to be evaluated broader than sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score ______

Appendix B. Summary of water quality data collected at the Spring Creek Watershed Community's Water Resources Monitoring Project's "Spring Creek Upper" (SPU) monitoring station (1999 – 2006) (Water Resources Monitoring Committee 2003; Water Resources Monitoring Committee, unpublished data).

	YEAR						
Constituent	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Total Nitrate (MG/L)	2.52	2.25	2.41	2.29	2.06	2.55	2.79
Total Orthophosphate (MG/l)	0.014	0.060	0.013	0.017	0.012	0.011	0.000
Chloride (MG/L)	15	14	16	16	17	20	18
Total Suspended Solids (MG/L)	31	14	13	12	9	4	4

Appendix C. SWR field data.

Stream habitat assessment scores

Site Name	Stream km	SHA 1	SHA 2	SHA 3	SHA 4	SHA 5	SHA 6	SHA 7	SHA 8_LB	SHA8_RB	SHA 9 _LB	SHA 9_RB	SH 10_LB	SHA 10_R	SHA T
1-FS-1	40.19	20	20	11	20	20	15	20	10	10	10	10	10	10	186
1-FS-2	40.05	10	10	14	7	13	18	16	7	5	6	6	5	5	122
SWR 44 Rt 322 Tussey	39.12	15	15	0	13	0	16	0	4	4	7	7	5	5	91
4CF	38.5	10	6	0	8	0	13	0	2	2	5	5	1	1	53
6c-GP-1	38.08 (0.73 T)	18	16	11	11	11	20	18	8	8	6	6	10	10	153
7-O-1	38.02	5	5	0	5	0	13	0	6	6	3	3	1	1	48
SWR 23 Dreibilbis	36.7	1	0	0	0	1	1	0	3	3	2	2	2	2	17
SWR 21 NBB up	36.35	1	1	0	16	0	13	0	6	6	6	6	9	9	73
SWR 9 NBB HW FP	36.27	8	5	3	5	6	11	5	5	5	6	6	8	8	81
SWR 43 Tussey trib	36.0 (0.19 T)	5	0	2	17	3	13	0	8	8	8	8	8	8	88
14-SCE-1	35.6	5	5	2	5	10	8	2	7	7	5	5	2	2	65
DEP 21.1	34.9														
20.5-HT-1	34.5	8	6	9	8	7	11	5	6	6	6	6	8	8	94
20.5-HT-2	34.37	17	13	6	9	1	18	6	8	8	5	5	9	9	114
24-AR-1	34.274 (T)	20	13	20	13	20	20	20	10	10	10	10	10	10	186
23-AC-1	34.274 (T)	19	14	19	13	15	19	19	6	7	9	9	10	10	169
19-COP-1	34.1	18	18	18	15	0	16	0	6	8	4	8	5	2	118
23a-AC-1	33.56 (T)	16	15	9	11	6	20	18	7	3	6	6	5	9	131
32-WK-1	32.77 (T)	11	10	13	8	8	12	12	7	5	7	4	4	1	102
40-ND-1	32.04	16	16	16	16	11	15	20	6	6	6	6	3	3	140
44-PHM-1	31.44	16	16	8	10	15	16	11	5	5	5	5	8	8	128
DEP 18.6	29.93														

Standardized SHA scores

Site Name	Stream km	SHA T Std	SHA 1_std	SHA 2_std	SHA 3_std	SHA 4_std	SHA 5_std	SHA 6_std	SHA 7_std	SHA 8 T	SHA 9 T	SHA 10 T
1-FS-1	40.19	0.93	1	1	0.55	1	1	0.75	1	1	1	1
1-FS-2	40.05	0.61	0.5	0.5	0.7	0.35	0.65	0.9	0.8	0.6	0.6	0.5
SWR 44 Rt 322 Tussey	39.12	0.455	0.75	0.75	0	0.65	0	0.8	0	0.4	0.7	0.5
4CF	38.5	0.265	0.5	0.3	0	0.4	0	0.65	0	0.2	0.5	0.1
6c-GP-1	38.08 (0.73 T)	0.765	0.9	0.8	0.55	0.55	0.55	1	0.9	0.8	0.6	1
7-O-1	38.02	0.24	0.25	0.25	0	0.25	0	0.65	0	0.6	0.3	0.1
SWR 23 Dreibilbis	36.7	0.085	0.05	0	0	0	0.05	0.05	0	0.3	0.2	0.2
SWR 21 NBB up	36.35	0.365	0.05	0.05	0	0.8	0	0.65	0	0.6	0.6	0.9
SWR 9 NBB HW FP	36.27	0.405	0.4	0.25	0.15	0.25	0.3	0.55	0.25	0.5	0.6	0.8
SWR 43 Tussey trib	36.0 (0.19 T)	0.44	0.25	0	0.1	0.85	0.15	0.65	0	0.8	0.8	0.8
14-SCE-1	35.6	0.325	0.25	0.25	0.1	0.25	0.5	0.4	0.1	0.7	0.5	0.2
DEP 21.1	34.9	0.53	0.6	0.5	0.5	0.5	0.9	0.3	0.6	0.9	0.3	0.2
20.5-HT-1	34.5	0.47	0.4	0.3	0.45	0.4	0.35	0.55	0.25	0.6	0.6	0.8
20.5-HT-2	34.37	0.57	0.85	0.65	0.3	0.45	0.05	0.9	0.3	0.8	0.5	0.9
24-AR-1	34.274 (T)	0.93	1	0.65	1	0.65	1	1	1	1	1	1
23-AC-1	34.274 (T)	0.845	0.95	0.7	0.95	0.65	0.75	0.95	0.95	0.65	0.9	1
19-COP-1	34.1	0.59	0.9	0.9	0.9	0.75	0	0.8	0	0.7	0.6	0.35
23a-AC-1	33.56 (T)	0.655	0.8	0.75	0.45	0.55	0.3	1	0.9	0.5	0.6	0.7
32-WK-1	32.77 (T)	0.51	0.55	0.5	0.65	0.4	0.4	0.6	0.6	0.6	0.55	0.25
40-ND-1	32.04	0.7	0.8	0.8	0.8	0.8	0.55	0.75	1	0.6	0.6	0.3
44-PHM-1	31.44	0.64	0.8	0.8	0.4	0.5	0.75	0.8	0.55	0.5	0.5	0.8
DEP 18.6	29.93	0.67	0.7	0.7	0.8	0.7	0.9	0.6	0.8	0.8	0.5	0.2

Land cover within 1-km radius of sites

Site Name	Stream km	LAT	LON	WATER_	FOREST_	TRANS_	PERENNIAL_	ANNUAL_	BARREN_	SUBURBAN_	URBAN_	% forest std
1-FS-1	40.19	40.7820	77.7076									0.00
1-FS-2	40.05	40.7869	77.7140									0.00
SWR 44 Rt 322 Tussey	39.12	40.7867	-77.7166	0.03	32.4	7.84	10.41	48.03	0.26	0.95	0.09	0.32
4CF	38.5	40.7875	77.7234									0.00
6c-GP-1	38.08 (0.73 T)	40.7811	77.7226									0.00
7-O-1	38.02	40.7856	77.7285									0.00
SWR 23 Dreibilbis	36.7	40.7825	-77.7429	0.09	26.55	9.77	17.12	45.32	0.49	0.4	0.26	0.27
SWR 21 NBB up	36.35	40.7816	-77.7475	0.2	21.56	14.47	22.37	39.67	0.37	1.07	0.29	0.22
SWR 9 NBB HW FP	36.27	40.7809	-77.7467	0.14	25.8	13.49	21.07	37.82	0.4	1.01	0.26	0.26
SWR 43 Tussey trib	36.0 (0.19 T)	40.7794	-77.7508	0.35	22.57	16	23.21	34.68	0.46	2.31	0.43	0.23
14-SCE-1	35.6	40.7813	77.7589									0.00
DEP 21.1	34.9	40.7805	-77.7695	0.58	16.83	12.77	18.8	24.19	1.15	21.91	3.78	0.17
20.5-HT-1	34.5	40.7812	77.7642									0.00
20.5-HT-2	34.37	40.7806	77.7696									0.00
24-AR-1	34.274 (T)	40.7703	77.7629									0.00
23-AC-1	34.274 (T)	40.7749	77.7683									0.00
19-COP-1	34.1	40.7804	77.7730									0.00
23a-AC-1	33.56 (T)	40.7751	77.7769									0.00
32-WK-1	32.77 (T)	40.7760	77.7863									0.00
40-ND-1	32.04	40.7799	77.7928									0.00
44-PHM-1	31.44	40.7834	77.7981									0.00
DEP 18.6	29.93	40.7926	-77.7983	0.03	18.13	11.04	17.76	16.52	5.51	25.54	5.48	0.18

Adjacent land use (buffer)

Site Name	Stream km	100-300m	30-100	10-30	3-10	0-3	Total right	100-300m	30-100	10-30	3-10	0-3	Total left	Buffer Score	Buffer Score std
1-FS-1	40.19	**14**	**12**	**10**	**8**	**6**	**50**	**14**	**12**	**10**	**8**	**6**	**50**	100	1
1-FS-2	40.05	0	4	6	4	2	**16**	10	8	6	8	6	**38**	54	0.54
SWR 44 Rt 322 Tussey	39.12						**0**	12	9	6	4	2	**33**	33	0.33
4CF	38.5	**0**	**0**	**0**	**0**	**2**	**2**						**0**	2	0.71
6c-GP-1	38.08 (0.73 T)	14	12	10	8	6	**50**	10	8	6	4	2	**30**	80	0.8
7-O-1	38.02	0	0	0	0	2	**2**						**0**	2	0.57
SWR 23 Dreibilbis	36.7						**0**	**0**	**0**	**0**	**0**	**2**	**2**	2	0.02
SWR 21 NBB up	36.35												**0**	0	0
SWR 9 NBB HW FP	36.27						**0**	14	12	10	8	6	**50**	50	0.5
SWR 43 Tussey trib	36.0 (0.19 T)						**0**	13	9	7	7	6	**42**	42	0.42
14-SCE-1	35.6	0	0	0	0	2	**2**						**0**	2	0.43
DEP 21.1	34.9						**0**	0	0	8	8	4	**20**	20	0.2
20.5-HT-1	34.5	0	4	6	4	2	**16**	0	0	10	8	6	**24**	40	0.4
20.5-HT-2	34.37	0	0	10	8	6	**24**						**0**		0.2
24-AR-1	34.274 (T)	14	12	10	8	6	**50**	10	8	6	4	4	**32**	82	0.82
23-AC-1	34.274 (T)	11	12	10	8	6	**47**						**0**	47	0.29
19-COP-1	34.1	0	0	0	0	4	**4**								0.29
23a-AC-1	33.56 (T)	10	9	8	6	4	**37**	0	0	0	0	2	**2**	39	0.39
32-WK-1	32.77 (T)	0	0	0	0	4	**4**	0	0	0	6	6	**12**	16	0.16
40-ND-1	32.04	0	0	6	4	5	**15**	0	0	3	4	3	**10**	25	0.25
44-PHM-1	31.44	0	0	10	8	4	**22**	0	0	0	4	5	**9**	31	0.31
DEP 18.6	29.93						**0**	0	0	0	0	2	**2**	2	0.02

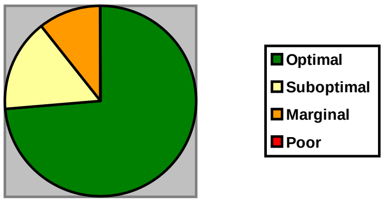
Bankful measures

Site Name	Stream km	BFH 1	BFH 2	BFH 3	BFH avg	BFW 1	BFW 2	BFW 3	BFW avg	FPH 1	FPH 2	FPH 3	FPH avg	BH 1	BH 2	BH 3	BH avg	BFW/D	Incision ratio std
1-FS-1	40.19	14.5	14	28.5	19	378	170	322	290	29	28	57	38	25	28	58.5	37.2	15.3	0.511
1-FS-2	40.05	16	9.5	12	12.5	69	60	57	62	32	19	24	25	32	24	35.5	30.5	4.96	0.410
SWR 44 Rt 322 Tussey	39.12																		
4CF	38.5	49	37	40	42	133	154	184	157	98	74	80	84	59.5	55	57	57.2	3.74	0.735
6c-GP-1	38.08 (0.73 T)	12	12	20	14. 7	240	180	230	217	24	24	40	29.3	21.5	26	35	27.5	14.8	0.533
7-O-1	38.02	30	30	23.5	27.8	118	118	132	123	60	60	67	62.3	42	59.5	34	45.2	4.41	0.616
SWR 23 Dreibilbis	36.7																		
SWR 21 NBB up	36.35																		0.5
SWR 9 NBB HW FP	36.27																		
SWR 43 Tussey trib	36.0 (0.19 T)																		0.3
14-SCE-1	35.6	41.2	45	53	46.4	237	198	177	204	82	90	106	92. 7	53	52	77	60. 7	4.4	0.765
DEP 21.1	34.9																		0.5
20.5-HT-1	34.5	33	31	28	30. 7	490	480	330	433	66	62	54	60. 7	44	43	46	44.3	14.1	0.692
20.5-HT-2	34.37	36.5	28	46	36.8	270	420	420	370	73	56	92	73. 7	46	56	53	51.7	10.0	0.713
24-AR-1	34.274 (T)	33	31	28	30.7	490	480	330	433	66	62	54	60.7	44	43	46	44.3	14.1	0.692
23-AC-1	34.274 (T)	36.5	28	46	36.8	270	420	420	370	73	56	92	73.7	46	56	53	51.7	10.0	0.713

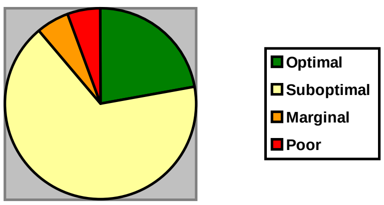
19-COP-1	34.1	76	68	88.5	77.5	1150	1000	970	1040	152	136	179	156	275	261	245	260	13.4	0.298
23a-AC-1	33.56 (T)	67	73	29	56.3	395	350	400	382	134	146	58	113	73	83.5	78.5	78.3	6.78	0.720
32-WK-1	32.77 (T)	43.5	49	51	47.8	770	390	290	483	87	98	102	95.7	119	113	105	112	10.1	0.426
40-ND-1	32.04	35	33	45	37.7	800	560	560	640	70	66	90	75.3	81	52	72	68.3	17.0	0.551
44-PHM-1	31.44	59.5	68	62	63.2	955	760	470	728	119	136	124	126	68	98	78	81.3	11.5	0.777
DEP 18.6	29.93																		

Appendix D. Overall condition charts summarizing the breakdown of assessment variables scores for each site.

Site id



1-FS-1



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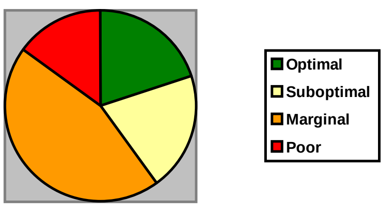

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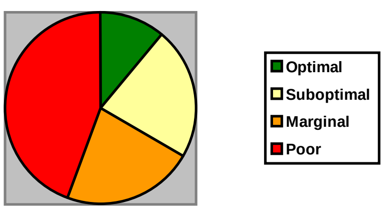
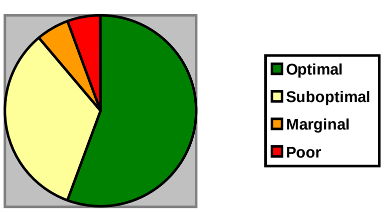
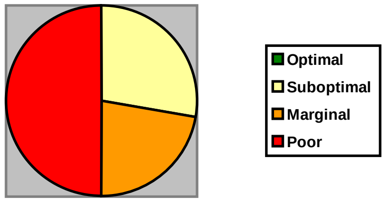


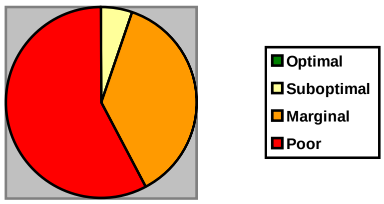
4CF



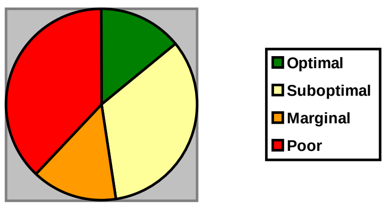
6c-GP-1



7-O-1



SWR 23



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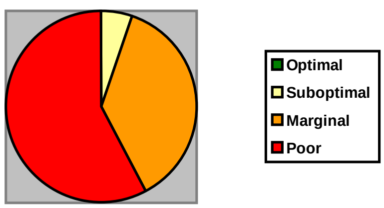

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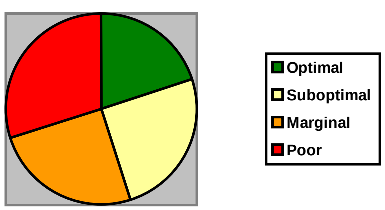

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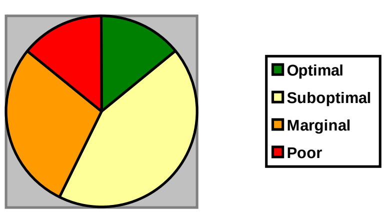
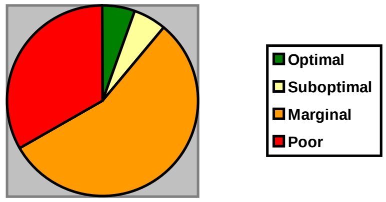


DEP
21.1



14-SCE-
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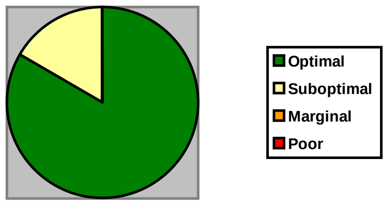
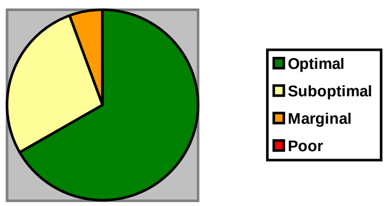
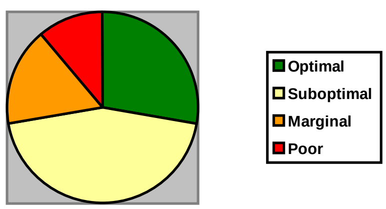


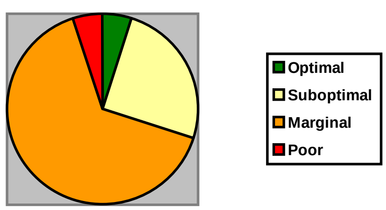
24-AR-1



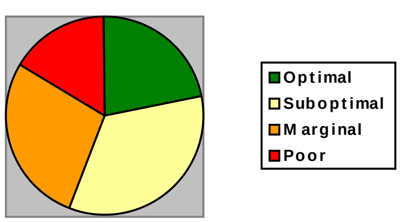
23-AC-1



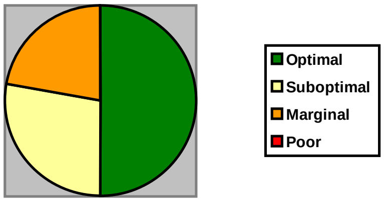
19-
COP-1



20.5-
HT-1



20.5-
HT-2



23a-AC-
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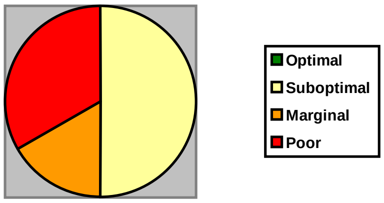

32-WK-
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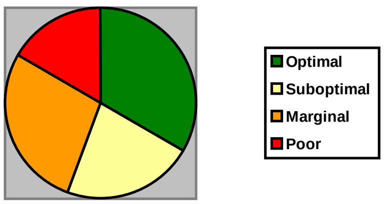

40-ND-
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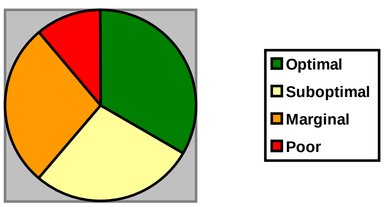
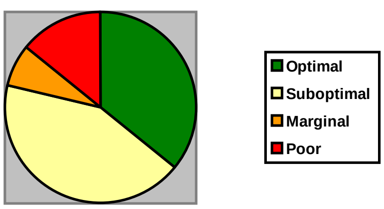
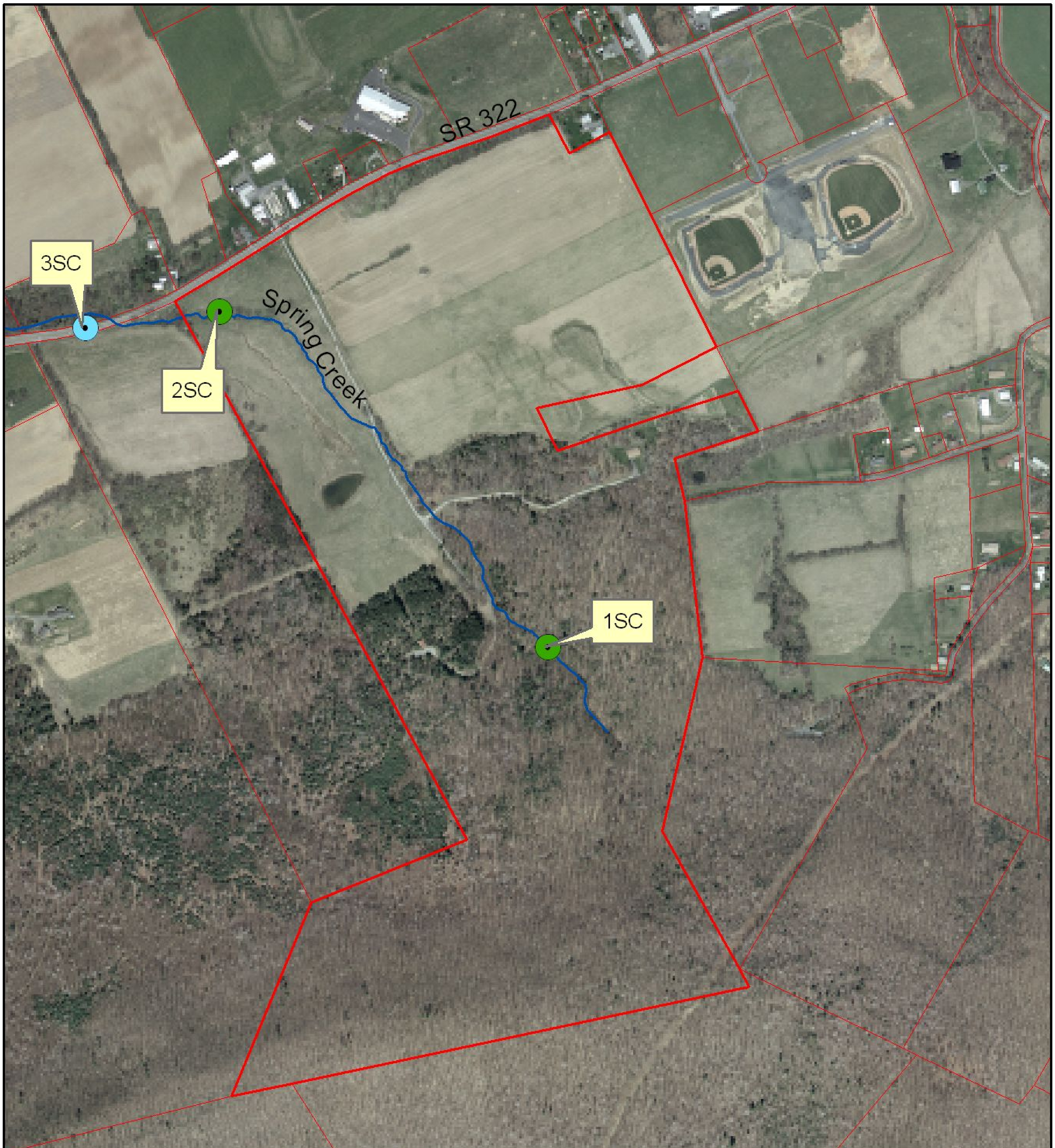


44-
PHM-1



DEP
18.6

Appendix E. Individual property maps showing the location of each assessment site.



Upper Spring Creek Watershed Assessment

Land Owner: Fred Strouse

Tax I.D. # = 20-008-005-0000

Number of Acres = 220.57

ClearWater assessment site

PSU CWC assessment site

North

0 100 200 400

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner= Kathy Confer
Tax I.D. # = 20-008-002A 0000
Number of Acres = 7.45
Approximate linear meters of stream = 470

PSU CWC assessment site

NOTE: GIS error caused the incorrect placement of this assessment site. The actual location is on Spring Creek on the Confer property.

North

0 20 40 80
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Franklin Chow
Tax I.D. # = 20-008-001-0000
Number of Acres = 158
Approx. linear meters of Stream = 735

ClearWater assessment site
PSU CWC assessment sites

North

0 75 150 300
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owners = Paul & Mayme Gigl

Tax I.D. # = 25-005-034-0000

Number of Acres = 14.65

Approximate linear meters of stream = 285

ClearWater assessment point

North

0 50 100 200

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = E.J. and Rebecca Oelbermann
Tax I.D. # = 25-005-015-0000
Number of Acres = 195
Approximate linear meters of stream = 1120

Floodplane

ClearWater assessment sites

North

0 100 200 400
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner - Galen Dreibelbis
Tax I.D. # = 25-005-001-0000
Number of Acres = 285
Approximate Linear meters of stream = 4,100

PSU CWC assessment sites

North

0 80 160 240 320 400
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Tag Land Inc

Tax I.D. # = 25-412-200-0000

Number of Acres = 28.97

Approximate Linear meters of stream = 1,035

ClearWater assessment sites

PSU CWC assessment sites

North

0 40 80 120 160 200

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = State College Elks Inc.
Tax I.D. # = 25-408-035-0000
Number of Acres = 146.2
Approximate linear meters of stream = 675

Floodplain

ClearWater assessment sites

PSU CWC assessment sites

North

0 110 220 440
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Harris Township
Tax I.D. # = 25-004A-200-0000
Number of Acres = 17.95
Approximate linear meters of stream = 735

Floodplain
DEP assessment sites
ClearWater assessment sites

North

0 50 100 200
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Randolph G. Aikens

Tax I.D. # = 24-004-055R-0000

Number of Acres = 192.21

Approximate linear meters of stream = 565

Floodplain

ClearWater assessment sites

North

0 75 150 300

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = PennDOT

Tax I.D. # = 25-004-005C-0000

Number of Acres = 6.43

Approximate linear meters of stream = 146

Floodplain

ClearWater assessment sites

North

0 30 60

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Charles Aikens
Tax I.D. # = 25-004-055M-0000
Number of Acres = 50.1
Approximate linear meters of stream = 1000

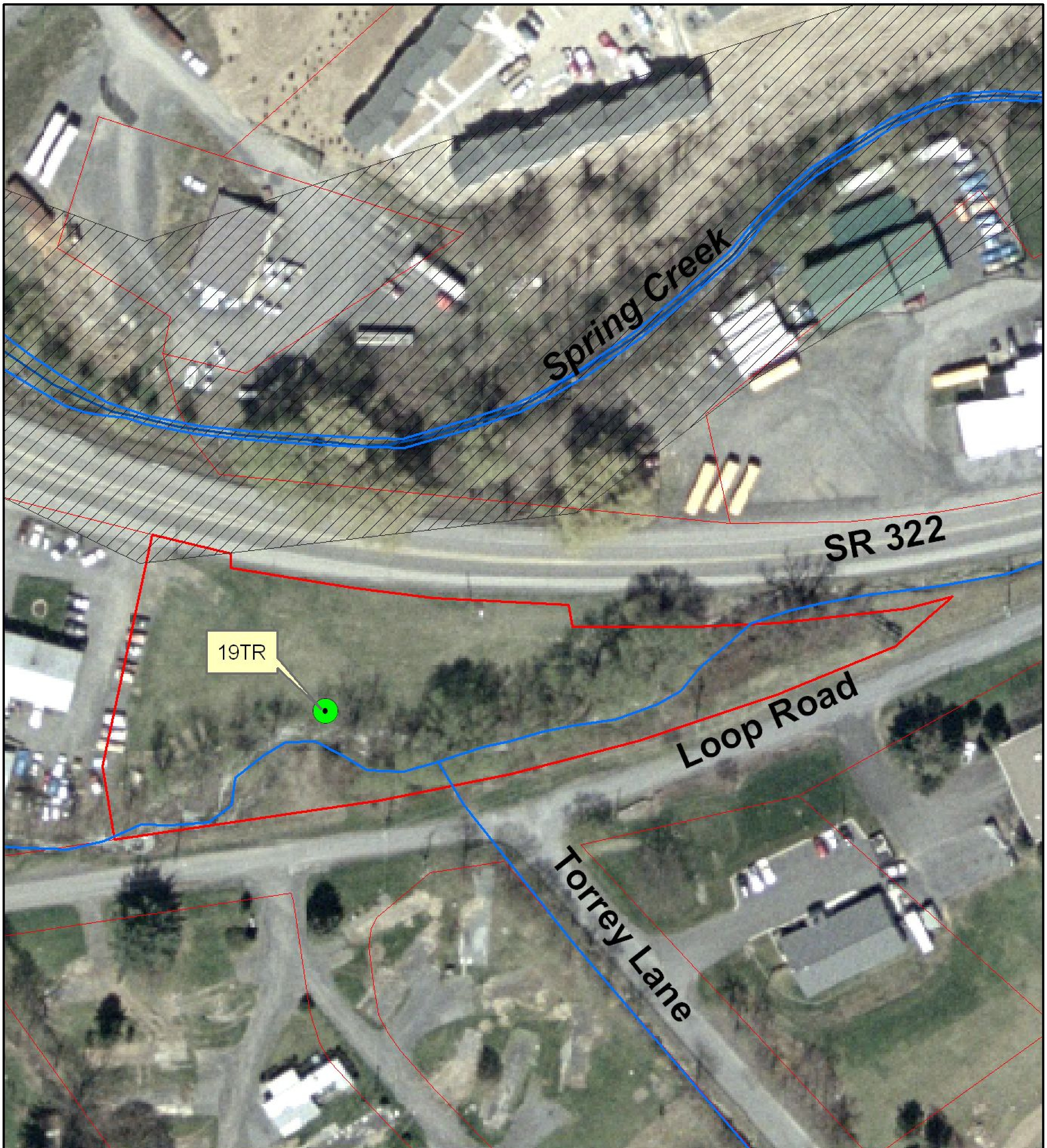
Floodplain
ClearWater assessment site

North

0 65 130 260
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909



Upper Spring Creek Watershed Assessment

Land Owner = Jill and Aaron Teel

Tax I.D. # = 25-012-184-0000

Number of Acres = 1.36

Approximate Linear meters of stream = 150

floodplain

ClearWater assessment sites

North

0 30 60

Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = Randy Bachman
Tax I.D. # = 25-010-034A-0000
Number of Acres = 7.71
Approximate linear meters of stream = 290

Floodplain

ClearWater assessment site

North

0 20 40 80
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner = PA Military Museum
Tax I.D. # = 25-004-001-0000
Number of Acres = 55.05
Approximate linear meters of stream = 750

ClearWater assessment site

Floodplain

North

0 37.5 75 150
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909

Upper Spring Creek Watershed Assessment

Land Owner - Joseph and Linda Westrick
Tax I.D. # = 19-006A-001-0000
Number of Acres = 1.21
Approximate Linear meters of stream = 50

PA DEP assessment sites

North

0 5 10 20 30 40 50
Meters

Aerial Photo: 2001

ClearWater Conservancy
2555 North Atherton Street
State College, Pennsylvania 16803
(814) 237-0400 Fax (814) 237-4909